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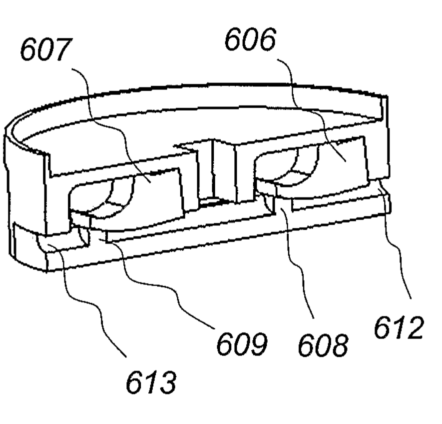
(54) **Title:** PUMP FOR FLUID DISPENSERS



(57) Abstract: The invention herein relates to pumps and valving arrangements for fluid dispensers. The pumps herein comprise a dose chamber, a resilient actuator, valves for controlling the flow of fluid into and out of the dose chamber and the upper and lower pump halves each formed from unitary mouldings, at least the upper pump half comprising a semirigid, thermoplastic material. The pumps are easily made via injection moulding from a small number of parts. Combination of the pump with a fluid reservoir provides a fluid dispenser which may further comprise an atomiser for forming a spray as fluid is ejected from a dispenser outlet. Methods of making the pump and valving arrangements are also provided by the invention.

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PUMP FOR FLUID DISPENSERS

FIELD OF THE INVENTION

The present invention relates to a pump which can be easily made and assembled from a small number of moulded parts, particularly from injection moulded parts. The invention further relates to a dispenser comprising the pump and to valving arrangements for pumps and dispensers. The pump and device are useful for dispensing fluids such as medicines, including nasal and throat sprays, perfumes, cosmetics, cleaning products and the like.

BACKGROUND OF THE INVENTION

The delivery of substances from a dispenser, particularly in carefully controlled amounts, generally requires a pump of some sort typically with one or more valves associated with it. The provision of such pumps not only adds to the cost and complexity of manufacturing dispensers, since typical pumps comprise many separate parts, but can also restrict their overall design. Efforts have been made to reduce the complexity of pumps. WO 98/08661 discloses a readily manufactured pump having a small number of stackable parts. However, it still requires four parts which need to be separately manufactured and assembled. WO 02/16047 discloses another simple diaphragm pump, incorporated into the inside of a dispensing flexible reservoir; it too comprises four parts.

US 6,460,781, US 2003/0071071, US 2002/0190081 and WO 00/06464 all describe simple product dispensers, suitable as sampling devices which comprise a reservoir and a resilient means which is deformable in order to produce a pumping action from the reservoir.

US 5,492,252, EP 641 722 and EP 442 858 each describe dispensers incorporating pumps which utilise a resilient actuator as an insert into a pre-moulded pump chamber comprising an inlet port.

Despite all the foregoing there remains a need for further improvements in product dispensers to enable simple, low cost manufacture of product dispensers incorporating pumps, in particular those which are capable of reliably delivering repeated controlled product doses. A related problem is that of enabling a simple method of modular construction of dispensers whereby differently functioning pumps, e.g. delivering different size doses, can be fitted to a common dispenser, enabling a flexible method of adapting a production line to provide different products.

A pump of simple construction has now been developed which can be manufactured from as few as two separate parts and, in particular, each part can be formed by mass production techniques such as injection moulding, compression moulding or thermoforming. The pump can be employed as a separate part in a more complex dispenser or indeed can be integrally moulded into a simple dispenser. The construction of the pump provides for much greater design freedom in the way that the pump is employed in dispensers and, as a result, in the dispenser design.

SUMMARY OF THE INVENTION

The invention herein relates to pumps and valving arrangements for fluid dispensers. The invention further relates to dispensers incorporating a pump. The pumps herein comprise a dose chamber, a resilient actuator and valves for controlling the flow of fluid into and out of the dose chamber. Combination of the pump with a fluid reservoir provides a fluid dispenser which may further comprise an atomiser for forming a spray as fluid is ejected from a dispenser outlet.

In accordance with a first aspect of this invention there is provided a pump for a fluid dispenser comprising:

a) an upper pump half comprising an upper inlet port wall and an upper outlet port wall;

b) a lower pump half engaging with the upper pump half and comprising a lower inlet port wall and a lower outlet port wall, wherein the upper inlet port wall engages with the lower inlet port wall to define a pump inlet port permitting fluid communication from a fluid source into the pump and the upper outlet port wall engages with the lower outlet port wall to define a pump outlet port permitting fluid flow out of the pump;

c) a resilient actuator connected to the upper pump half,

d) inlet and outlet valves associated with the pump inlet and outlet ports for controlling fluid flow through them; and

e) a dose chamber, at least partially bounded by the resilient actuator, for containing a single dose prior to delivery from the dispenser

whereby depression of the resilient actuator is effective to dispense the dose of fluid through the pump outlet port, and wherein the upper and lower pump halves are formed from unitary mouldings and at least the upper pump half comprises a semirigid, thermoplastic material.

In accordance with a second aspect of this invention there is provided a method of making a pump for a fluid dispenser, the pump comprising an upper pump half comprising a semirigid, thermoplastic material, a lower pump half, a dose chamber, a resilient actuator, a pump inlet port, a pump outlet port, an inlet valve and an outlet valve, the method comprising the steps of:

a) forming the upper pump half in a unitary moulding comprising the resilient actuator, an upper inlet port wall and an upper outlet port wall;

b) forming the lower pump half in a unitary moulding comprising a lower inlet port wall, a lower outlet port wall and a lower dose chamber wall ; and

c) fixing the upper pump half onto the lower pump half such that the resilient actuator and the lower dose chamber wall bound the dose chamber, the upper inlet port wall engages with the lower inlet port wall to define a pump inlet port permitting fluid communication from a fluid source into the pump and the upper outlet port wall engages with the lower outlet port wall to define a pump outlet port permitting fluid flow out of the pump.

In accordance with a third aspect of this invention there is provided a method of making a pump for a fluid dispenser, the pump comprising an upper pump half comprising a semirigid, thermoplastic material, a lower pump half, a dose chamber, a resilient actuator, a pump inlet port, a pump outlet port, an inlet valve and an outlet valve, the method comprising the steps of:

a) forming the upper pump half in a unitary moulding comprising an upper inlet port wall and an upper outlet port wall;

b) forming the lower pump half in a unitary moulding comprising a lower inlet port wall and a lower outlet port wall;

c) fixing the upper pump half onto the lower pump half such that the upper inlet port wall engages with the lower inlet port wall to define a pump inlet port permitting fluid communication from a fluid source into the pump and the upper outlet port wall engages with the lower outlet port wall to define a pump outlet port permitting fluid flow out of the pump; and

d) attaching a resilient actuator to the upper pump half so that the resilient actuator bounds the dose chamber.

In accordance with a fourth aspect of this invention there is provided a valve module for a pump for a fluid dispenser comprising:

a) an upper pump half including an upper inlet port wall, an upper outlet port wall and a flow channel providing fluid communication between upper and lower surfaces of the upper pump half;

b) a lower pump half engaging with the upper pump half and including a lower inlet port wall, a lower outlet port wall and a lower dose chamber wall wherein the upper inlet port wall engages with the lower inlet port wall to define a pump inlet port permitting fluid communication from a fluid source into the pump and the upper outlet port wall engages with the lower outlet port wall to define a pump outlet port permitting fluid flow out of the pump; and

c) inlet and outlet valves for controlling fluid flow through the pump inlet and outlet ports;

wherein the valve module comprises an alignment means selected from positioning lugs, indents, a non-circular external wall section and combinations thereof to enable the valve module to be received in a dispenser in a fixed orientation.

In accordance with a fifth aspect of this invention there is provided a valving arrangement, suitable for use in a pump dispenser, comprising a flow channel having semirigid upper and lower walls, a fluid inlet through which fluid enters the arrangement from a fluid supply and a fluid outlet through which the fluid exits the valving arrangement, the flow channel further comprising inlet and outlet elastomeric, flap valves, mounted inside the flow channel, each valve having a surface immovably fixed to the upper flow channel wall and a flap sealingly compressed against the lower flow channel wall, whereby each valve prevents flow of fluid along the flow channel until a positive fluid pressure differential on an upstream side of the flap of the valve causes the flap to lift thereby allowing fluid to flow past the valve, the valves permitting fluid flow in the same direction along the flow channel whereby an increase in fluid pressure in a section of flow channel between the two valves causes the outlet valve to open and the inlet valve to remain closed and a reduction in fluid pressure in the section of flow channel between the two valves causes the inlet valve to open and the outlet valve to remain closed.

In preferred embodiments of the invention the pump is incorporated into a dispenser further comprising a fluid reservoir in fluid communication with the pump inlet port. Preferably the reservoir is co-moulded with the pump.

The resilient actuator of the pumps preferably has a threshold force for actuation which facilitates consistent unit dosing. The pumps, valving arrangements, dispensers and actuators herein are amenable to a modular approach to construction which provides substantial flexibility in a mass manufacturing environment.

DETAILED DESCRIPTION OF THE INVENTION

The invention will now be described in more detail with reference to component parts of the pumps, valve modules and dispensers herein, first in general terms and then with reference to specific embodiments.

Definitions

The pumps and dispensers comprise upper and lower halves. The terms “half” and “halves” herein are intended only to indicate corresponding parts and are not intended to imply any equality in size, construction or function. The terms “upper” and “lower” in respect of the pump or dispenser are used only to distinguish the two halves and are not intended to imply any particular orientation of the parts in use.

As used herein a "semirigid" refers to a material having a flexural modulus of at least about 300, preferably at least about 500 MPa, measured using ASTM D790. Pump and dispenser parts herein made from a semirigid material are generally moulded with sufficient wall thicknesses that they are self-supporting, by which is meant that they will not substantially bend under their own weight. However, certain embodiments of reservoirs herein, such as flexible sachets, are non-self supporting structures through being made of thin laminates, even though the laminates may comprise semirigid materials.

By a "unitary moulding" is meant a moulding formed in a single piece or completely formed within a single mould. It may comprise only one material but the term "unitary moulding" also comprises workpieces formed from two or more materials in a common moulding operation such as a two-shot injection moulding where different materials are co-injected or sequentially injected into a common mould.

A "fluid" herein refers to a flowable liquid or gel.

"Monostable" as used herein in respect of an actuator or an element thereof means having a force-deflection curve including a priming region wherein the force initially increases for increasing deflection, in the manner of, say, a conventional spring, and then at some threshold force there is at least one inflection point such that further deflection of the element occurs with a reduction in the applied force. Such a curve is shown in Figure 26. Preferably the initial priming region deflection is kept as small as possible.

"Bi-stable", in respect of an actuator or an element thereof, refers to an actuator or an element thereof that behaves like a monostable actuator or element until the defined force threshhold is overcome but then "flips" to stay permanently in a depressed position.

<u>Dose Chamber</u>

The pumps according to the invention comprise a dose chamber. The dose chamber is formed by the co-operation of the upper and lower pump halves when the pump is assembled. The dose chamber holds a single dose of the fluid to be dispensed which, in preferred embodiments, can be replenished from a reservoir in fluid communication with the dose chamber. The dose chamber is in fluid communication with a pump inlet port, through which fluid can be received from the reservoir, and a pump outlet port from which fluid can be dispensed. In certain embodiments illustrated herein the pump inlet and outlet ports are at opposite sides of the dose chamber and for many applications this will be the most appropriate geometry however the invention is not so limited. The inlet and outlet ports can be adjacent to each other or placed in any other position relative to each other and the dose chamber provided they perform their intended function of permitting fluid flow into and out of the dose chamber. Fluid flow into and out of the dose chamber is controlled by inlet and outlet valves described in more detail below. The pumps further comprise a resilient actuator, also described further below whose actuation results in the dispensing of a dose of fluid from the dose chamber. The volume of the dose dispensed by the pump will generally be less than the pump volume since actuation of the pump via the resilient actuator will generally not result in all of the fluid contained within the pump being dispensed. Dose volumes herein may vary from a few microlitres to several millilitres depending upon the pump dimensions and construction. The dose volume is preferably a metered dose substantially pre-determined by the dimensions of the dose chamber. Means for achieving this, comprising restricting a user's ability to modify the dose volume are described further below in the section on resilient actuators.

Before first use the dose chamber may require priming with the fluid to be dispensed. The greater the ratio of the pump volume to the dose volume the greater the number of priming strokes needed to replace air inside the unprimed pump with fluid drawn from a reservoir. The preferred number of priming strokes is three or fewer.

In a preferred aspect of the invention the dose chamber has a lower wall which creates an endpoint for the deflection of the resilient actuator and stops its movement when the actuator abuts it. Changing the distance between the actuator in its resting position and the lower dose chamber wall can provide a method for fine adjustment of the dose volume of the pump, thereby at least partially defining a metered dose. This is advantageous in a commercial production environment when different dose volumes need to be produced in a cost effective way. Of course, the dose volume can also be adjusted by changing other parameters such as the actuator shape and size.

Resilient actuator

An important feature of the pump herein is the actuator. The actuator is preferably resilient. It can be a separately manufactured piece fitted to the upper pump half but is preferably an integral, resilient wall section of the upper pump half bounding the dose chamber. Resilience is provided by selection of the material from which the actuator is made and by control over its thickness and shape. Suitable materials for the actuator are thermoplastic elastomers, silicones, rubbers or soft grades of polyolefins (e.g. polyethylene or polypropylene). A suitable thickness for the actuator when manufactured from the same semi-rigid material as the pump body is from about 0.1 to 0.8 mm, preferably from about 0.3 to 0.7 mm, more preferably from about 0.4 to 0.6 mm. In an alternative embodiment, resilience may be provided by a two component system whereby a spring or other resilient apparatus is placed immediately beneath the actuating wall to return it to its unpressed position following actuation.

The actuator is depressed by a user in order to decrease the volume of the dose chamber and thus dispense a dose of fluid from the pump. For a resilient actuator, when the depressing force is removed, its resilience causes the actuator to spring back to its original shape causing a pressure reduction in the dose chamber to draw fluid into the dose chamber from a reservoir.

The design of the actuator influences the dose size and accuracy of the overall system. For many applications the precise requirement for the delivered dose is not so critical and dose tolerances of +/- 20% are acceptable. Simple resilient actuators in form of buttons are well known in the art. The actuator can be integrally moulded with the upper pump half (in a manner similar to the gas bellows shown in US patent application 2002/074359), co-moulded, overmoulded, or moulded separately and assembled via a mechanical snap or friction fit, such as in the pump of WO 98/08661, or attached via a welding operation.

Simple actuators can have the disadvantage that the user can choose the force applied whilst dispensing a fluid, which can lead to a big variation in dose quantity and quality. The relationship between the applied force and the degree of deflection of the actuator may approximate to linear, or at least require continuously increasing force for ever greater deflections. If a user only presses gently then the dispensed volume and pressure of the fluid may be suboptimal, resulting, for example, in incomplete or variable dosing, an undesirable spray pattern or poor particle size distribution. Although this may be acceptable for certain applications or products, applications in the area of medical devices typically require more rigorous dose tolerances, especially when delivering active pharmaceutical ingredients. In order to overcome this particular disadvantage the actuator herein preferably includes monostable or bi-stable elements. These elements are characterised in that they do not have a linear force-deflection relationship. The use of monostable or bi-stable elements in an actuator for a delivery system provides added control to a user's operation of the device.

The use of monostable elements in form of buttons or snap-domes is known in the electronics industry in form of input devices (keypads for mobile phones, calculators, etc) and circuit board switches. Snaptron Inc. of Loveland, Colorado 80537, USA distributes metal snap domes in various sizes and geometries. Monostable elements, in the form of "snap-domes" are known, for example, in switches from e.g., US patent nos. 4,933,522; and 5,510,584. The principle has also been disclosed for use in a sample type spray dispenser in US 6,460,781. WO 02/016796, assigned to Valois SA, describes a two-leaved spring which acts a monostable element and can be used inside a dispensing reservoir. A further elaboration on this type of actuating element is described in US 6,271,487 which discloses a switch having tactile feedback and three states of switching. Monostable elements are also used in the toy industry. Monostable elements as used herein can be separate elements, such as a snap dome located underneath the resilient actuator or they can be an integral feature of the actuator formed by appropriate construction of the actuator wall as disclosed in US 6,460,781.

For monostable elements in an actuator the typical force-deflection curve is like that shown in Figure 26. Initial deflection requires a continuously increasing force. If only a low force is applied by a user's finger to an actuator fitted to a pump primed with fluid, there will typically be no delivery of fluid at all since the force applied generates insufficient pressure in the fluid to open the outlet valve of the pump. The actuator has a threshold point though at which further deflection of the element occurs with a reduction in the applied force, this threshold point should be a little greater than that required to create sufficient fluid pressure to open the outlet valve. The practical effect of this is that the momentum of the user's finger depression results in a rapidly increasing deflection making it difficult to prevent full actuation once the pre-defined threshold point has been passed. The result is a much smaller variation in the dispensed amount of fluid and better control over any associated spray pattern. This process of passing the threshold point is preferably accompanied by an audible 'click' or tactile feedback to signal correct operation of the element to the user. Preferably, past the threshold point the deflection D (axis graduated in mm) increases by at least 50% even though the force F (axis graduated in Newtons) is reduced by at least 10%, more preferably the deflection increases by at least 75% even though the force is reduced by at least 25%. Preferably the slope of the curve from the origin to the first threshold point is at least 5 Nmm^{-1}, more preferably at least 10 Nmm^{-1}.

In a separate aspect of this invention there is provided an actuator for use with a dispensing pump, the actuator comprising a shaped, preferably disc-like, plate comprising an outer flange lying in a first plane and a central resiliently deflectable dome, the dome comprising an apex and at least one annular trough whereby, when the actuator is fixed at its outer flange, the actuator has, for forces applied perpendicularly to the first plane, a force-deflection curve that includes a priming region wherein the force initially increases for increasing deflection of the dome, and at least one inflection point such that further deflection of the dome occurs with a reduction in the applied force.

Typically, at some point past the threshold point on the force-deflection curve of the actuator, the applied force required to achieve further deflection increases again, usually as some material limit of the actuator is reached. A predefined endpoint for the deflection may also be achieved due to the actuator abutting some stopping element, in which case of course the applied force will increase very rapidly for slight or no further deflection. The deflection endpoint may be defined by the physical dimensions of the actuator or a further stop element can be introduced, such as the lower dose chamber wall.

For resilient actuators, when the applied force is removed then the actuator returns to its original undeflected starting point. Bi-stable actuators which stay in a permanently depressed position are not resilient as intended herein. Although this type of actuator is not suitable for repeated dosing, if several are used in one dispensing package it can have advantages for controlled dosing regimens. In a further aspect of the invention herein there is provided a reservoir containing a fluid to be dispensed, the reservoir comprising boundary walls and a fluid outlet, wherein the boundary walls of the reservoir comprise a plurality of bi-stable actuators such that each depression of a bi-stable actuator results in a substantially identical dose of fluid being dispensed from the fluid outlet. A preferred bi-stable actuator will present a convex dome to the exterior of the reservoir and, when depressed past its threshold, will permanently deform to present a concave depression to the exterior of the reservoir. The preferred embodiment of this further aspect of the invention comprises a reservoir having a plurality of externally convex deformable bi-stable actuators arranged in a regular array on one face of the reservoir, to give the appearance of a blister pack.

Valves and valving arrangements

Further important features of the pumps herein are inlet and outlet valves. The inlet valve is associated with the pump inlet port for controlling fluid flow through the inlet port and the outlet valve is associated with the pump outlet port for controlling fluid flow through the inlet port. By 'associated with' is meant that each valve is located in the respective port or in a flow channel directly connected to the port. If not located in the port then the valve can be upstream or downstream of the port provided it is able to perform its intended function of controlling fluid flow through the port. It is highly preferred that both the inlet and outlet valves are of the non-return type, allowing movement of fluid in one direction along a conduit or flow channel but preventing the flow of fluid in the reverse direction. Suitable valves include flap valves, duckbill valves, ball valves and slit valves. Flap valves are preferred for ease of in-situ moulding. In preferred embodiments the inlet and outlet valves are made from an elastomeric material having a Shore A hardness of from about 5 to about 90, more preferably from about 20 to about 70. Suitable elastomeric materials include thermoplastic elastomers and silicones and rubbers. The flap and slit valves can be various shapes such as rectangular or triangular or more complex shapes as described in more detail below. The valves can be co-injected, overmoulded, insert moulded as an extra part or separately assembled such as by welding, interference fitting or snap fitting. In an alternate embodiment the inlet and outlet valves are integrally moulded with either the upper or lower pump half from the same semirigid, thermoplastic material as the pump half with which they are integrally moulded. In a further alternate embodiment the inlet and outlet valves may be injection moulded as a single piece with a bridge of material connecting the two. This may enable separate manufacture and ease of installation into the pump body, and predetermined directional arrangement.

A preferred valve arrangement comprises an elastomeric valve mounted inside a flow channel, the valve comprising an upper surface, the upper surface being immovably fixed, preferably by injection moulding, to an upper flow channel wall, the valve further comprising a flap having a lower surface which is sealingly compressed against a lower flow channel wall in the absence of a differential in fluid pressure across the valve flap, wherein an increase in fluid pressure on against the lower surface of the flap lifts the flap from the lower flow channel wall and permits fluid to flow past the valve. In the embodiments herein it is preferred that the one of the upper or lower pump halves comprises the upper flow channel wall of the valve arrangement and the other of the upper or lower pump halves comprises the lower flow channel wall against which the lower surface of the valve flap is sealingly compressed. The lower surface of the valve flap is generally coplanar with the lower flow channel wall and the valve flap is oriented in the direction of fluid flow along the flow channel. If back pressure in the fluid should urge it to flow in the reverse direction, the fluid presses against an upper surface of the valve flap, sealingly compressing the flap against the lower flow channel wall and thereby increasing resistance to reverse fluid flow. By varying the profile of the valve flap and/or by design of the upper and lower pump halves a desired threshold pressure for valve actuation can be set. Only when the pressure differential across the valve exceeds the threshold pressure is the valve opened. A normally closed valve system is beneficial, as it ensures that the pump only has to be primed once and it reduces the risk of contamination from outside. Preferably the threshold pressure for the valve is such that the outlet valve opens when the force applied to the resilient actuator is in the range from about 70% to about 100%, preferably from about 90% to about 100%, of the threshold actuation force for the resilient actuator.

In a particularly preferred valve arrangement the flow channel is restricted at the point where fluid flowing along it would first encounter the valve and the valve comprises a foot portion which is permanently compressed against the lower flow channel wall such that the only fluid passage past it is along a groove in the lower flow channel wall, the groove being flanked by side walls. The groove is bridged by a sealing ridge rising to the height of the side walls and the valve flap sits across the sealing ridge and the side walls preventing fluid flow until the fluid pressure rises sufficiently to lift the valve flap away from the sealing ridge and the adjacent side walls. More particularly two such valve arrangements are preferably used in tandem with the valves in each arrangement being separated from each other and a dose chamber being arranged on a fluid flow path intermediate the two valves such that the valves act as inlet and outlet valves for the dose chamber.

The pump herein without its resilient actuator can be used as a valve module and is useful in its own right since it can be combined with differently sized or shaped actuators to provide pumps with different characteristics, such as different dose volumes. The pumps and valving modules herein can of course be designed so that the valves are fixed to either the upper or lower pump halves.

Atomiser

In certain embodiments herein the pump or dispenser includes an atomiser associated with an outlet flow channel to break up dispensed fluid into a spray. The outlet flow channel can be formed from upper and lower outlet flow channel halves which are preferably integrally moulded with the upper and lower pump halves.

US 6,059,150 illustrates a typical atomiser for a nasal spray application using a hollow nozzle adaptor which includes a spray orifice incorporating a swirl chamber geometry.

Alternatively, atomisers are known wherein a cup shaped component, including a spray orifice and swirl chamber geometry, is separately assembled to a nozzle adaptor, an example of such a component is the nozzle cap disclosed in US 5,738,282.

These types of atomisers are typically separate units to the pump and subsequently need assembly to a pump unit. This is typically done via mechanical connection, such as a friction or snap fit and requires precise moulding and assembly effort to achieve a fluid tight seal. This necessarily imposes some limitations on the overall design of the delivery system.

A solution for a much more versatile atomiser design is disclosed in WO 01/89958 where the atomiser for an aerosol spray device is formed by two halves of a simple injection moulded component with tailor made geometry to allow atomisation of a particular fluid. Such an approach allows a greater design freedom for a spray delivery device and offers greater means of controlling the spray characteristics for a wide range of products by shaping the flow channel geometry in a suitable way.

A plain dispensing orifice is sufficient for highly viscous fluids that cannot be broken up into small particles to form a spray. The orifice can be formed entirely within either of the upper or lower outlet flow channel halves or from a combination of part mouldings in both halves. Where a circular orifice is required then this can be done by moulding a semicircular channel in each of the upper or lower outlet flow channel halves. Due to the small dimensions and tolerances it can be difficult to exactly match the edges of top and bottom half. In order to eliminate this particular issue the orifice can be formed with one side being flat, therefore small variations in assembly positioning will not matter. This principle is illustrated in WO 01/32317. A dispensing orifice can also be formed entirely within either of the upper and lower outlet flow channel halves.

The dispensing orifice can also comprise a movable plug to seal the orifice when it is not in use. This can help avoid clogging of the orifice and also provides better protection from contaminants for fluid remaining in the dispenser. WO 03/078073 discloses an arrangement whereby a plugging element is movable between a sealing and non-sealing position upon operation of the device without other intervention by the user.

Reservoir

The purpose of the pump is to enable dispensing of a fluid from a fluid source or reservoir. The fluid can be any that is compatible with components of the pump and that is not too viscous to be pumped including, without limitation, cosmetic products such as perfumes and lotions; medicines; veterinary products, liquid foods or sauces and other household products such as cleaning fluids. The pump can be permanently or detachably connected to a reservoir and, optionally, an atomising nozzle or applicator, to form a complete dispenser and/or it can form part of a more complex product comprising other parts such as a housing and a handle. An atomising nozzle is preferred for certain medicinal applications, such as nasal or throat treatment. An applicator suitable for spreading the fluid onto a substrate may be preferred for other treatments. Useful applicators comprise spreading means selected from brush heads, elastomeric wiping blades and disposable cloths. The pump can be directly connected to a reservoir or connection can be made, for example by means of intermediate tubing if it is desirable for the pump and reservoir to be remote from each other. Provision for permanent attachment to a reservoir can be made, for example by co-moulding a weld spout with the pump inlet port so that the pump can be sealed in a fluid tight manner to a flexible sachet.

The pumps provided herein can be manufactured at low cost and are economically suited to applications where a pump is provided with each reservoir. In this case, the reservoir and pump are preferably permanently connected via a heat-sealing, welding, in-mould or snap fit operation. There are applications though, in particular where the pump is associated with a more complex device, where it can be beneficial for the reservoir to be detachably connected to the pump such that replacement reservoirs can be fitted to the same pump. Though a detachable connection avoids throwing away the pump if the reservoir must be replaced, it introduces further complexity in order to provide a reliable, fluid tight, re-usable connection. However, suitable fitments for this purpose are known in the art. Exemplary fitments are disclosed in WO 99/05446, WO 00/66448 and WO 03/095322.

The reservoir itself can be semirigid or flexible. If it is semirigid then it may be necessary to provide means for venting the reservoir, for example by means of a one-way valve allowing air ingress, in order to avoid the development of a vacuum in the reservoir which could inhibit further dispensing or cause suck-back past the pump outlet valve requiring the pump to be re-primed. The venting means can also comprise a narrow mesh filter that prevents fluid passing through it and escaping to the external environment. For example a biofilter that filters out bacteria, spores and the like from the in-drawn air, thus enabling the fluid in the reservoir to be preservative free. A biofilter capable of maintaining a sterile filtration barrier can be made from GORE-TEX® expanded PTFE laminate, available from W. L. Gore & Associates, Inc. of Newark, Delaware, USA. In preferred embodiments of a dispenser herein the pump is combined with a reservoir in the form of a flexible sachet containing a fluid, the sachet collapsing as fluid is withdrawn from it by the pump. A reservoir made of a flexible laminate offers the benefit of improved barrier properties. Flexible reservoirs are preferably charged with fluid via an airless filling operation so that the charged reservoir contains no air.

In many cases it will be convenient and simpler to manufacture the pump as an external fitment to the reservoir. However, where total space is a problem then the reservoir can be built around the pump so that the pump is internal to, or contained within, the reservoir, by which is meant that walls of the reservoir substantially enclose the pump even though parts of the pump, such as, in particular its actuator and a lower pump surface opposed to the actuator may be contiguous with upper and lower outside walls of the reservoir. Preferred embodiments herein include a dispenser comprising a reservoir with an integral pump contained within the reservoir. Alternately the pump can be contained within a flexible sachet so that the actuator of the pump can be actuated by pressing against that portion of the sachet wall which overlies the actuator, as shown for example in the device of WO 02/16047. Preferably, in embodiments with the pump contained within the reservoir, the pump upper and lower halves are integrally moulded with upper and lower halves of the reservoir.

Whether the reservoir is semirigid or flexible it may be preferable to include a dip tube inside the reservoir to assist the removal of all of the fluid in the reservoir in certain orientations dependent upon the orientation of the dispenser when in use. A dip tube will generally be used when the reservoir is semirigid and can also be useful in a flexible sachet. The method of construction of pumps, reservoirs and dispensers herein, from upper and lower moulded halves, can also be applied to the construction of dispensing devices and reservoirs with dip tubes, even if a pump is not incorporated. Thus in a further inventive aspect herein there is provided a dispensing device comprising upper and lower halves, the upper and lower halves co-operating to form a fluid reservoir and a dispensing outlet at a first end of the reservoir characterized in that the upper and lower halves each comprise sections of an integrally moulded channel, the sections co-operating to form a dip tube, or flow channel, in fluid communication with the dispensing outlet and terminating at an inlet end close to a second end of the reservoir remote from the first. The dip tube preferably has a length from the dispensing outlet end to its inlet end of at least 90%, preferably at least 95% of the length of the reservoir. In a preferred embodiment of this dispensing device at least one of its upper and lower halves comprises a resiliently deformable region enabling fluid to be pumped from the reservoir through the dispensing outlet. This resiliently deformable region may comprise a substantial proportion, say at least 30%, more preferably at least 50%, of the external area of the pump half comprising it. Alternatively the deformable region may be relatively small and be in the form of a resilient actuator as herein described, preferably comprising a monostable element. A further mechanism for dispensing fluid from the device comprises providing a plurality of bi-stable actuators, as described further above, such that compression of each actuator delivers a unit dose of the fluid. As for other embodiments herein, this dispensing device can also comprise an atomising nozzle in fluid communication with the dispensing outlet and, if necessary an outlet valve and a vent valve.

Manufacture of the pump

In general the pumps, dispensers, valves, valve modules and actuators herein can be made by low cost making moulding techniques such as injection moulding, compression moulding and thermoforming. Injection moulding is preferred. However, it is also possible for at least one of the upper and lower pump halves to be compression moulded or thermoformed, and the present invention comprises pumps with compression moulded or thermoformed upper and/or lower pump halves comprising valves as herein described. Assembly of the component parts can be by snap or friction fit or by welding. Further sealing, where necessary, can be provided by additional injection moulded seals or by other techniques known in the art, such as ultrasonic sealing, laser welding or heat sealing.

In an embodiment, each of the upper and lower pump or dispenser halves is formed in one single shot injection moulding operation from a suitable, semirigid thermoplastic resin material. Alternatively, the upper and lower pump or dispenser halves may be assembled after moulding. Suitable resins include thermoplastics having a flexural modulus of at least 300, preferably at least 500 MPa, preferably at least 1000 MPa, measured using ASTM D790 and include polypropylene, polyethylene, polyethylene terephthalate (PET), polyesters, polycarbonates, polyamides, polystyrenes and blends thereof. Preferred materials include polypropylene, polyethylene and polyethylene terephthalate, most preferred is polypropylene. By careful choice of dimensions, flap valves can be integrally moulded with the upper or lower pump half in a single shot injection moulding process. Alternately, the valves can be co-moulded from a softer material in a two-shot injection moulding.

In certain embodiments it may be appropriate for all or part of the either the upper of lower pump half to be made of a more flexible material such as a thermoplastic elastomer. For example, an upper pump half may be substantially composed of a semirigid material with its resilient actuator being formed from a thermoplastic elastomer in a two shot injection moulding operation. In particular, the inlet and outlet valves can be and preferably are formed from a second resin material co-moulded with either of the upper and lower pump halves in a two-shot injection moulding operation. Conveniently this can be done within the same mould or tool as that employed for the first step. The second resin material is preferably an elastomeric material having a Shore A hardness, measured using ASTM D2240, of from 5 to 90, preferably from 20 to 70.

The upper pump half and the lower pump half are then assembled onto each other. Where flap valves are used, their compression takes place at this stage. Once the two pump halves are assembled, a sealing element can be formed by injecting an additional resin, bonding the sealing element to the upper and lower halves, thus holding them together and creating a fluid tight seal. An alternative option for sealing the upper and lower half together is the use of a welding operation, such as by high frequency sealing. A third option for assembly of upper and lower halves is to integrate a snap feature into one or both halves which enables the upper and lower halves to maintain the assembled position once brought together. In this case it may be necessary to use an O-ring or gasket to provide adequate sealing. In an alternative embodiment, a co-moulded TPE seal may be used.

Though in the preferred embodiment the preceding steps are all integrated into a single injection moulding process using one injection moulding tool, it will be appreciated that each be performed on separate, dedicated injection moulding tools.

If the resilient actuator has not been integrally moulded with the pump upper half then it can be made in a separate operation and assembled to form the completed pump via e.g., an in-mould sealing operation.

The invention will now be described in more detail by reference to preferred particular embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a pump according to the invention, shown with associated nozzle and connector.

Fig. 2 is a perspective view of the lower half of the pump of Fig. 1.

Fig. 3 is a perspective view of the upper half of the pump of Fig. 1.

Fig. 4 is a partial, longitudinal cross-section of the pump of Fig. 1 to show the relationship of the valves to the dose chamber.

Fig. 5 is a transverse cross-section of the pump of Fig. 1.

Fig. 6a shows, in perspective view, a flap valve used in the pump of Fig. 1.

Fig. 6b is a perspective view of an alternate flap valve shape.

Fig. 7 is a partial, perspective view of the lower half of the pump of Fig. 1 showing the exit orifice.

Fig. 8 is a partial end view of the nozzle of the pump of Fig. 1 showing the formation of the exit orifice at the part line of the upper and lower pump halves.

Fig. 9 is a partial, longitudinal cross-section of the pump of Fig. 1 showing an initial force being applied to the resilient actuator.

Fig. 10 is a further cross-section view of the pump of Fig. 1, showing the deformation of the resilient actuator and the operation of the outlet valve as fluid is dispensed.

Fig. 11 is a yet further cross-section view of the pump of Fig. 1, showing the resilient actuator returning to its start position and the re-priming of the pump with fluid from the reservoir (not shown).

Fig. 12 is a perspective view of an atomising outlet for use with a dispenser according to the invention.

Fig. 13 is a perspective view of one half of the atomising outlet shown in Fig. 12.

Fig. 14 is a perspective view of a second embodiment of a pump according to the invention incorporated with a reservoir to form a dispenser.

Fig. 15 is a perspective view of the dispenser of Fig. 14 shown without its protective sleeve.

Fig. 16 is a perspective view of the dispenser of Fig. 14 with a fitted protective cap.

Fig. 17 is a perspective view of a third embodiment of a dispenser according to the invention.

Fig. 18 is a transverse section of the dispenser of Fig. 17 through its pump.

Fig. 19 is a perspective view of the lower half of the dispenser of Fig. 17.

Fig. 20 is a perspective view of the upper half of the dispenser of Fig. 17.

Fig. 21 shows a resilient actuator for use in the dispenser of Fig. 17.

Fig. 22 is a plan view of the monostable element built into the actuator of Fig. 21.

Fig. 23 is a further cross-section of the pump of Fig. 17 to more clearly show the structure and use of the actuator, with incorporated monostable element, of Fig. 21.

Fig. 24 is a sectional view of a fourth embodiment of a dispenser according to the invention.

Fig. 25 is a section through the monostable resilient actuator of the dispenser of Fig. 24.

Fig. 26 Force (F) vs. deflection (D) curve showing the characteristics of a monostable element.

Fig. 27 is a sectional view of a fifth embodiment of a dispenser according to the invention.

Fig. 28 is a perspective view from above of the upper half of the dispenser of Fig. 27.

Fig. 29 is a perspective view from below of the upper half of the dispenser of Fig. 27.

Fig. 30 is a perspective view from above of the lower half of the dispenser of Fig. 27.

Fig. 31 is a perspective view of the actuator strip of the dispenser of Fig. 27.

Fig. 32 is a perspective view of a valve module for a pump.

Fig. 33 is a section through the valve module of Fig. 31.

Fig. 34 is a sectional view showing the valve module of Fig. 31 being assembled into an upper pump half.

Fig. 35 is a sectional view of an assembled pump comprising the valve module of Fig. 31.

Description of preferred embodiments

Figures 1 to 11 show a first embodiment of a pump according to the invention and its mode of operation. Figure 1 shows the assembled pump 101 in perspective view. Pump 1 comprises an extended nozzle and a connector 125 in the form of a weld spout by which the pump can be connected to a fluid reservoir (not shown). The pump comprises an upper pump half 102 and a lower pump half 103 sealed together via a joining element 104. Figures 2 and 3 respectively show the lower and upper pump halves in more detail. The connector 125 is not shown in these figures. The upper and lower pump halves co-operate to form a dose chamber 114, an inlet flow channel 116 and outlet flow channel 117, the dose chamber and flow channels being in fluid communication with each other and the reservoir. The joining element 104 is added by a moulding shot and seals the upper half and the lower half of the pump together, securing both parts against further movement and creating a fluid tight path for the fluid as it passes through the pump. In alternative embodiments the upper and lower pump halves can be fitted directly together by snap fit, welding or gluing operations eliminating the need for the sealing element 104.

Referring in more detail to Figures 2 and 3, lower pump half 103 has a geometry corresponding to that of the upper pump half 102 which comprises opposed sealing ridges 129 for receiving the lower pump half 103. Sealing ridges 129 comprise upper inlet port walls 115a, upper dose chamber walls 130 and upper outlet port walls 115b. Lower inlet port walls 110a are received inside upper inlet port walls 115a to define inlet flow channel 116 and pump inlet port 112. An inlet sealing ridge 108 bridges the lower inlet port walls. Lower dose chamber wall 122 is received inside upper dose chamber walls

130 to bound a dose chamber 114 which is closed by resilient actuator 105. The lower dose chamber wall in this embodiment is a substantially solid block, divided by a flow channel, extending across the width of the dose chamber. This enables it to limit the travel of resilient actuator 105 and thereby help define the dose volume. It also has the effect of reducing the pump volume so that fewer priming strokes are needed. Lower outlet port walls 110b on the lower pump half are received inside upper outlet port walls 115b on the upper pump half to define pump outlet port 113. An outlet sealing ridge 109 bridges the lower outlet port walls. Outlet flow channel walls 111 on lower pump half 103 are received inside upper pump half sealing ridges 129 to form outlet flow channel 117 leading from pump outlet port 113 to exit orifice 118. Outlet flow channel 117 is further bounded by the outlet flow channel upper wall 121 on upper pump half 102. Outlet flow channel walls 111 converge at one end of flow channel 117 to form exit orifice 118 in conjunction with outlet flow channel upper wall 121, as shown more clearly in Figures 7 and 8. Inlet and outlet positioning lugs 123 and 124 are provided on upper pump half 102 and are received in corresponding recesses in an outer rim of the dose chamber wall 122 to assist in positioning and sealing during pump assembly.

Upper pump half 102 is shown fitted with inlet and outlet flap valves 106 and 107, shown separately in Figure 6. In a preferred embodiment the valves are co-moulded onto upper pump half 102 either in the same moulding operation or in a separate moulding operation ("over moulding"). Alternatively, the valves can be moulded independently and assembled to the upper pump half by e.g., friction fit and/or by thermal sealing or gluing or compressed between upper and lower pump halves. The inlet valve prevents backflow of a fluid from the dose chamber 114 into the reservoir. When the upper and lower pump halves are assembled the flap of inlet valve 106 is compressed against inlet sealing ridge 108 and lower inlet port walls 110a. Similarly, the flap of outlet valve 107 co-operates with outlet sealing ridge 109 and lower outlet port walls 110b to form a non return outlet valve at pump outlet port 113. The outlet valve prevents backflow of fluid from outlet flow channel 117 into the dose chamber. The outlet valve can also prevent contamination of fluid in the dose chamber from the air or other potential external contaminant sources. Moving outlet valve 107 and corresponding outlet sealing ridge 109 closer to the exit orifice 118 of the pump can help prevent drying out of the fluid in the outlet flow channel and avoid potential clogging of certain products, as well as helping to avoid contamination. This will have the effect, however, of increasing the pump volume.

The upper pump half comprises resilient actuator 105 which is a thin wall section of the upper pump half where it bounds dose chamber 114. Figure 5 shows more clearly, by cross-sections, the formation of dose chamber 114 between resilient actuator 105 and lower dose chamber wall 122. Joining element 104 helps seal the upper and lower pump halves together. Pressure by a user's finger on actuator 105 reduces the volume of dose chamber 114, forcing fluid to exit the dose chamber through the pump outlet port 113 and along outlet flow channel 117 towards exit orifice 118. In other embodiments according to the invention the actuator can be made from a different material to that of the upper pump half which can be co-injected in the same process step as when the valves are formed. It will be appreciated that the actuator can also be formed by a combination of materials when this is of advantage for the specific application.

Reference will now be made to Figures 9 to 11 to show more clearly the mode of operation of pump 101. Figure 9 shows the situation as a user initially applies a force F_1 to resilient actuator 105. The pump is primed and dose chamber 114 contains a dose of fluid to be dispensed. At this stage the actuator has not appreciably deformed and inlet and outlet valves 106 and 107 are still in their normal mode of being compressed against inlet and outlet sealing ridges 108 and 109 so that the pump inlet and outlet ports, 112 and 113, are closed.

As shown in Figure 10, as the applied force is increased to the threshold force F_2 of the actuator, the actuator deforms rapidly, significantly decreasing the volume inside the dose chamber 114 and increasing the pressure of its contained fluid. The increase in pressure has the effect of applying further pressure to the upper surface of inlet valve 106 thereby keep inlet port 112 closed. At the same time though, pressure on the underside of the flap of outlet valve 107 is increased, causing it to lift, opening pump outlet port 113 and thereby allowing fluid to flow out of the dose chamber, along outlet flow channel 117 and ultimately to be dispensed through exit orifice 118, as shown by the arrows.

Figure 11 shows the situation after the dose of fluid has been dispensed and the user removes the force applied to the actuator. The resilience of the actuator now causes it to return to its starting position with force F_3. The effect of this is to increase the volume inside the dose chamber 114, reducing its internal pressure. The reduction in pressure results in outlet valve 107 closing once more through its natural resilience combined with atmospheric pressure on the upper surface of its flap. At the same time the pressure on the flap of inlet valve 106 is reduced so that fluid pressure from the reservoir lifts it away from the sealing ridge 108 thereby opening pump inlet port 112 and allowing the dose chamber to be recharged from the reservoir. It will be understood that for this process to work efficiently preferably the reservoir needs to be collapsible or it needs to be vented.

Figures 12 and 13 show cross sectional views of an atomising outlet 119 which can be moulded in two halves and integrally moulded into the design of the nozzle of the first embodiment according to the invention. A swirl chamber geometry has been integrated into the upper and lower halves around exit orifice 118, without need for side action on the moulding tool. This geometry will be coupled to a baffle (not shown) also moulded into each of the upper and lower halves of the nozzle to force fluid to exit through the swirl chamber.

Figures 14 to 16 show a second embodiment according to the invention which is a dispenser 250 comprising a pump having essentially the same construction as that of Figure 1 but with modifications to the nozzle. A flexible laminate reservoir 220 is bonded to the weld spout connector 225. To provide the reservoir with some protection and to provide a more aesthetically appealing package a sleeve 260, which can be made of, say, folding boxboard or plastic, encloses the reservoir. A hole in the sleeve provides access to resilient actuator 205. If the sleeve is flexible then it can of course be provided without a hole and the actuator can be depressed through the sleeve. In this case indicia can be provided on the sleeve to indicate where the user needs to press. The modifications to the nozzle 266 include the provision of a shoulder 265 which provides support to sleeve 260 and cap 255 which is provided to cover the nozzle and keep it clean. Shoulder 265 can be integrally moulded in two halves with the pump and nozzle or alternatively, as here, it can be a separate part assembled by a clip/snap or friction fit.

A very different solution for a dispenser according to the invention is shown in Figures 17 to 20 which represent a third embodiment of the invention. In this embodiment the whole dispenser 350, including reservoir 320, is integrally moulded with pump 301 in two halves. The advantage of following this approach is that an entire multiple controlled-dose dispenser can be obtained with a minimum of parts and moulding / assembly operations. Compared to the dispenser 250 shown in Figures 14 to 16 this solution provides a more compact dispenser for the same amount of contained fluid as it utilises the otherwise unused space by building the reservoir around the pump so that the pump is internal to the reservoir. The need for the reservoir to be moulded imposes some restrictions on the materials that can be used for the reservoir, for example laminates will generally be unsuitable, but this may not be critical for many applications. This design also requires a process for sealing two areas: a first, inner, seal which isolates the pump components, including outlet flow channel 317, from the reservoir 320 and a second, outer, seal at the outer perimeter which seals the reservoir 320 from the outside air. With this design the inner seal can no longer be created via an injection moulded joining element as in the pump of Figure 1. The seal is instead created by a snap fit, welding or gluing process when upper pump / dispenser half 302 is assembled to lower half 303. The outer seal can be formed using other processes such as the afore-mentioned joining element or by using in-mould sealing. The dispenser further comprises an atomiser 319 to generate a spray from dispensed fluid as the fluid exits outlet flow channel 317. Inlet flow channel 316 is open to the reservoir 320 at a point close to an end of the dispenser disposed opposite to the atomiser 319, providing an inlet point whereby fluid can be drawn from the reservoir into the flow channel. Having the inlet point close to the end of the dispenser ensure that, in normal use, most of the fluid can be dispensed from the reservoir. Together, the inlet and outlet flow channels and the pump 301 form a continuous reservoir flow path, acting like a dip tube, having an outlet end through which fluid is dispensed from the dispenser and an inlet end through which fluid is drawn from the reservoir, the flow path being isolated from the reservoir along its length except at its inlet end. In order to optimise fluid withdrawal from the reservoir, the reservoir flow path preferably has a length from its outlet end to its inlet end of at least 90%, preferably at least 95% of the length of the dispenser.

Reservoir 320 is in the form of compartments symmetrically disposed about pump 301 and inlet and outlet flow channels 316 and 317. The inlet and outlet valves are not shown in the Figures but operate in the same way as already described in relation to Figures 9 to

11 such that, after a dose of fluid has been dispensed from dose chamber 314, fluid is drawn from the reservoir via inlet flow channel 316 to recharge the dose chamber. Though it is not shown in the Figures it is highly preferred that the reservoir is also fitted with a vent membrane filter to keep the reservoir at atmospheric pressure. During initial manufacture the reservoir is filled with fluid via fill port 381 after the assembly of the upper and lower halves 302 and 303, the port then being sealed with fill port plug 380 which may be integrally moulded to either the upper or lower halves 302 and 303. It will be appreciated that dispenser 350 can be various shapes and thicknesses and sized to suit the particular application. It can also be moulded with a shoulder for receiving a protective cap. In preferred embodiments for medicament dispensers the dispenser has a length of from about 20 to about 100 mm, more preferably from about 40 to about 70 mm, a width of from about 15 to about 80 mm, more preferably from about 20 to about 55 mm and a depth of from about 5 to about 10 mm. The reservoir preferably has a volume of from about 0.5 to about 40 mls. Of course for other applications much larger reservoirs may be appropriate.

Whilst dispenser 350 can incorporate an integrally moulded actuator as part of the upper half 302, as described in the first embodiment, Figures 21 to 23 show in more detail a composite resilient actuator 305 used in the third embodiment. The actuator comprises a separate monostable button 340 covered on top and bottom surfaces by a soft, elastomeric material to form the resilient actuator. The separate monostable element can be made of various materials, in this embodiment it is a commercially available metal snap dome from Snaptron Inc. The actuator is insert-moulded into upper pump half 302 where it is located and fixed by means of positioning lugs 341.

Figure 24 shows a fourth embodiment of the invention comprising a dispenser 450 of similar construction to that shown in Figures 17 to 20, including reservoir 420 moulded around an integral pump, the whole being in two halves. Reservoir 420 comprises fill port plug 480 sealing a fill port through which the reservoir can be charged with fluid during manufacture. In this embodiment outlet flow channel 417, in fluid communication with dose chamber 414, runs as far as a cylindrical projection on upper half 402, the projection mating with a corresponding recess formed in a boss in lower half 403, the recess being open to the outside by exit orifice 418. Although the cylindrical projection and exit orifice 418 are shown as passing perpendicularly through lower half 403 they can of course be formed at an oblique angle to it so that, for example, the dispensed fluid emerges at an angle to the plane of the reservoir.

The resilient actuator 405 of this embodiment is a thermoformed, polypropylene disc insert-moulded to a corresponding recess on upper half 402. The actuator is shown in section in Figure 25 to give a better appreciation of its shape. It includes a central dome 487, a flange 486 for securing the actuator to a pump and an annular trough 485. The function of the annular trough is to allow the central dome to distort sufficiently to invert without its distortion being inhibited by the flange which will be held fixed. The actuator can also be provided, as in the first embodiment, as an integrally moulded thin wall section of upper half 402.

Figure 27 shows a sectional view of a dispenser 550 which is a fifth embodiment according to the invention. This construction of the dispenser affords some advantages in construction and assembly at the expense of an additional part since the dispenser now requires a minimum of three parts. In this dispenser it is the upper pump half 502, shown separately from above and below in Figures 28 and 29, which comprises the lower dose chamber wall 522. At the centre of the lower dose chamber wall is the pump inlet port 512 which provides fluid communication between the dose chamber and the inlet flow channel. In this embodiment the resilient actuator 505 is formed as a separate injection moulded piece with two integrally formed strips extending from it, as illustrated in Figure 31. Upper pump half 502 further comprises a recessed portion corresponding in outline shape to the actuator and strip moulding. This recessed portion comprises substantial portions of the lower part of inlet flow channel 516 and outlet flow channel 517 as grooves running longitudinally along the centre of the recessed portion. For these flow channel portions the outlet flow channel upper wall 521 and an upper portion of the inlet flow channel 516 are provided by the actuator and strip moulding. A reservoir port 526 at one end of the inlet flow channel 516 provides fluid communication between the inlet flow channel and the reservoir 520.

Referring again to Figure 27, inlet valve 506 and outlet valve 507 are pre-formed duckbill valves located in recesses of upper pump half 502, the recesses having holes at the bottom for fluid communication with lower pump half 503. One of these holes serves as pump outlet port 513. Suitable duckbill valves include the DU 027.001 SD valve available from Minivalve International of Jaartsveldstraat 5a, 7575 BP Oldenzaal, The Netherlands. Alternate valves such as slit valves can be co-moulded with upper half 502, lower half 503 or indeed the strip integrally formed with the actuator.

Referring now to Figure 30, lower pump and dispenser half 503 is a simple moulding comprising lower inlet port wall 510a at one end of a dumbbell shaped wall defining a portion of inlet flow channel 516. A further dumbbell shaped wall provides lower outlet port wall 510b which is continuous with outlet flow channel side wall 511, the latter defining a short portion of outlet flow channel 517. A raised lip running around the periphery of the lower pump and dispenser half fits snugly inside an outer side wall of upper pump and dispenser half 502. The two dumbbell shaped walls receive, in their interior spaces, correspondingly shaped projections, shown in Figure 29, on the upper pump and dispenser half 502. The projections include the upper inlet port wall 515a and upper outlet port wall 515b.

As seen most clearly in Figure 31, the strip incorporating the actuator has on its underside two C-shaped projections which locate inside the recesses of upper pump half 502, securing the duckbill valves in place. A portion of the strip comprises an outlet flow channel upper wall 521 which covers the outlet flow channel 517 on its upper side. Likewise a portion of the strip on the opposite side of the actuator covers the inlet flow channel 516 on its upper side.

When the actuator 505 is depressed with sufficient force, fluid in the dose chamber, located between dose chamber lower wall 522 and the actuator 505, is dispensed through outlet valve 507, located in outlet port 513, and passes along the portion of the outlet flow channel 517 formed between the upper and lower halves 502 and 503. The fluid then flows through a connecting channel formed in the upper half and along the remaining section of outlet flow channel 517 that lies between the outlet flow channel upper wall 521 and the upper pump and dispenser half before being dispensed through the exit orifice.

When the actuator is released, fluid from the reservoir 520 is drawn along the section of inlet flow channel 516 lying between the upper pump and dispenser half 502 and one of the strip extensions of the actuator. The fluid then passes through inlet valve 506 and along the section of inlet flow channel 516 formed between the upper and lower halves 502 and 503, from where it passes through pump inlet port 512 into the dose chamber. Though not shown in the Figures, the reservoir of this embodiment, like that of the dispenser of the fourth embodiment can further comprise a vent valve such that the pressure inside the reservoir is maintained at atmospheric pressure. A microfilter in the vent valve can substantially prevent outside contamination of fluid in the reservoir.

Finally, a sixth embodiment of the invention is a valve module as illustrated in Figures 32 to 35. The valve module can be manufactured as a separate item for assembly to variously shaped pump or dispenser constructions, thus providing greater manufacturing flexibility. The valve module comprises upper and lower halves 602 and 603. Lower half 603 comprises a flat injection moulded strip having a central groove which forms the basis for inlet and outlet ports 612 and 613. The groove is interrupted by inlet and outlet sealing ridges 608 and 609 against which the flaps of inlet and outlet valves 606 and 607 are compressed, preventing the flow of fluid along the groove until sufficient pressure is exerted by the fluid to lift the valve flaps (during dispensing in the case of outlet valve 607 or during dose chamber recharging in the case of inlet valve 606). An upper surface of the upper half 602 provides lower dose chamber wall 622. A channel passes through the centre of this to provide fluid communication between the dose chamber and the inlet and outlet ports. The lower dose chamber wall is bounded by a raised annular boundary wall 631 for receiving an actuator or interacting with a dispenser, as shown in Figures 34 and 35 which illustrate the assembly of the valve module into a dispenser section (shown only in part), comprising a resilient actuator 605 to provide a completed pump 601. The lower half 603 of the valve module is shaped with a substantially rectangular external wall section which provides a means for ensuring correct alignment of the valve module with other parts of a dispenser with which it is intended to fit. Alternate alignment means which can be used include positioning lugs and indents. More than one type of alignment means can of course be used. An important feature of this embodiment is that the valves are sandwiched between the upper and lower halves 602 and 603, thus enabling the provision of a compact valve module and provides substantial design flexibility.

Reference key for the parts shown in the drawings

The following list provides a key to the part numbers used in the figures and their foregoing description. The same part number may be referred to in different embodiments of the invention and will be prefaced by a number indicating the number of the embodiment. Thus a 'pump inlet port' number below as '12' will appear as 112 when referred to as a part of the first embodiment but 612 when referred to as a part of the sixth embodiment. For consistency of numbering, a single digit number below will be padded with a leading zero to two digits before the embodiment number is appended. Thus, a 'resilient actuator' (number 5 below) will appear as 405 in the description when described as a part of the fourth embodiment. Not all parts are described or necessarily used in each embodiment.

1	Pump
2	Upper pump (and, optionally, dispenser) half
3	Lower pump (and, optionally, dispenser) half.
4	Joining element.
5	Resilient actuator
6	Inlet valve
7	Outlet valve
8	Inlet sealing ridge
9	Outlet sealing ridge
10a	Lower inlet port wall
10b	Lower outlet port wall
11	Outlet flow channel side wall
12	Pump inlet port
13	Pump outlet port
14	Dose chamber
15a	Upper inlet port wall
15b	Upper outlet port wall
16	Inlet flow channel
17	Outlet flow channel
18	Exit orifice

19	Atomiser
20	Reservoir
21	Outlet flow channel upper wall
22	Lower dose chamber wall
23	Inlet positioning lug
24	Outlet positioning lug
25	Connector
26	Reservoir port
29	Upper pump half sealing ridge
30	Upper dose chamber wall
31	Boundary wall
40	Monostable button for use in a resilient actuator
41	Monostable button positioning lug
50	Dispenser
55	Cap
60	Sleeve
65	Shoulder
66	Nozzle
80	Fill port plug
81	Fill port
85	Actuator annular trough
86	Actuator flange
87	Actuator dome

What is claimed is:

1. A pump (101, 201, 301) for a fluid dispenser comprising:

a) an upper pump half (102, 302) comprising an upper inlet port wall (115a, 515a) and an upper outlet port wall (115b, 515b);

b) a lower pump half (103) engaging with the upper pump half (102) and comprising a lower inlet port wall (110a, 510a) and a lower outlet port wall (110b, 510b), wherein the upper inlet port wall (115a, 515a) engages with the lower inlet port wall (110a, 510a) to define a pump inlet port (112, 512) permitting fluid communication from a fluid source into the pump and the upper outlet port wall (115b, 515b) engages with the lower outlet port wall (110b, 510b) to define a pump outlet port (113, 513) permitting fluid flow out of the pump;

c) a resilient actuator (105, 205, 305, 405, 505) connected to the upper pump half;

d) an inlet valve (106, 506) associated with the pump inlet port (112, 512) for controlling fluid flow through the pump inlet port; and

e) an outlet valve (107, 507) associated with the pump outlet port (113, 513) for controlling fluid flow through the pump outlet port;

f) a dose chamber (114, 314, 414), at least partially bounded by the resilient actuator, for containing a single dose prior to delivery from the dispenser;

whereby depression of the resilient actuator is effective to dispense the dose of fluid through the pump outlet port, and wherein the upper and lower pump halves are formed from unitary mouldings and at least the upper pump half comprises a semirigid, thermoplastic material.

2. A pump according to Claim 1 wherein the dose chamber (114, 414) is bounded by a lower dose chamber wall (122, 522) so arranged that it limits the movement of the resilient actuator, thereby at least partially defining a metered dose.

3. A pump according to any preceding claim wherein the lower pump half (103) is formed from a unitary moulding comprising a semirigid, thermoplastic material.

4. A pump according to any preceding claim wherein one or more of the inlet and outlet valves is made from an elastomeric material having a Shore A hardness of from 5 to 90.

5. A pump according to claim 4 wherein one or more of the inlet and outlet valves is integrally moulded with either the upper or lower pump half.

6. A pump according to any of Claims 1 to 3 wherein one or more of the inlet and outlet valves is integrally moulded with either the upper or lower pump half from the semirigid, thermoplastic material.

7. A pump according to Claim 1 wherein at least one of the upper and lower pump halves is thermoformed.

8. A pump according to Claim 1 wherein at least one of the upper and lower pump halves is compression moulded.

9. A pump according to any preceding claim wherein the resilient actuator is integrally moulded with the upper pump half.

10. A pump according to any preceding claim wherein the resilient actuator (305) comprises a monostable element (340).

11. A pump according to any preceding claim wherein the pump is co-moulded with a weld spout (125) for attachment to a flexible sachet.

12. A pump according to any preceding claim wherein the semirigid, thermoplastic material is selected from the group consisting of polypropylene, polyethylene, polyethylene terephthalate (PET), polyesters, polycarbonates, polyamides, polystyrenes and blends thereof, preferably from polypropylene, polyethylene and polyethylene terephthalate.

13. A method of making a pump (101), for a fluid dispenser, the pump comprising an upper pump half (102) comprising a semirigid, thermoplastic material, a lower pump half (103), a dose chamber (114), a resilient actuator (105), a pump inlet port

(112), a pump outlet port (113), an inlet valve (106) and an outlet valve (107), the method comprising the steps of:

a) forming the upper pump half (102) in a unitary moulding comprising the resilient actuator (105), an upper inlet port wall (115a) and an upper outlet port wall (115b);

b) forming the lower pump half (103) in a unitary moulding comprising a lower inlet port wall (110a), a lower outlet port wall (110b) and a lower dose chamber wall (122); and

c) fixing the upper pump half (102) onto the lower pump half (103) so that the resilient actuator (105) and the lower dose chamber wall (122) bound the dose chamber (114), the upper inlet port wall (115a) engages with the lower inlet port wall (110a) to define a pump inlet port (112) permitting fluid communication from a fluid source into the pump and the upper outlet port wall (115b) engages with the lower outlet port wall (110b) to define a pump outlet port (113) permitting fluid flow out of the pump.

14. A method of making a pump (101), for a fluid dispenser, the pump comprising an upper pump half (102) comprising a semirigid, thermoplastic material, a lower pump half (103), a dose chamber (114), a resilient actuator (105), a pump inlet port (112), a pump outlet port (113), an inlet valve (106) and an outlet valve (107), the method comprising the steps of:

a) forming the upper pump half (102) in a unitary moulding comprising an upper inlet port wall (115a) and an upper outlet port wall (115b);

b) forming the lower pump half (103) in a unitary moulding comprising a lower inlet port wall (110a) and a lower outlet port wall (110b);

c) fixing the upper pump half (102) onto the lower pump half (103) so that the upper inlet port wall (115a) engages with the lower inlet port wall (110a) to define a pump inlet port (112) permitting fluid communication from a fluid source into the pump and the upper outlet port wall (115b) engages with the lower outlet port wall (110b) to define a pump outlet port (113) permitting fluid flow out of the pump; and

d) attaching a resilient actuator (105) to the upper pump half (102) so that the resilient actuator (105) bounds the dose chamber (114).

15. A method according to Claim 13 or Claim 14 further including the step of attaching the inlet valve (106) and the outlet valve (107) to either the upper pump half (2) or the lower pump half (103), before the upper pump half (102) is fixed to the lower pump half (103), the inlet and outlet valves being made of an elastomeric material.

16. A method according to Claim 13 or Claim 14 wherein the inlet valve (106) and the outlet valve (107) are formed with either the upper pump half (2) or the lower pump half (103) in a unitary moulding.

17. A method according to any of Claims 13 to 16 wherein the upper and lower pump halves are formed by injection moulding.

18. A method according to Claim 15 wherein the inlet and outlet valves are formed by injection moulding.

19. A dispenser comprising a pump according to any of Claims 1 to 12 and a fluid reservoir (120) in fluid communication with the pump inlet port (112), whereby the fluid reservoir acts as the fluid source.

20. A dispenser according to Claim 19 wherein the fluid reservoir comprises upper and lower halves respectively integrally moulded with the upper and lower pump halves.

21. A dispenser according to Claim 19 or Claim 20 wherein the pump is internal to the fluid reservoir.

22. A dispenser according to Claim 19 further comprising an atomiser (119) in fluid communication with the pump outlet port (113).

23. A dispenser according to Claim 22 wherein the atomising nozzle is formed from upper and lower halves respectively integrally moulded with the upper and lower halves of the pump.

24. A dispenser according to Claim 19 further comprising an applicator suitable for spreading the fluid onto a substrate.

25. A dispenser according to Claim 24 wherein the applicator comprises spreading means selected from a brush head, an elastomeric wiping blade and a disposable cloth.

26. A dispenser according to Claim 21 wherein comprising a reservoir flow path which has an outlet end, through which fluid is dispensed from the dispenser and an inlet end through which fluid is drawn from the reservoir, the flow path being isolated from the reservoir along its length except at its inlet end, and having a length from its outlet end to its inlet end of at least 90%, preferably at least 95% of the length of the dispenser.

27. A valve module for a pump for a fluid dispenser comprising:

a) an upper pump half (602) including an upper inlet port wall, an upper outlet port wall and a flow channel providing fluid communication between upper and lower surfaces of the upper pump half;

b) a lower pump half (603) engaging with the upper pump half (602) and including a lower inlet port wall, a lower outlet port wall and a lower dose chamber wall (622) wherein the upper inlet port wall engages with the lower inlet port wall to define a pump inlet port (612) permitting fluid communication from a fluid source into the pump and the upper outlet port wall engages with the lower outlet port wall to define a pump outlet port (613) permitting fluid flow out of the pump; and

c) an inlet valve (606) and an outlet valve (607) for controlling fluid flow through the pump inlet and outlet ports respectively;

wherein the valve module comprises an alignment means selected from positioning lugs, indents, a non-circular external wall section and combinations thereof to enable the valve module to be received in a dispenser in a fixed orientation.

28. The valve module of Claim 27 wherein the lower dose chamber wall (622) is provided by the upper surface of the upper pump half.

29. The valve module of Claim 28 wherein the lower dose chamber wall is bounded by a raised boundary wall (631) for receiving an actuator or interacting with a dispenser.

30. The valve module of any of Claims 27 to 29 wherein the inlet and outlet valves are attached to the lower surface of the upper pump half.

31. The valve module of any of Claims 27 to 30 wherein the inlet and outlet valves are respectively located upstream and downstream of the flow channel providing fluid communication between upper and lower surfaces of the upper pump half.

32. A valving arrangement, suitable for use in a pump dispenser, comprising a flow channel having semirigid upper and lower walls, a fluid inlet through which fluid enters the arrangement from a fluid supply and a fluid outlet through which the fluid exits the valving arrangement, the flow channel further comprising inlet and outlet elastomeric, flap valves, mounted inside the flow channel, each valve having a surface immovably fixed to the upper flow channel wall and a flap sealingly compressed against the lower flow channel wall, whereby each valve prevents flow of fluid along the flow channel until a positive fluid pressure differential on an upstream side of the flap of the valve causes the flap to lift thereby allowing fluid to flow past the valve, the valves permitting fluid flow in the same direction along the flow channel whereby an increase in fluid pressure in a section of flow channel between the two valves causes the outlet valve to open and the inlet valve to remain closed and a reduction in fluid pressure in the section of flow channel between the two valves causes the inlet valve to open and the outlet valve to remain closed.

33. The valving arrangement of Claim 32 wherein the flow channel comprises at least one sealing ridge (108, 109), formed on the lower flow channel wall, against which the valve flap of one of the valves is compressed.

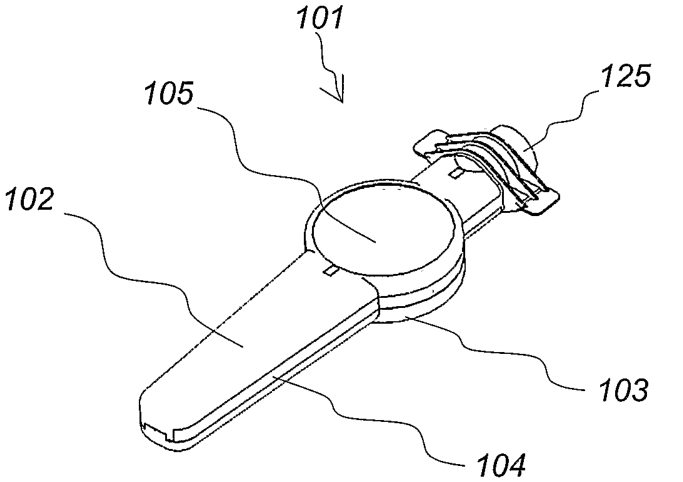

101
105
125
102
103
104

Fig. 1

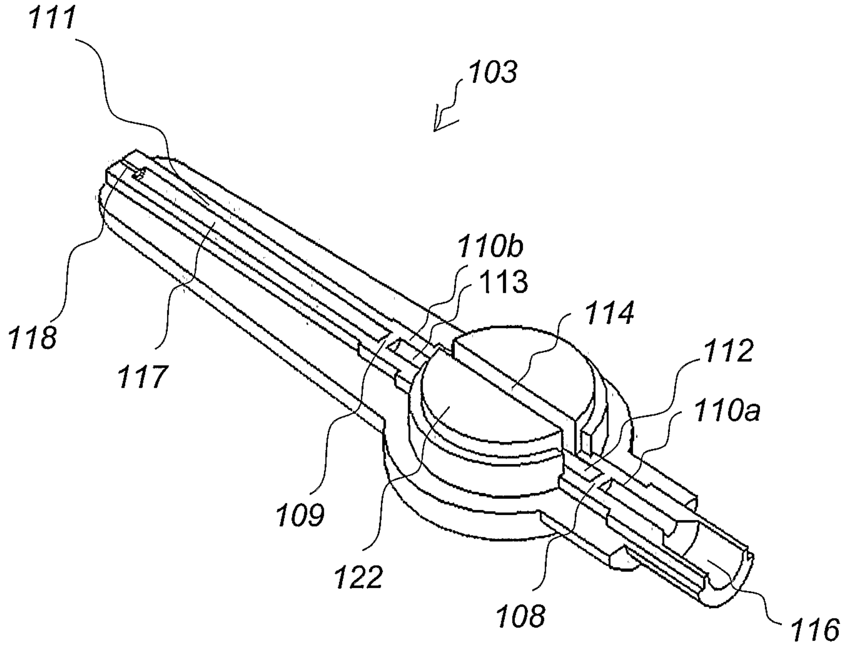
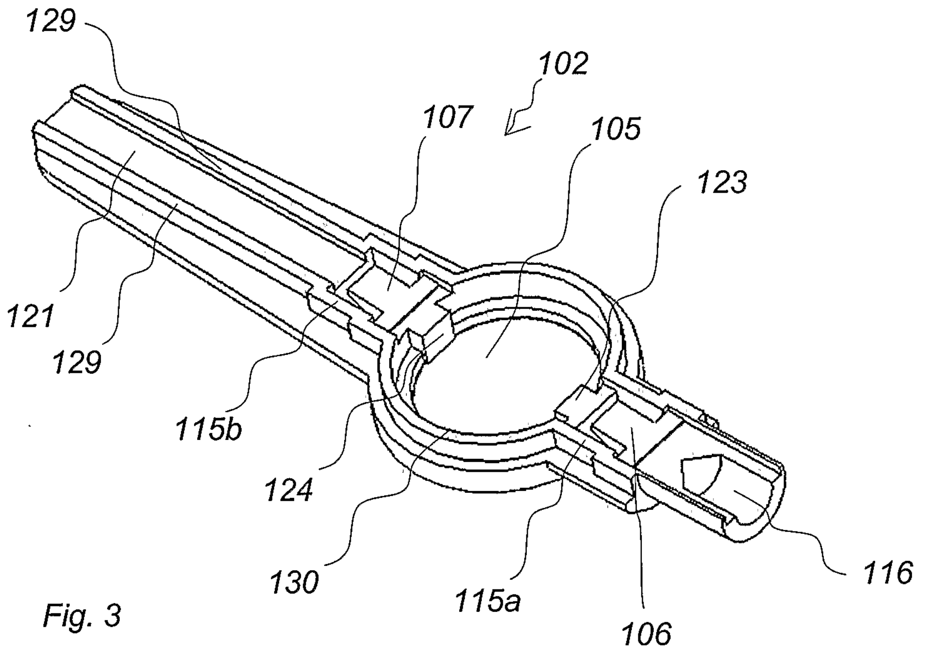
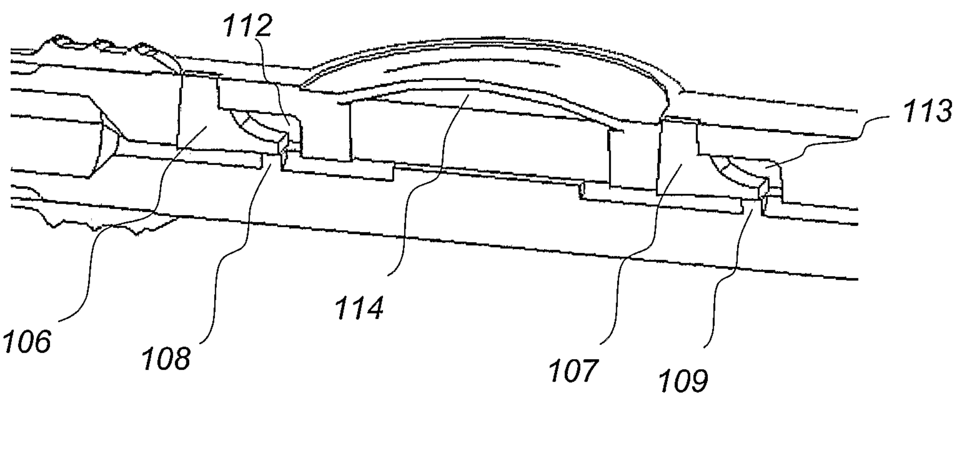

111
103
110b
113
114
112
110a
118
117
109
122
108
116

Fig. 2


129
102
107
105
123
121
129
115b
124
130
115a
106
116
Fig. 3


112
113
106
108
114
107
109
Fig. 4

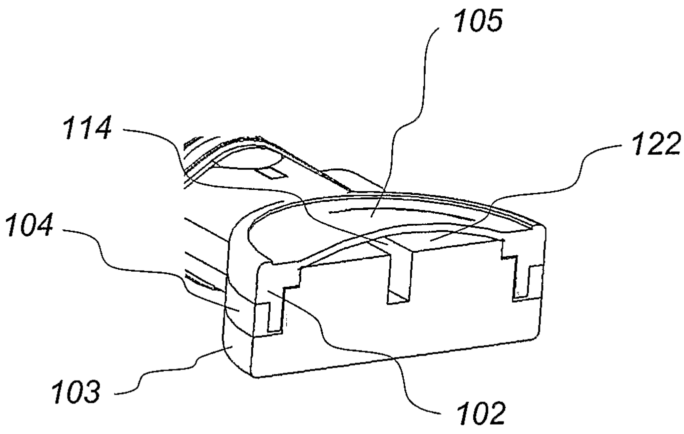


Fig. 5

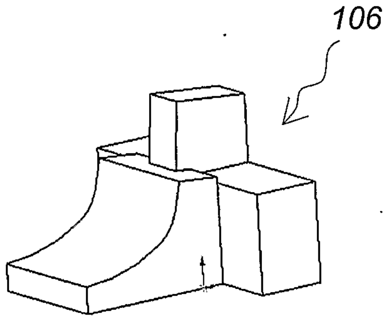


Fig. 6a

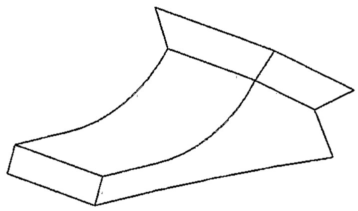


Fig. 6b

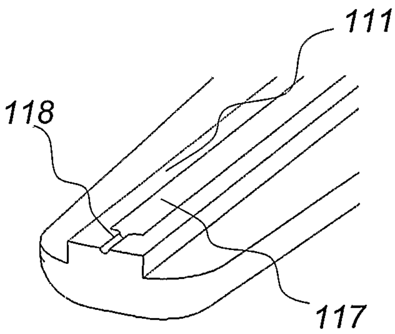


Fig. 7

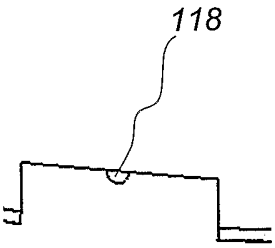


Fig. 8

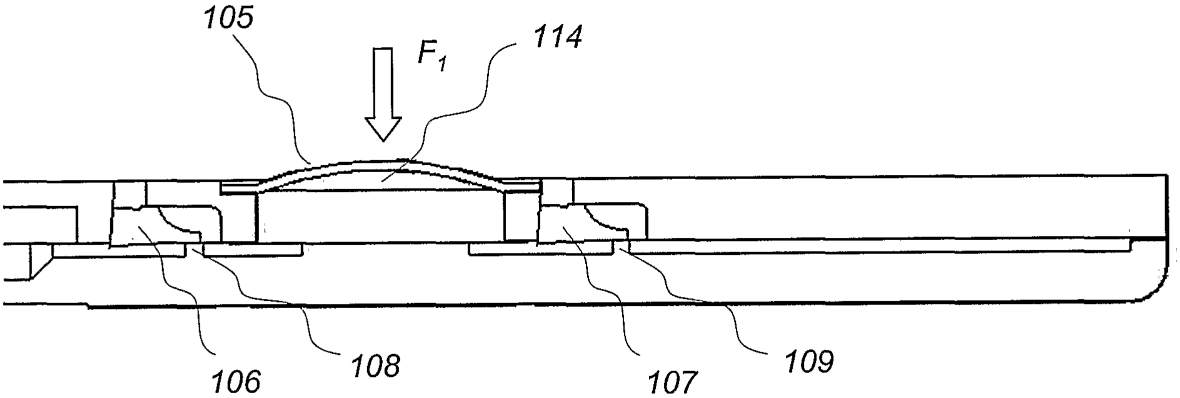


Fig. 9

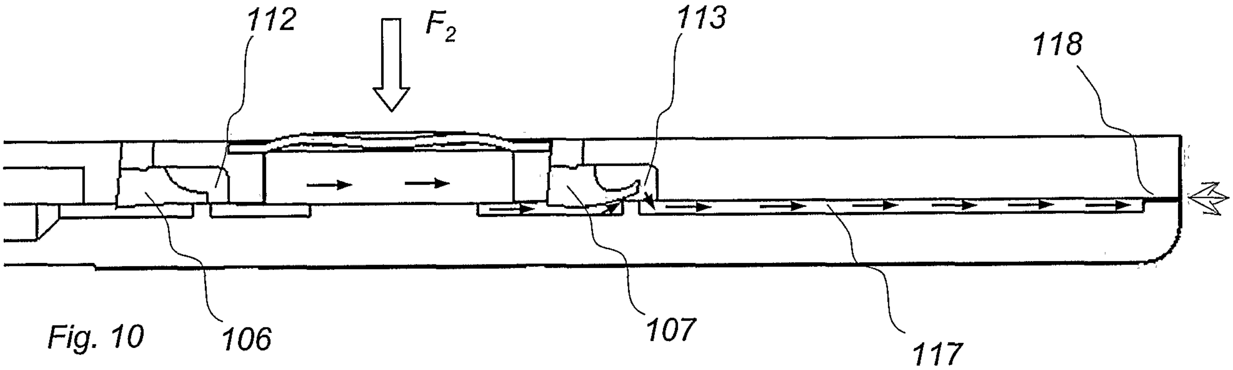


Fig. 10

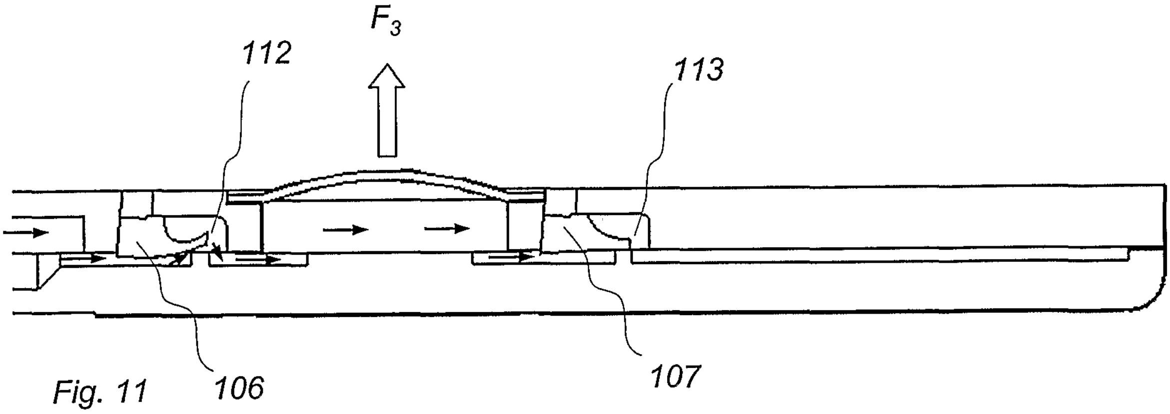


Fig. 11

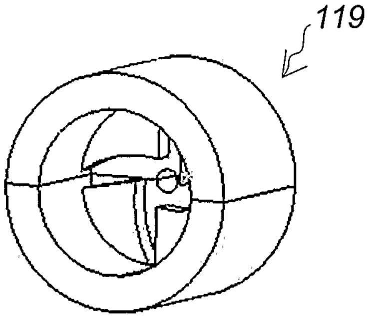


Fig. 12

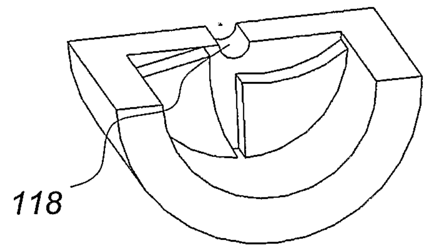


Fig. 13

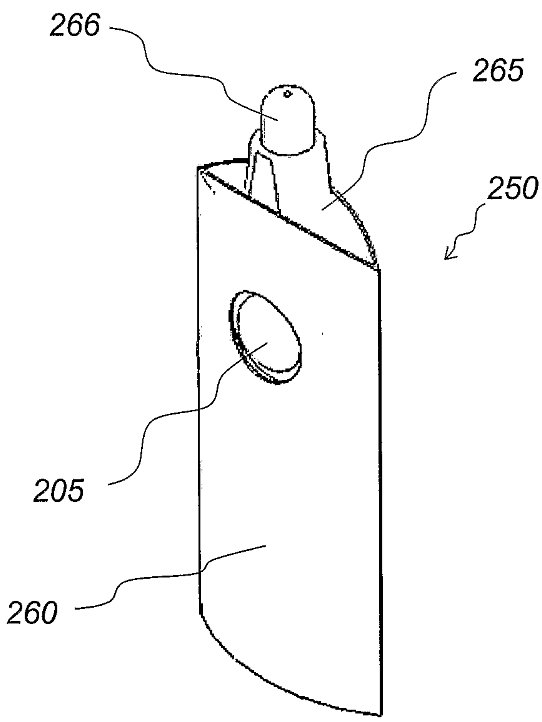


Fig. 14

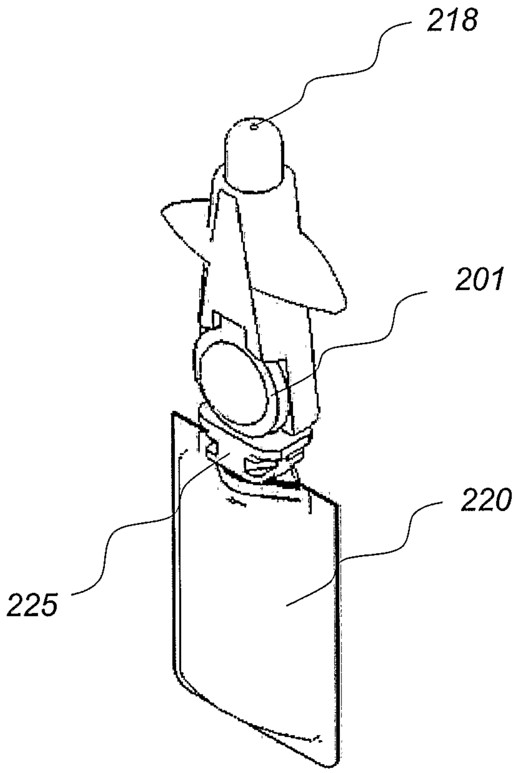


Fig. 15

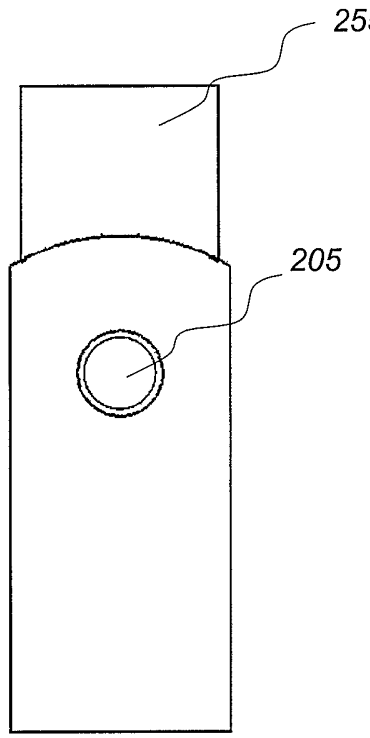


Fig. 16

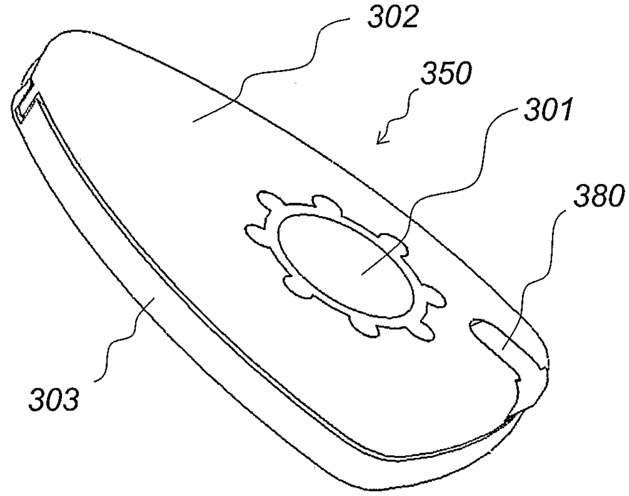


Fig. 17

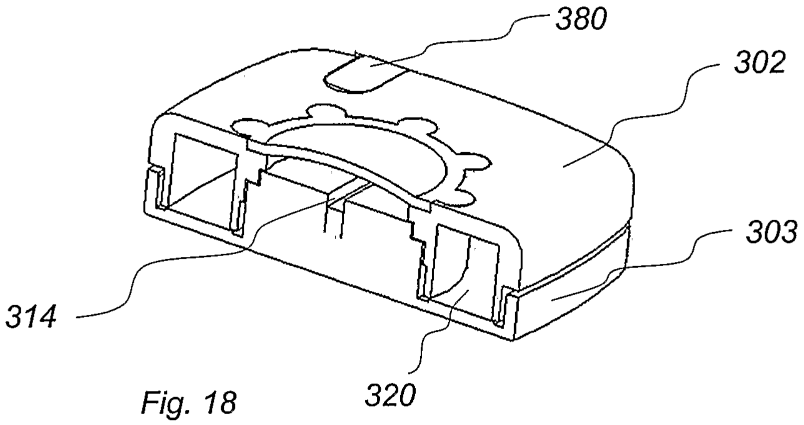


Fig. 18

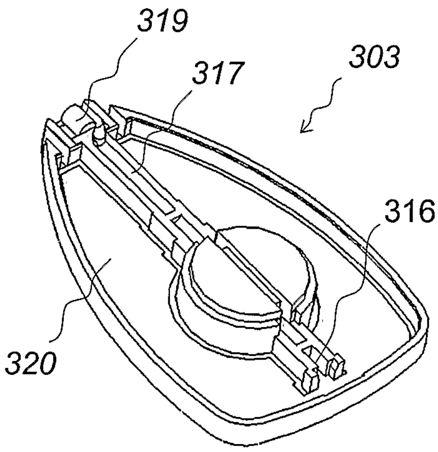


Fig. 19

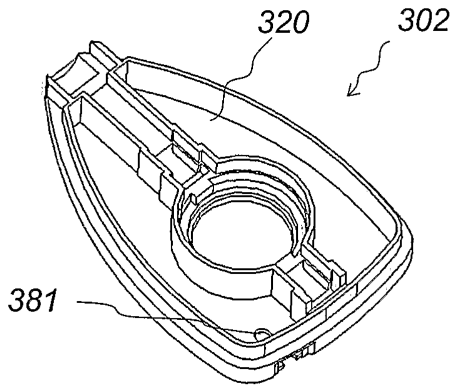


Fig. 20

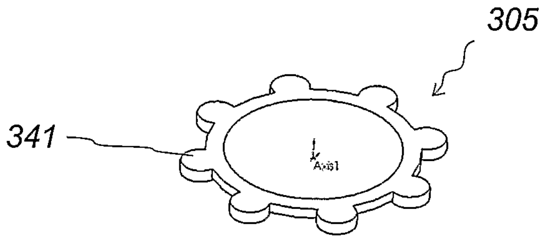


Fig. 21

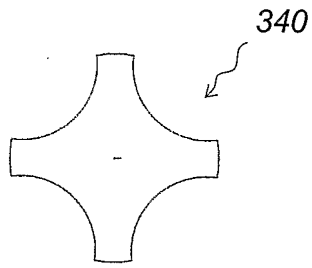


Fig. 22

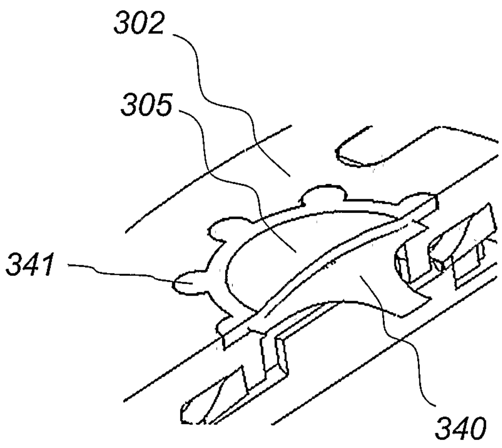


Fig. 23

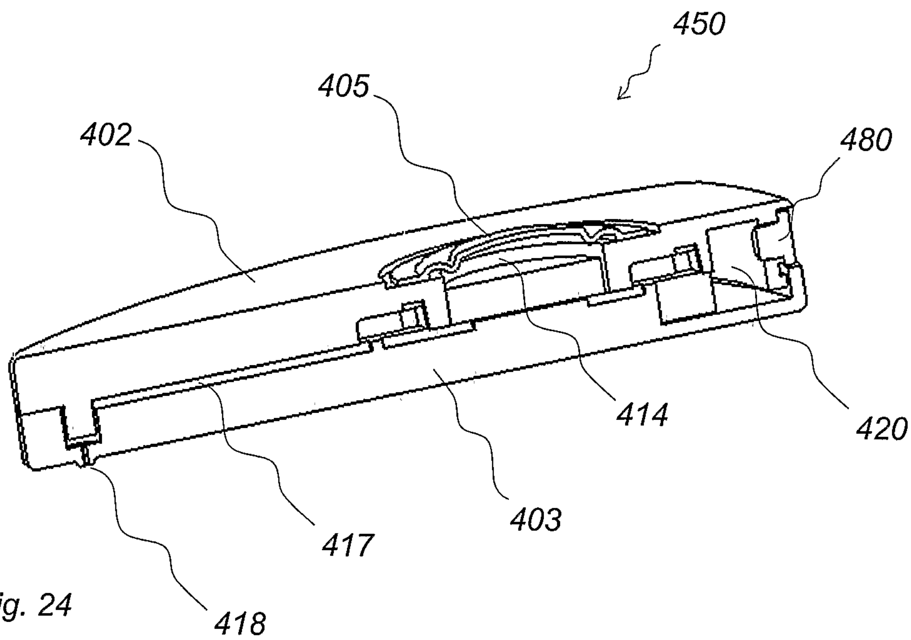


Fig. 24

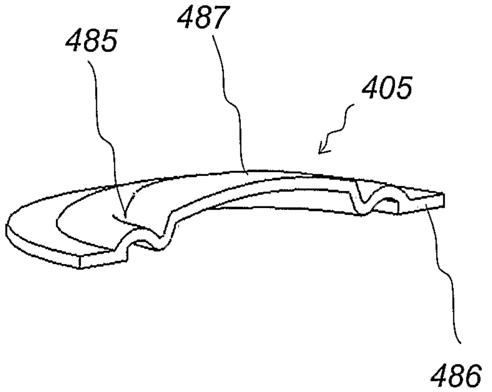


Fig. 25

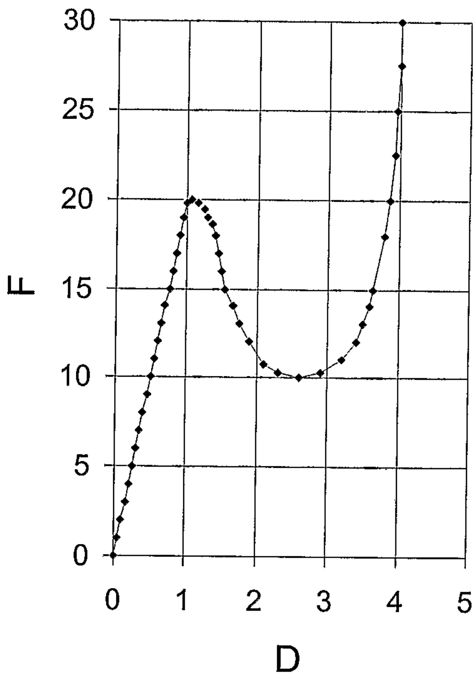


Fig. 26

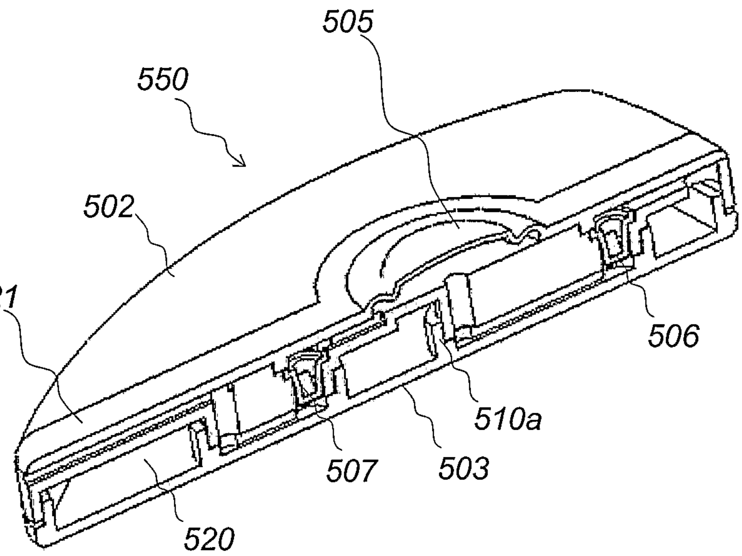


Fig. 27

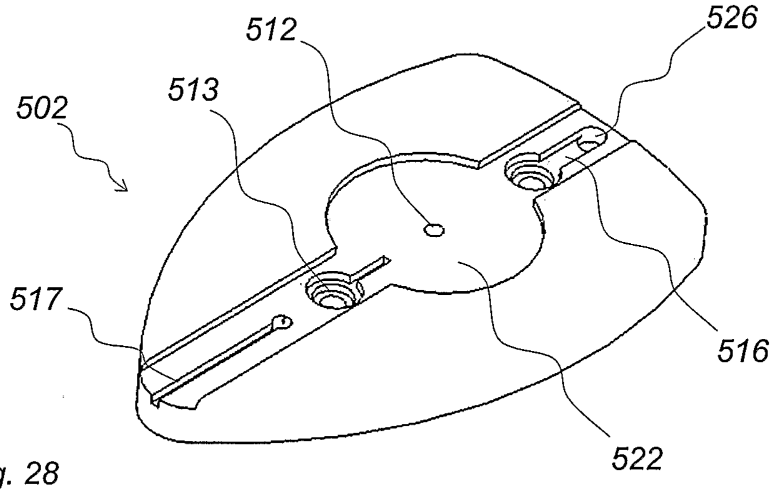


Fig. 28

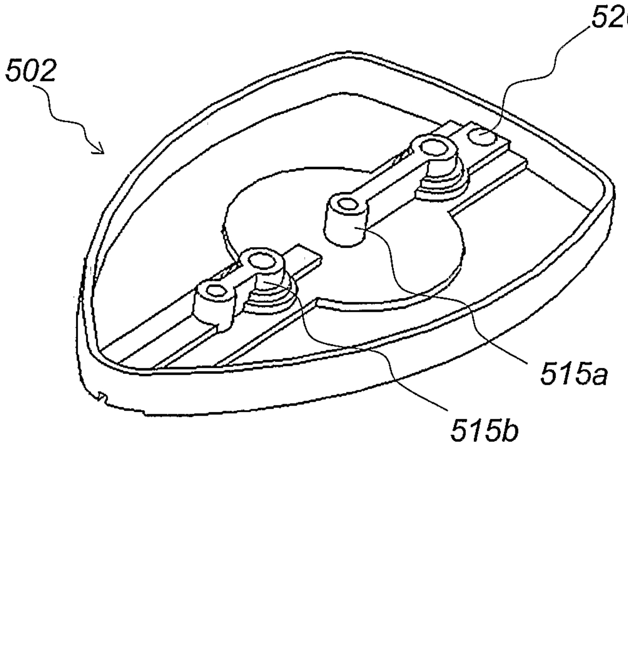


Fig. 29

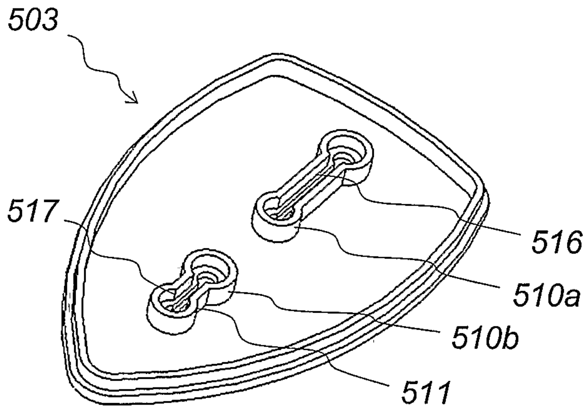


Fig. 30

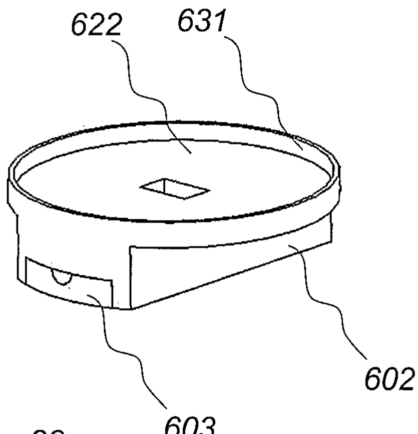


Fig. 32

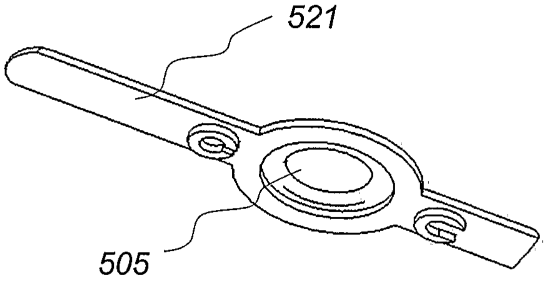


Fig. 31

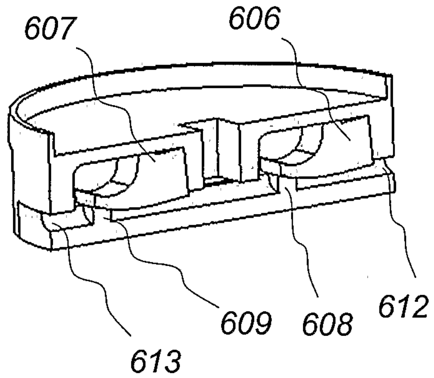


Fig. 33

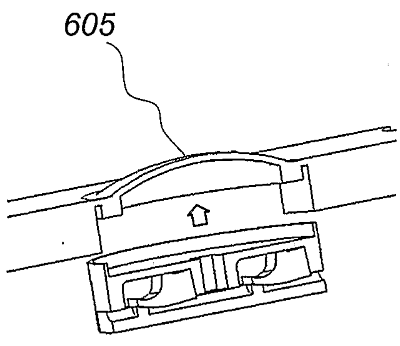


Fig. 34

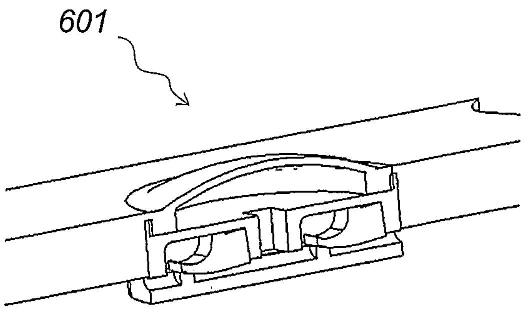


Fig. 35

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/018071

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B05B11/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B05B

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

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

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 127 774 A (POLYPUMP CURAÇAO NV) 13 October 1972 (1972-10-13) page 2, line 18 - page 9, line 26; figures	1-10, 12-14, 16-19, 22,27, 30-33
X	GB 2 211 251 A (THE PROCTER & GAMBLE CO) 28 June 1989 (1989-06-28) page 3, line 35 - page 6, line 32; figures 3,4,6	1-10, 12-14, 16-19, 22,27, 30-33

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° *Special categories of cited documents :*

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 September 2005	07/10/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Innecken, A

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 843 025 A (HOLT, W.) 22 October 1974 (1974-10-22) column 1, line 64 - column 2, line 49; figures 1,2,5	1-10,12, 13, 16-19, 22,24, 27,30-32
X	US 3 726 442 A (DAVIDSON, T. ET AL) 10 April 1973 (1973-04-10) column 5, line 41 - column 6, line 43; figures 5,6	1-10,12, 13, 16-19, 22,27, 30-32
X	US 3 986 644 A (BLAKE, WILLIAM S. ET AL) 19 October 1976 (1976-10-19) column 2, line 50 - column 4, line 45; figures	1-4,7,8, 10, 12-14, 17-19,24
X	US 5 273 191 A (MESHBERG, PHILIP) 28 December 1993 (1993-12-28) column 4, line 59 - column 5, line 6; figures 3,4	27
X	WO 03/076079 A (JAEGER-WALDAU REINHOLD KARL; NATERSKY KLAUS (DE); METAL BOX PLC (GB);) 18 September 2003 (2003-09-18) page 12, lines 21-30; figures 5,8,9	27
X	US 5 845 817 A (NILSON, BILLY) 8 December 1998 (1998-12-08)	32
A	column 3, line 41 - column 4, line 47; figures 4-10	1,13,14
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 07, 29 September 2000 (2000-09-29) -& JP 2000 117162 A (MATSUMOTO, AKIRA), 25 April 2000 (2000-04-25) abstract	1,13,14
A	EP 0 641 722 A (ASEPT INT AB) 8 March 1995 (1995-03-08) cited in the application column 2, line 18 - column 5, line 56; figures 3,4	1,13,14
A	EP 0 442 858 A (STERISOL AB) 21 August 1991 (1991-08-21) cited in the application column 3, line 8 - column 4, line 36; figures	1,13,14

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-12,13,14-18,19-26

   Pump for a fluid dispenser made of two halves formed from unitary mouldings

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2. claims: 27-31

   Valve module comprising alignment means to enable the valve module to be received in a dispenser in a fixed orientation

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3. claims: 32,33

   Valving arrangement comprising a semirigid flow channel and two flap valves

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US2005/018071

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