(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 October 2013 (03.10.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/147619 A1

(51) International Patent Classification:
B05B 9/00 (2006.01) *B05B 1/00* (2006.01)
F16K 11/00 (2006.01) *B05D 1/00* (2006.01)
A61D 7/00 (2006.01)

(21) International Application Number:
PCT/NZ2013/000050

(22) International Filing Date:
25 March 2013 (25.03.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
599027 26 March 2012 (26.03.2012) NZ

(71) Applicant: **SIMCRO LIMITED** [NZ/NZ]; 6-8 Latham Court, Hamilton, 3204 (NZ).

(72) Inventor: **TROW, David Andrew**; 23 Stella Place, Chartwell, Hamilton, 3210 (NZ).

(74) Agent: **BALDWINS INTELLECTUAL PROPERTY**; P O Box 5999, Wellesley Street, Auckland, 1141 (NZ).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: APPLICATOR

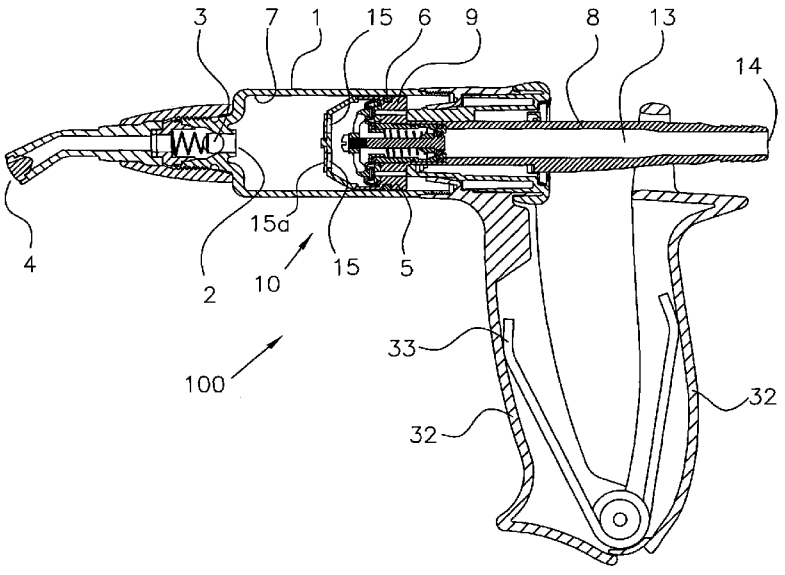


Figure 1

(57) Abstract: An applicator 102 has a fluid supply inlet (14), an outlet (4) and a barrel (1) having a barrel outlet (2) and a barrel inlet (15a). The barrel inlet (15) is in fluid communication, or selective fluid communication, with the fluid supply inlet (14). A one way outlet valve (3) is in fluid communication with the barrel outlet (2) and with the outlet (4). The applicator 100 has

[Continued on next page]

WO 2013/147619 A1

Published:

— *with international search report (Art. 21(3))*

piston actuation means (32) for moving a piston (5) relative to the barrel (1). The applicator further comprises pressure limiting means (10) for limiting a maximum pressure of fluid entering the barrel (1) from the fluid supply inlet (14).

APPLICATOR

The present invention relates to fluid applicators, and in particular, but not exclusively, to applicators for use in applying animal remedies.

Background to the Invention

Animal remedies for sheep, cattle and the like are applied by a number of methods including topical or "pour-on" application, oral application, injection and nasal infusion. Each of these is typically dispensed from a "pistol grip" style dispensing means.

Typically such applicators have a piston or plunger which can be reciprocated within a barrel by squeezing and releasing a first handle relative to a second handle. The liquid to be dispensed is drawn into the barrel through an inlet via a one way inlet valve when the plunger is withdrawn inside the barrel, and is dispensed through a nozzle via an outlet valve when the plunger is extended towards the outlet valve. Such an applicator is described in the applicant's New Zealand patent No. 521084, the contents of which are herein incorporated by reference.

As is described above, conventional fluid applicators incorporate two one-way valves. These valves are referred to as the inlet valve and the outlet valve.

The valves are typically biased with springs, so that they open only when there is a predefined difference in the fluid pressure between the upstream side of the valve and the downstream side. Fluid cannot flow backwards through either valve, as flow in this direction will tend to push the valves more tightly closed.

When the applicator is at rest, both valves are closed. When the applicator is in use, it is intended that only one valve opens at a time. During the discharge stroke, the outlet valve is pushed open by the raised fluid pressure within the barrel. During the refill stroke, the inlet valve is pushed open by fluid entering the barrel (where there is now a partial vacuum).

A problem with conventional applicators is that they require a relatively large force to squeeze the handles together during the application stroke of the piston. This may be fatiguing for the operator, particularly when the applicator is used to treat a large group of animals.

The large force is required because the outlet valve of a conventional applicator is set to open only when there is a relatively large pressure in the barrel of the applicator. The reasons for this are as follows:

Firstly, the momentum of fluid travelling through the feed tube causes a pressure pulse (sometimes referred to as water hammer) at the completion of the refill stroke. The magnitude of this pressure pulse depends on factors such as the fluid velocity and the hardness of the feed tube. This pressure pulse can potentially force open both the inlet valve and the outlet valve simultaneously, and result in an unwanted discharge of fluid from the applicator. End-users strongly dislike this discharge of fluid, even if it is only a small volume.

Secondly, if the fluid supply container is held higher than the applicator (for example in a backpack) then the increased pressure can cause the fluid to flow continuously through the applicator, even when it is not squeezed, or it may drip continuously.

It would be useful to develop an applicator which allows for an outlet valve which opens under a lower pressure than the applicators of the prior art, but which does not allow any unwanted discharge of fluid from the applicator outlet.

When the applicator is used in the veterinary and/or animal husbandry fields it should preferably have the following characteristics:

- be simple and reliable, suited to use in an agricultural environment.
- be inexpensive to implement.
- not interfere with the dose accuracy of the applicator.
- work regardless of the height of the fluid source relative to the applicator.
- work regardless of the viscosity of the fluid.
- work regardless of the speed of discharge or refill.
- work correctly during all stages of the applicator's operating cycle, including discharge, refill, and unexpected pauses in mid-stroke.
- withstand attack by aggressive chemicals.

Throughout the description and the claims, all reference to pressures are to gauge pressures, i.e. pressure relative to the ambient pressure. Therefore, a reference to zero pressure means

ambient pressure. Reference to negative pressure means suction. Reference to a partial vacuum is any pressure below ambient pressure but greater than a total vacuum.

Reference to the "upstream" direction is towards the direction in the fluid flow path from which fluid enters the applicator. Reference to the "downstream" direction is to the direction in which the fluid normally flows.

The reference to any prior art in the specification is not, and should not be taken as, an acknowledgement or any form of suggestion that the prior art forms part of the common general knowledge in any country.

Object of the Invention

It is an object of a preferred embodiment of the invention to provide an applicator which will overcome or ameliorate at least one problem with such applicators at present, or at least one which will provide a useful choice.

Other objects of the present invention may become apparent from the following description, which is given by way of example only.

Brief Summary of the Invention

According to one aspect of the present invention there is provided an applicator comprising:

a fluid supply inlet;

an outlet;

a barrel having a barrel outlet and a barrel inlet which is in fluid communication, or selective fluid communication, with the fluid supply inlet;

a one way outlet valve in fluid communication with the barrel outlet and with the outlet;

a piston moveable relative to the barrel and in sealing engagement with the barrel;

piston actuation means for moving the piston relative to the barrel;

the applicator further comprising pressure limiting means for limiting a maximum pressure of fluid entering the barrel from the fluid supply inlet.

Preferably, the pressure limiting means is configured such that the fluid entering the barrel has a pressure which is at or below an ambient atmospheric pressure.

Preferably, the pressure limiting means is configured such that the fluid entering the barrel has a pressure which is at or below a pressure required to open the outlet valve.

Preferably, the pressure limiting means is provided at or adjacent the barrel inlet.

Preferably, the pressure limiting means is integral with the piston.

Preferably, the pressure limiting means comprises a diaphragm.

Preferably the diaphragm is annular in shape.

Preferably a first side of the diaphragm is in fluid communication, or selective fluid communication, with fluid in the barrel.

Preferably an opposite second side of the diaphragm is exposed to ambient atmospheric pressure.

Preferably displacement of the diaphragm changes an internal volume of a conduit supplying fluid to the barrel inlet.

Preferably the diaphragm is carried by the piston.

Preferably the applicator is provided with a one way valve means for preventing fluid flow from the barrel though the barrel inlet.

Preferably the pressure limiting means is adapted to prevent fluid flow from the barrel inlet to the fluid supply inlet.

Preferably the pressure limiting means comprises a first valve head and a first valve seat, wherein the first valve head can be moved from a closed position to an open position by movement of the diaphragm.

Preferably the pressure limiting means comprises a second valve head and second valve seat, wherein the second valve head is connected to the first valve head and moves with the first valve head.

Preferably a pressure difference across said first valve head is substantially equal to a pressure difference across said second valve head.

Preferably the pressure difference across said first valve head creates a resultant force in a first direction and the pressure difference across said second valve head creates a resultant force in a second direction which is opposite to the first direction.

Preferably the resultant forces are substantially equal.

Preferably the resultant force on the second valve head is greater than the resultant force on the first valve head.

According to a second aspect of the present invention there is provided an applicator comprising:

a fluid supply inlet;

an outlet;

a barrel having a barrel outlet and a barrel inlet in fluid communication, or selective fluid communication, with the fluid supply inlet;

a one way outlet valve in fluid communication with the barrel outlet and with the outlet;

a piston moveable relative to the barrel and in sealing engagement with the barrel;

piston actuation means for moving the piston relative to the barrel; and

a diaphragm in fluid contact, or selective fluid communication, with a fluid within the barrel, wherein movement of the diaphragm controls a valve means provided between the fluid supply inlet and the barrel inlet.

According to a third aspect of the present invention there is provided an applicator system comprising an applicator and fluid supply conduit, the applicator comprising:

a fluid supply inlet;

an outlet

a barrel having a barrel outlet and a barrel inlet in fluid communication, or selective fluid communication, with the fluid supply inlet;
a one way outlet valve in fluid communication with the barrel outlet;
a piston moveable relative to the barrel and in sealing engagement with the barrel;
piston actuation means for moving the piston relative to the barrel;
the fluid supply conduit having an inlet and an outlet which is in fluid communication, or selective fluid communication, with the fluid supply inlet of the applicator;
the system further comprising pressure limiting means for limiting a maximum pressure of fluid entering the barrel in use.

According to a further aspect of the present invention there is provided an applicator substantially as herein described with reference to any one of Figures 1 to 3, Figures 4 and 5, or Figures 6 to 8.

The invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, in any or all combinations of two or more of said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which the invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

Further aspects of the invention, which should be considered in all its novel aspects, will become apparent from the following description given by way of example of possible embodiments of the invention.

Brief Description of the Figures

Figure 1 Is a diagrammatic cross-section side view of an applicator according to one embodiment of the present invention.

Figure 2 Is an enlarged diagrammatic cross-section side view of the piston head and pressure limiting means of the applicator shown in Figure 1 with the pressure limiting valve closed.

Figure 3 Is an enlarged diagrammatic cross-section side view of the piston head and pressure limiting means of the applicator shown in Figure 1 with the pressure limiting valve open.

Figure 4 Is a diagrammatic cross-section side view of an applicator according to a second embodiment of the present invention.

Figure 5 Is an enlarged diagrammatic cross-section side view of the piston head and pressure limiting means of the applicator shown in Figure 4 with the pressure limiting valve closed.

Figure 6 is a diagrammatic cross-section side view of an applicator according to a third embodiment of the present invention.

Figure 7 is an enlarged diagrammatic cross-section side view of the piston head and pressure limiting means of the applicator shown in Figure 6 with the pressure limiting valve closed.

Figure 8 is an enlarged diagrammatic cross-section side view of the piston head and pressure limiting means of the applicator shown in Figure 6 with the pressure limiting valve means open, and fluid flowing into the barrel of the applicator.

Brief Description of Preferred Embodiments of the Invention

Referring first to Figures 1, and 2, an applicator according to one embodiment of the present invention is generally referenced by arrow 100.

The applicator 100 has a barrel 1 with an outlet 2. A one way outlet valve 3 is provided at or adjacent the barrel outlet 2. The barrel outlet 2 is in selective fluid communication with an applicator outlet 4 from which fluid is discharged in use. In other embodiments (not shown) the one way valve 3 may be provided at or adjacent the applicator outlet 4.

A piston or plunger 5 is located within the barrel 1 and has sealing means 6, for example an O-ring seal, to sealingly engage an inner surface 7 of the barrel 1.

In the embodiment shown the piston 5 has an integral hollow pushrod 8 and a substantially cylindrical head 9 that travels along the cylindrical barrel.

The piston 5 is provided with a pressure limiting means, generally referenced by arrow 10.

In the embodiment shown, the pressure limiting means 10 comprises a flexible diaphragm 11 connected to a valve means, generally referenced 12. The valve means 12 is provided inside the hollow pushrod 8, the hollow pushrod providing a conduit 13 between a fluid inlet 14 and an inlet 15 to the barrel. In the embodiment shown, a one way valve means 15a is provided to prevent flow from the barrel 1 towards the inlet 14.

The diaphragm 11 is preferably annular in shape, and is clamped (and sealed) to the piston head 9 by clamping means 16.

A force transfer component 17 is provided which consists of an outer ring or hub 18 provided in front of the diaphragm 11, and an inner hub 19, with the two being connected by several spokes 20. The spokes 20 allow fluid to pass through the component 17.

The valve means 12 comprises a valve stem 21 connected to a valve head 22.

The force transfer component 17 is connected to the valve stem 21 by suitable connecting means, for example screw 23. The connection between the force transfer component 17 and the valve stem 21 may have a degree of flexibility, to allow for misalignment between the parts without upsetting correct operation. In some embodiments the valve stem 21 may be able to slide through force transfer component 17 without moving the latter with it, but the force transfer component 17 cannot move forward (i.e, further into the barrel) without contacting screw 23 and also moving the valve stem 21, and thereby opening the valve 12.

A valve seat 24 and spacer 25 are fixed in place in the plunger conduit. O-ring seals 26 prevent leakage past the spacer 25 and valve seat 24.

The valve head 22 is provided with a suitable sealing means, preferably an O-ring seal 27. The valve head 22 seals against the valve seat 24 when in a closed position (as shown in Figure 2). The valve head 22 is preferably frusto-conical in shape, and the valve seat 24 is preferably a complimentary shape.

A valve travel limiting means, for example one or more fins or tabs 28, is arranged to limit the travel of the valve head 22. In the embodiment shown the tabs 28 contact spacer 25 when the valve head 22 has moved a predetermined maximum distance away from the valve seat 24.

A biasing means, for example spring 29, urges the valve head 22, and the components connected to the valve head, including the force transfer component 17, in the upstream direction.

A vent means 30 may be provided in the piston head 9 to ensure that the side of the diaphragm 11 which is not in contact with the fluid in the barrel is maintained at ambient atmospheric pressure.

In the embodiment shown the relationship between the force transfer component 17 and the diaphragm 11 is such that a clearance space 31 is maintained between them when the diaphragm 11 is in its relaxed state, as shown in Figure 2. This occurs when the valve 12 is closed and the pressure inside the barrel 1 is substantially equal to atmospheric pressure (as shown). This allows spring 29 to bias valve head 22 and O-ring 27 against the valve seat 24 without interference.

In some embodiments guide means (not shown) may be provided to ensure that the valve stem 21 remains on-centre at its forward end.

Figure 2 shows the positions of the components when the pressure inside the barrel 1 is substantially equal to atmospheric pressure. The diaphragm 11 is in its relaxed position, and the valve 12 is held closed by spring 29.

The force of spring 29 is sufficient to hold valve 12 closed against the pressure of the fluid in the conduit 13, even if the fluid reservoir (not shown) which supplies fluid to the fluid inlet 14 is raised a limited distance above the applicator 100.

When the user operates the actuating means (handles 32 in the embodiment shown) to drive the piston 5, the piston 5 is pushed forwards and displaces fluid which flows through the one-way outlet valve 3 and out through the outlet 4. The force required to open the outlet valve 3 causes the pressure inside the barrel 1 to rise above atmospheric pressure. In the embodiment

shown the one way valve 15a prevents this pressure from pushing the diaphragm 11 rearwards against the piston 5. The diaphragm 11 does not move from the position shown in Figure 2 during this phase of operation. Valve 12 is still held closed by spring 29.

In preferred embodiments the outlet valve 3 is configured to open under a lower pressure than the outlet valves of conventional applicators. This reduces the pressure of the fluid within the barrel during the application stroke, and hence reduces the required hand squeeze force on the handles 32.

When the user releases the handles 32, a biasing means, for example a handle spring 33 provided inside the handles 32, pulls the piston 5 rearwards. This induces a partial vacuum inside the barrel 1, which is communicated to the diaphragm 11 through the inlet 15 and one way valve 15a.

Air pressure acting on the rearward-facing side of the diaphragm 11 pushes the diaphragm forwards, closing clearance space 31. The diaphragm 11 then pushes forwards against the force transfer component 17. When the pressure of the fluid in the barrel 1 is low enough, the force generated by the diaphragm 11 overpowers the spring 29 and moves the valve head 22 away from the valve seat 24, as shown in Figure 3, thereby allowing fluid to flow through the valve 12.

The distance that the valve 12 opens depends (amongst other things) on how low the pressure in the barrel 1 is. The valve 12 may open fully, or only part-way. In some embodiments the stiffness of the diaphragm 11 may cause it to act like a spring, adding to the biasing force created by spring 29.

Figure 3 shows the assembly with the diaphragm 11 deflected and the valve 12 fully open. This occurs when the piston 5 is being retracted and the barrel 1 is filling with fluid through the valve 12 and inlet 15.

At the end of the barrel refilling stroke the piston 5 contacts a fixed stop. The stop is typically part of a variable dosage control means. Suitable dosage control means are known to the art, and include that described in the applicant's New Zealand patent number 521084, the contents of which are included herein by reference.

The momentum of the fluid flowing in the conduit 13 and in the upstream supply tube (not shown) may tend to keep the fluid moving past the valve 12 and into the barrel 1, even though the spring 29 is acting on the valve head 22 to try to close the valve 12. If this occurs, the pressure in the barrel 1 rises and the diaphragm 11 moves rearward, pulled back by the spring 29 acting on the diaphragm via the force transfer component 17.

The valve 12 returns to its substantially closed position before the rising pressure in the barrel 1 reaches atmospheric pressure. Closure of the valve 12 may result in a pressure pulse (from water hammer) in the conduit 13 and the preceding supply tube. However, the force of the spring 29 may be sufficient to keep the valve 12 substantially closed despite the momentary increase in pressure caused by the pressure pulse. Since the pressure pulse cannot pass the closed valve 12, the problem of fluid discharging from the nozzle at this time is avoided. Since the valve 12 is opened by the diaphragm 11 when necessary, the spring 29 may be selected to provide a larger biasing force than that used by the applicators of the prior art.

Assuming that there are no leaks, the pressure in the barrel 1 remains slightly below atmospheric pressure. Because no more fluid can pass the closed valve 12, the diaphragm 11 may remain deflected slightly forwards, touching the force transfer component 17 (i.e. the clearance space 31 is closed).

Those skilled in the art will appreciate that although the pressure in the barrel 1 of the embodiment described above is below atmospheric at the end of the inlet stroke, other embodiments may be configured such that the pressure is at or above atmospheric pressure at that stage. In particular, the water hammer pressure pulse may be large enough to force a small volume of fluid past valve 12, preventing the valve from closing fully, or even reopening it slightly, despite the biasing force of the spring 29. The passage of this small volume of fluid will displace the diaphragm rearward, reopening a gap between the force transfer component 17 and the diaphragm 11. There may be a corresponding rise in the pressure of the fluid in the barrel. While this pressure rise may be mitigated by the increase in available volume caused by the deflection of the diaphragm, in some circumstances the pressure may rise to above atmospheric pressure. However, as long as the pressure within the barrel is not high enough to force the outlet valve 3 open, there will be no unwanted discharge of fluid.

Those skilled in the art will also appreciate that while the invention described above uses a flexible diaphragm, in some embodiments part or all of the diaphragm component may be

substantially rigid, provided the diaphragm component can be sealed against the piston head 9 and is able to move to a sufficient degree to actuate valve 12.

While the pressure limiting means 10 is shown integrated into the piston 5 in the embodiment described above, in other embodiments (not shown), particularly those in which space is limited, the pressure limiting means may be provided upstream of the barrel inlet. However, it is preferred that the diaphragm be in at least selective fluid communication with the fluid in the barrel.

Referring next to Figures 4 and 5, a second embodiment of the invention is described, with similar reference numerals referring to similar components as in Figures 1 to 3.

In the embodiment shown in Figures 4 and 5 the valve means 12 is provided with a hollow valve stem 34. The hollow valve stem 34 has one or more openings 34a on the downstream side of a valve head 35. The valve stem 34 extends past valve head 35 to a balancing valve head 36. The hollow valve stem 34 provides a conduit between the opening(s) 34a and a chamber 37 on the upstream side of the balancing valve head 36. The chamber 37 is defined by a balancing cylinder formation 38. The balancing cylinder formation 38 has a bore 39 with a substantially cylindrical portion 40 leading into an inwardly tapering portion 41, as shown. The balancing cylinder formation 38 is provided within the hollow pushrod 8. In the embodiment shown the formation 38 is held within the conduit by radial fins 42, and is fixed in place. Fluid is able to flow freely past fins 42 and into a chamber 43 which is upstream of valve seat 24.

The balancing valve head 36 (which is typically provided with a sealing means such as an O-ring 44) is fixed to the hollow valve stem 34.

The operation of the embodiment shown in Figures 4 and 5 differs from the operation of the embodiment shown in Figures 1-3 as follows.

The hollow valve stem 34 ensures that the pressure in chamber 37 remains close to the pressure immediately downstream of valve head 35, which is in turn approximately equal to the pressure within the barrel 1.

In this way the resultant force from the pressure difference across valve head 35 is essentially balanced by the resultant force from the pressure difference across valve head 36. This greatly

reduces the tendency for valve head 35 to open under the influence of a pressure pulse in chamber 43, as the pressure also acts on the forward facing side of valve head 36, creating a substantially equal and opposite force. This means that the opening of valve head 35 is controlled primarily by diaphragm 11, and reduces the influence of the pressure of the fluid on the upstream side of valve head 35.

In the embodiment shown in Figure 4 and 5, the balancing valve head 36 has a slightly larger diameter than valve head 35. This means that raised pressure in chamber 43 will actually tend to close valve head 35 more firmly.

To reduce friction, O-ring 44 may not be designed to seal within the cylindrical portion 40 of the balancing cylinder 38. The O-ring seal preferably has only a light interference fit, or a small clearance. Leakage past O-ring seal 44 flows through the hollow valve stem 34 and into the barrel 1. When valve head 35 is closed, O-ring 44 seals in the conical bore 41 of the balancing cylinder formation 38 to prevent leakage.

In an alternative embodiment (not shown) the valve stem 34 may be solid, or may not allow fluid communication between the chamber 37 and the conduit downstream of valve head 35. In such an embodiment a separate conduit may be provided to balance the pressure in the chamber 37 with that immediately downstream of valve head 35.

It is noted that the embodiment shown in Figures 4 and 5 does not have a separate component on the downstream side of the piston 5 which carries a one way valve 15a. In this embodiment, the barrel inlet 15b is in the head of the plunger 5. However, in other alternatives the embodiment shown in Figures 1-3 may be used without a separate one way valve 15a, and the embodiment shown in Figures 4 and 5 may be used with a separate one way valve 15a.

While the embodiments shown and described above have a barrel inlet integrated in the piston or plunger, and a barrel outlet provided in an end wall of the barrel, in other embodiments the position of the inlet and outlet may be reversed, while in still further embodiments both the barrel inlet and barrel outlet may be provided at or adjacent the end wall of the barrel.

Referring next to Figures 6-8, a further embodiment of the invention is shown which is a variation on the embodiment shown in Figures 1-3.

In this embodiment the outlet valve 3 is of a type commonly known as an umbrella valve, selected because of its ability to open at relatively low pressure and therefore reduce the squeeze force required to be applied to handles 32. A valve incorporating a spring, as shown in Figure 1, could be used instead.

In this embodiment piston 5 has a hollow shaft 8 with fluid passage 13 and a substantially cylindrical piston head 50. O-ring 6 seals the piston head 50 within the barrel. A felt washer 51 is preferably provided on the atmospheric side of the O-ring seal 6. The washer 51 is soaked in oil and provides lubrication.

The barrel inlets 15 are provided by apertures in the piston head 50, and provide a fluid passage into the barrel. In this embodiment the one way valve 15a is a valve disc which is held in place by a pin 52.

The piston shaft 8 is fitted with jet component 53 which defines an orifice 54 for fluid to flow into a cavity provided in the piston head 50.

An annular diaphragm 11 is clamped to the piston 5 by a clamp ring 58, held in place by integral clips 59. The clips 59 pass through apertures 30 in the piston 5. These apertures 30 also provide venting to one side of the diaphragm 11.

A force transfer component 55 has an outer ring or hub 18 which is (in this figure) separated from the diaphragm 11 by clearance space 31. The force transfer component 55 has multiple spokes 20 which connect the outer hub 18 to an inner portion 56 which carries a sealing washer 57.

A spring 29 biases the force transfer component 55 and the sealing washer 57 against the jet 53, blocking the orifice 54. In this way the sealing washer 57 functions as a valve head 22, and the end of the jet component 53 functions as a valve seat 24.

A plurality of radially inwardly extending fins 60 define a guide for the spring 29 and the force transfer component 55. The fins 60 may also limit the maximum travel of the force transfer component 55, when the outer rim 18 contacts the fins 60. In this way the fins 60 may limit the opening of the sealing washer 57 from the jet component 53, thereby limiting the flow rate of

fluid 61 travelling through the inlet conduits into the barrel. By limiting this flow rate, the magnitude of the pressure pulse created at the end of the barrel refilling stroke may be limited.

As with the embodiment shown in Figures 1-3, the use of the diaphragm 11 to provide an opening force on the sealing washer 57 means that the spring 29 can be configured to provide a relatively high closing force, thereby reducing the likelihood that the pressure pulse created when the piston reaches the end of the refilling stroke will pass into and through the barrel. The ability of the diaphragm itself to deflect (effectively increasing the volume of the inlet conduit), thereby absorbing any small amount of fluid which the pressure pulse does force past the pressure limiting means valve head, also reduces the likelihood that fluid will leak from the outlet valve, even if the fluid pressure required to open the outlet valve is low compared to the applicators of the prior art.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense, that is to say, in the sense of "including, but not limited to".

Where in the foregoing description, reference has been made to specific components or integers of the invention having known equivalents, then such equivalents are herein incorporated as if individually set forth.

Although this invention has been described by way of example and with reference to possible embodiments thereof, it is to be understood that modifications or improvements may be made thereto without departing from the spirit or scope of the invention.

Claims

1. An applicator comprising:
   a fluid supply inlet;
   an outlet;
   a barrel having a barrel outlet and a barrel inlet which is in fluid communication, or selective fluid communication, with the fluid supply inlet;
   a one way outlet valve in fluid communication with the barrel outlet and with the outlet;
   a piston moveable relative to the barrel and in sealing engagement with the barrel;
   piston actuation means for moving the piston relative to the barrel;
   the applicator further comprising pressure limiting means for limiting a maximum pressure of fluid entering the barrel from the fluid supply inlet.

2. The applicator of claim 1 wherein the pressure limiting means is configured such that the fluid entering the barrel has a pressure which is at or below an ambient atmospheric pressure.

3. The applicator of claim 1 or 2, wherein the pressure limiting means is configured such that the fluid entering the barrel has a pressure which is at or below a pressure required to open the outlet valve.

4. The applicator of claim 1, 2 or 3 wherein the pressure limiting means is provided at or adjacent the barrel inlet.

5. The applicator of claim 4 wherein the pressure limiting means is integral with the piston.

6. The applicator of claim 1 wherein the pressure limiting means comprises a diaphragm.

7. The applicator of claim 6 wherein a first side of the diaphragm is in fluid communication, or selective fluid communication, with fluid in the barrel.

8. The applicator of claim 7 wherein an opposite second side of the diaphragm is exposed to ambient atmospheric pressure.

9. The applicator of any one of claims 6 to 8 wherein displacement of the diaphragm changes an internal volume of a conduit supplying fluid to the barrel inlet.

10. The applicator of any one of claims 6 to 9 wherein the diaphragm is carried by the piston.

11. The applicator of any one of claims 6 to 10 provided with a one way valve means for preventing fluid flow from the barrel though the barrel inlet.

12. The applicator of any one of claims 6 to 10 wherein the pressure limiting means is adapted to prevent fluid flow from the barrel inlet to the fluid supply inlet.

13. The applicator of any one of claims 6 to 12 wherein the pressure limiting means comprises a first valve head and a first valve seat, wherein the first valve head can be moved from a closed position to an open position by movement of the diaphragm.

14. The applicator of claim 13 wherein the pressure limiting means comprises a second valve head and second valve seat, wherein the second valve head is connected to the first valve head and moves with the first valve head.

15. The applicator of claim 14 wherein a pressure difference across said first valve head is substantially equal to a pressure difference across said second valve head.

16. The applicator of claim 15 wherein the pressure difference across said first valve head creates a resultant force in a first direction and the pressure difference across said second valve head creates a resultant force in a second direction which is opposite to the first direction.

17. The applicator of claim 16 wherein the resultant forces are substantially equal.

18. The applicator of claim 16 wherein the resultant force on the second valve head is greater than the resultant force on the first valve head.

19. An applicator comprising:

a fluid supply inlet;

an outlet;

a barrel having a barrel outlet and a barrel inlet in fluid communication, or selective fluid communication, with the fluid supply inlet;

a one way outlet valve in fluid communication with the barrel outlet and with the outlet;

a piston moveable relative to the barrel and in sealing engagement with the barrel;

piston actuation means for moving the piston relative to the barrel; and

a diaphragm in fluid contact, or selective fluid communication, with a fluid within the barrel, wherein movement of the diaphragm controls a valve means provided between the fluid supply inlet and the barrel inlet.

20. An applicator system comprising an applicator and fluid supply conduit, the applicator comprising:

a fluid supply inlet;

an outlet

a barrel having a barrel outlet and a barrel inlet in fluid communication, or selective fluid communication, with the fluid supply inlet;

a one way outlet valve in fluid communication with the barrel outlet;

a piston moveable relative to the barrel and in sealing engagement with the barrel;

piston actuation means for moving the piston relative to the barrel;

the fluid supply conduit having an inlet and an outlet which is in fluid communication, or selective fluid communication, with the fluid supply inlet of the applicator;

the system further comprising pressure limiting means for limiting a maximum pressure of fluid entering the barrel in use.

21. An applicator substantially as herein described with reference to any one of Figures 1 to 3, Figures 4 and 5, or Figures 6 to 8.

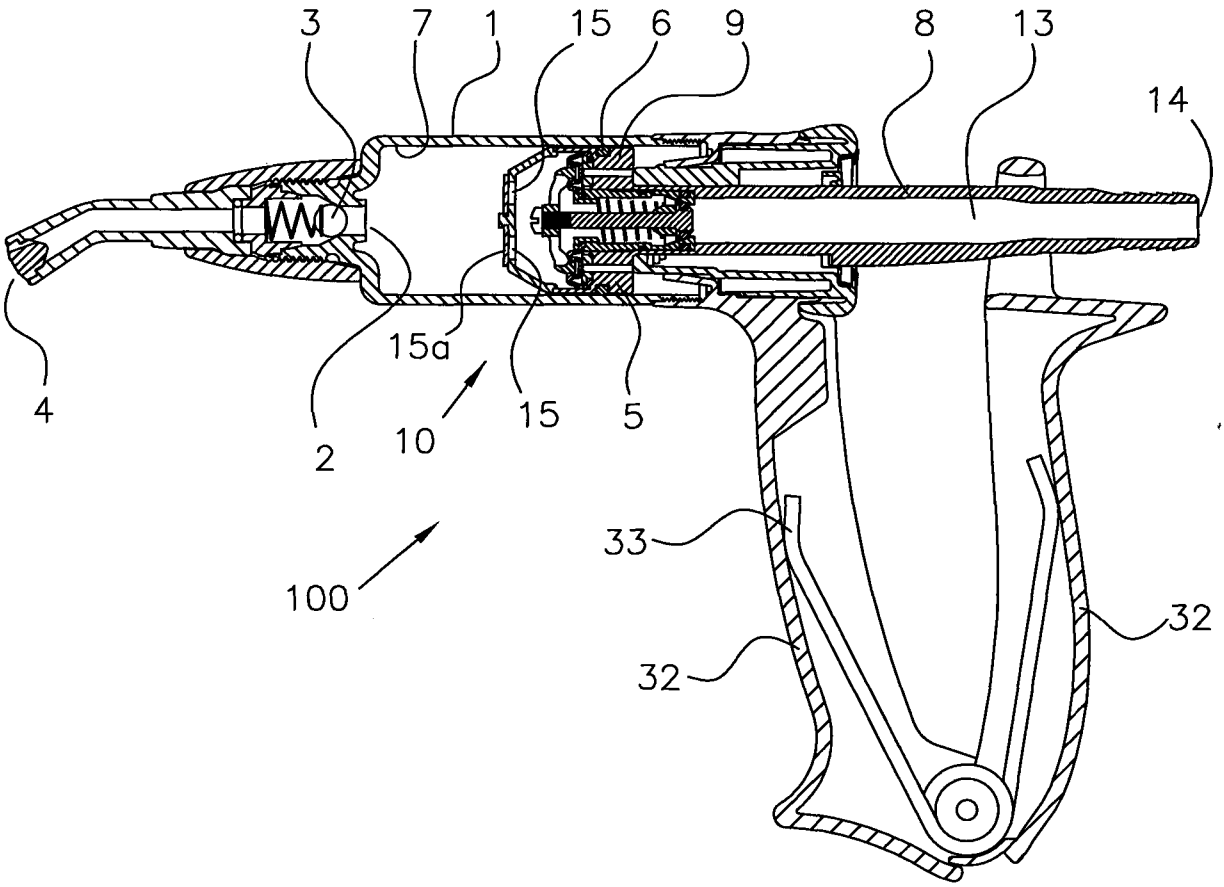


Figure 1

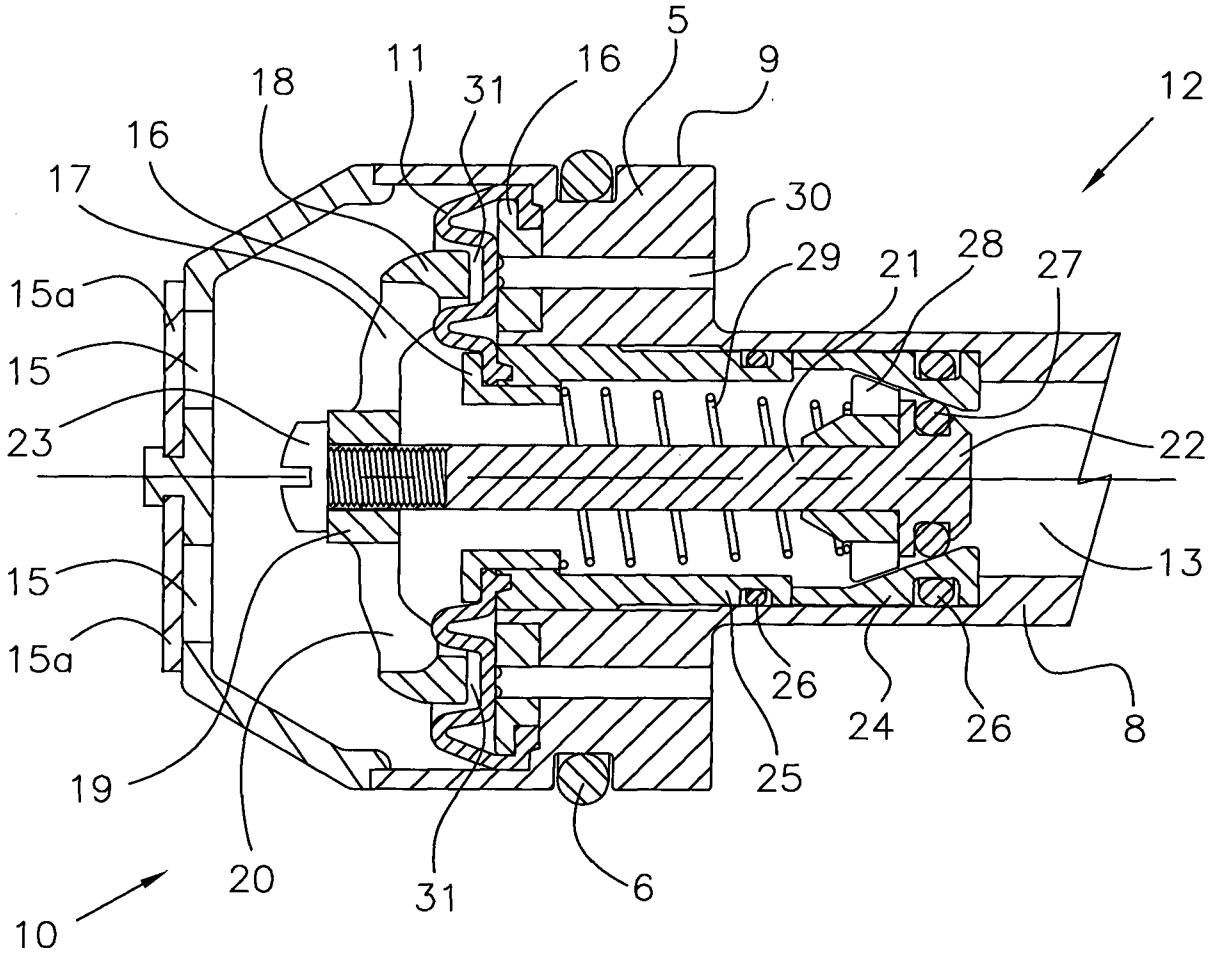

5
11
16
9
18
31
12
16
17
30
29
21
28
27
15a
15
23
22
13
15
15a
26
24
26
8
19
25
20
31
6
10

Figure 2

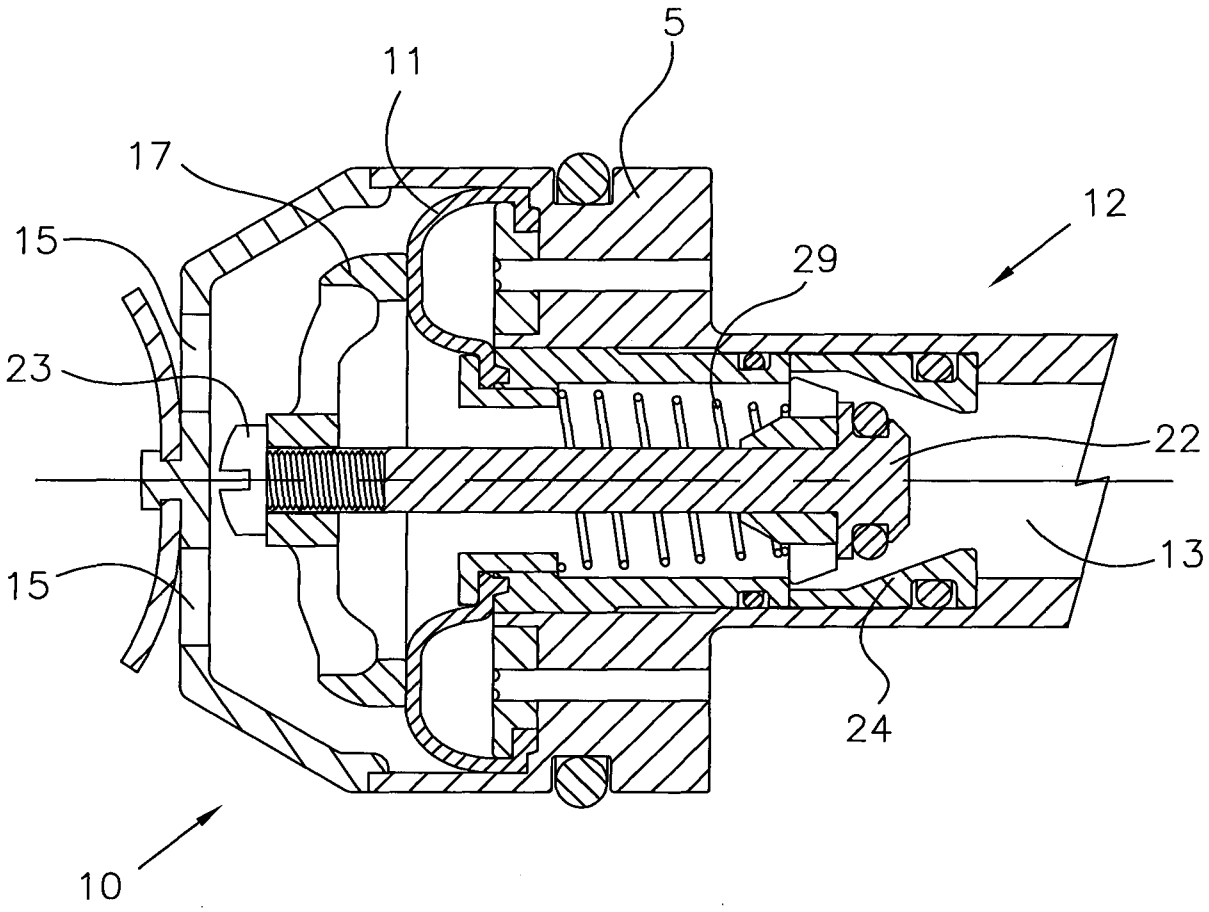


Figure 3

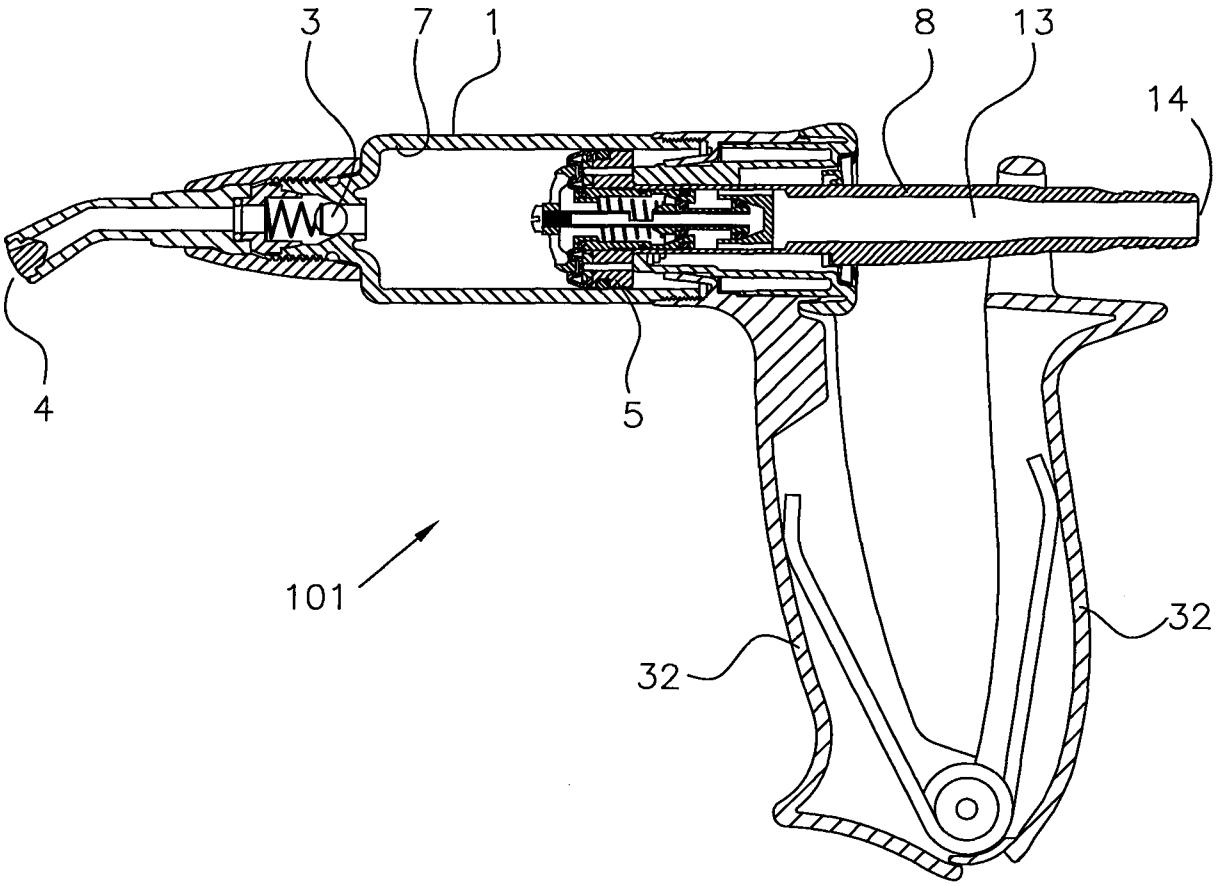


Figure 4

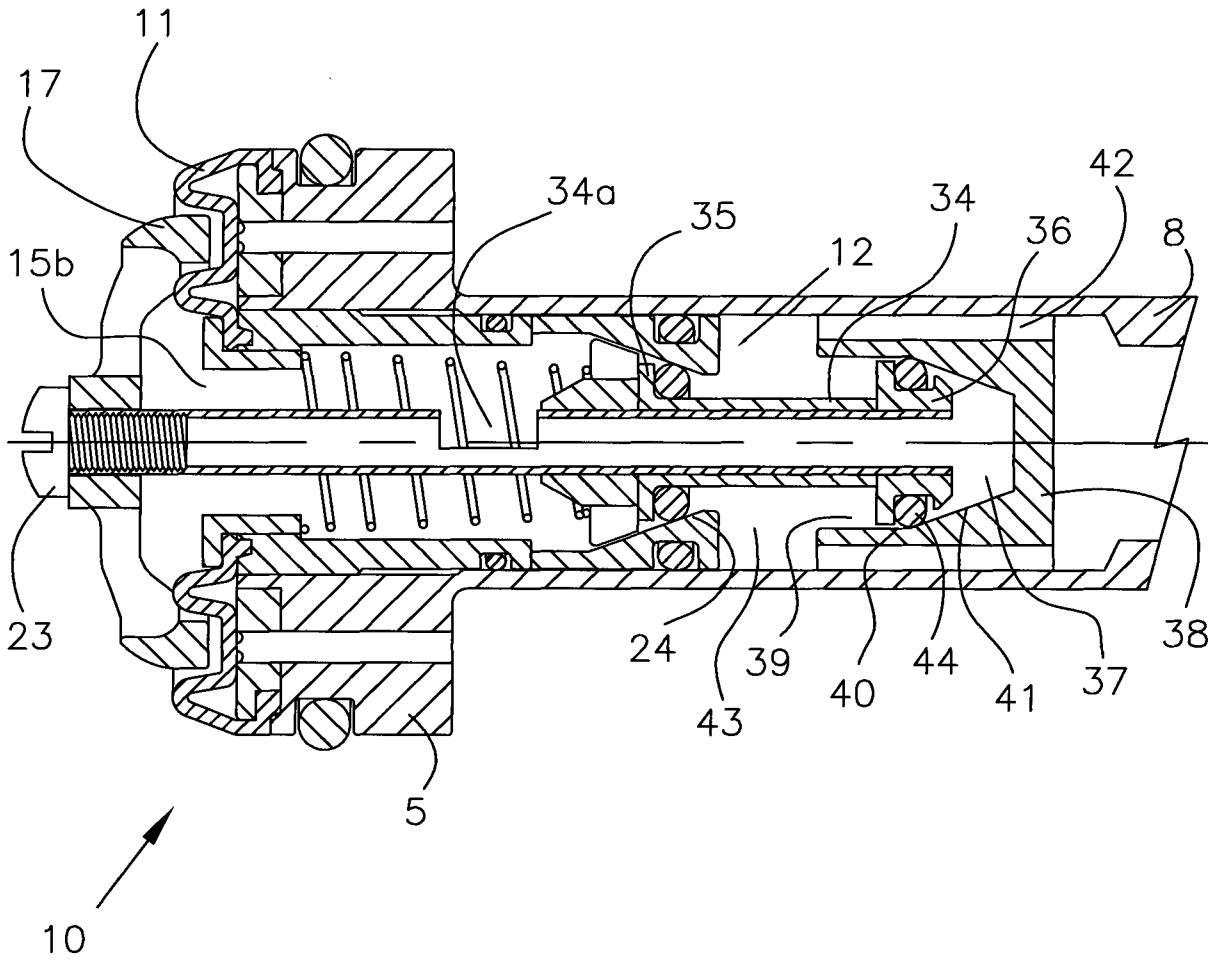


Figure 5

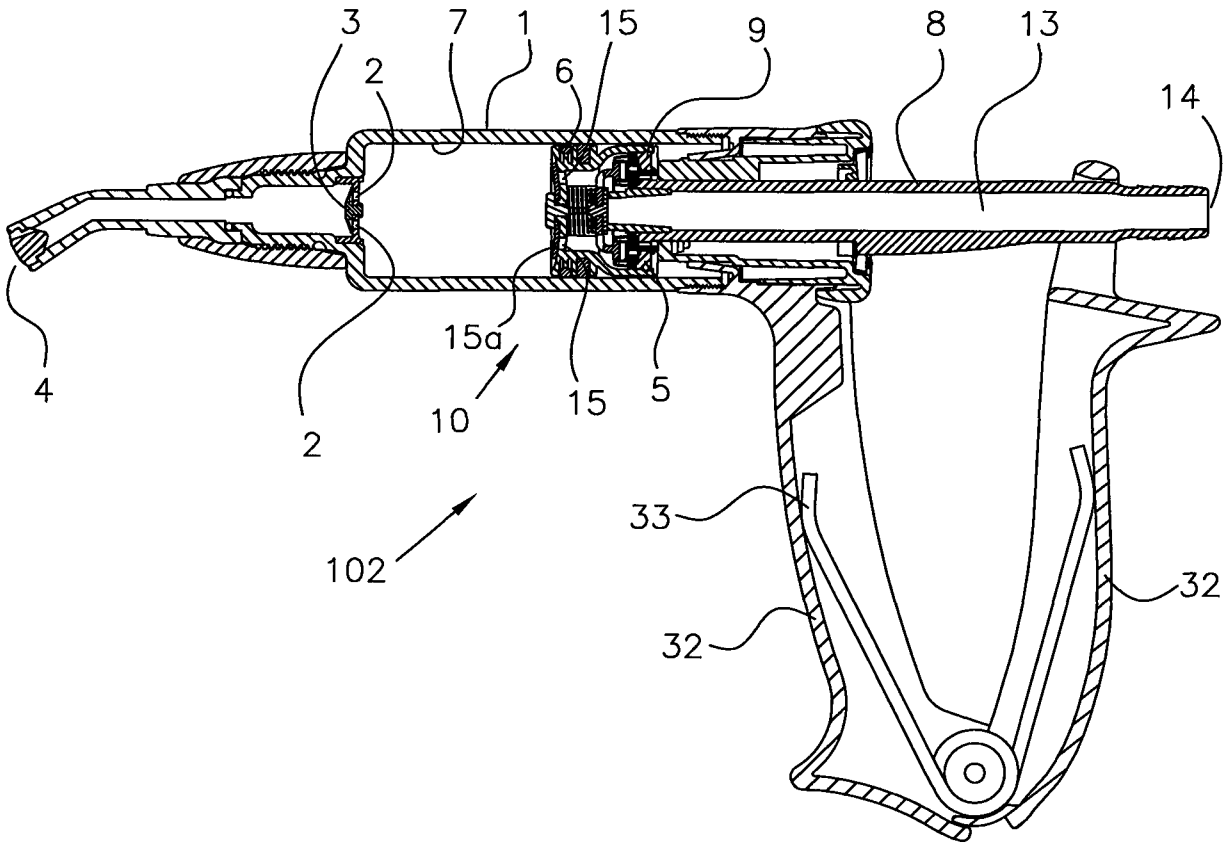


Figure 6

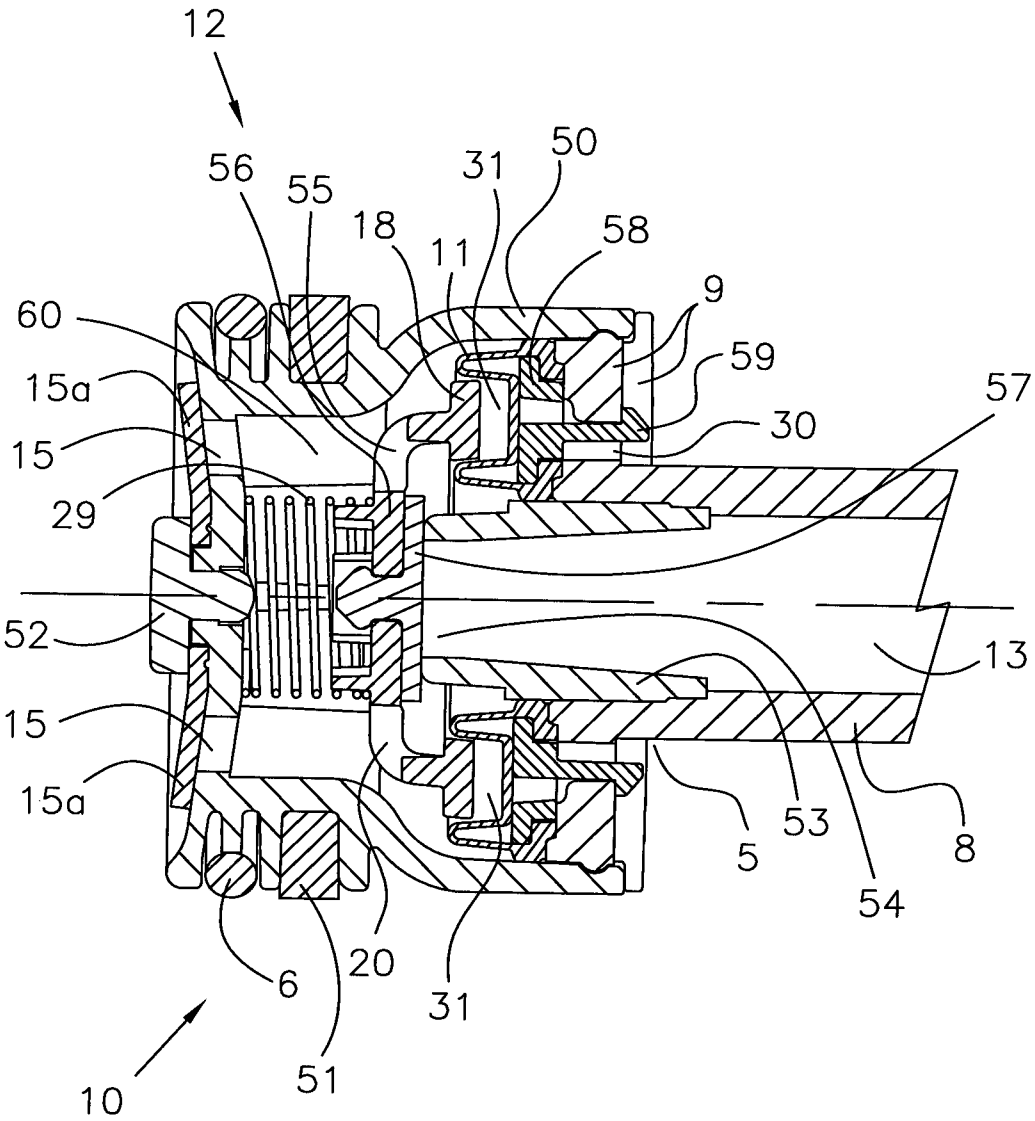

12
56
55
18
11
31
50
58
9
59
57
60
15a
15
29
30
52
13
15
15a
53
5
8
54
6
20
31
51
10

Figure 7

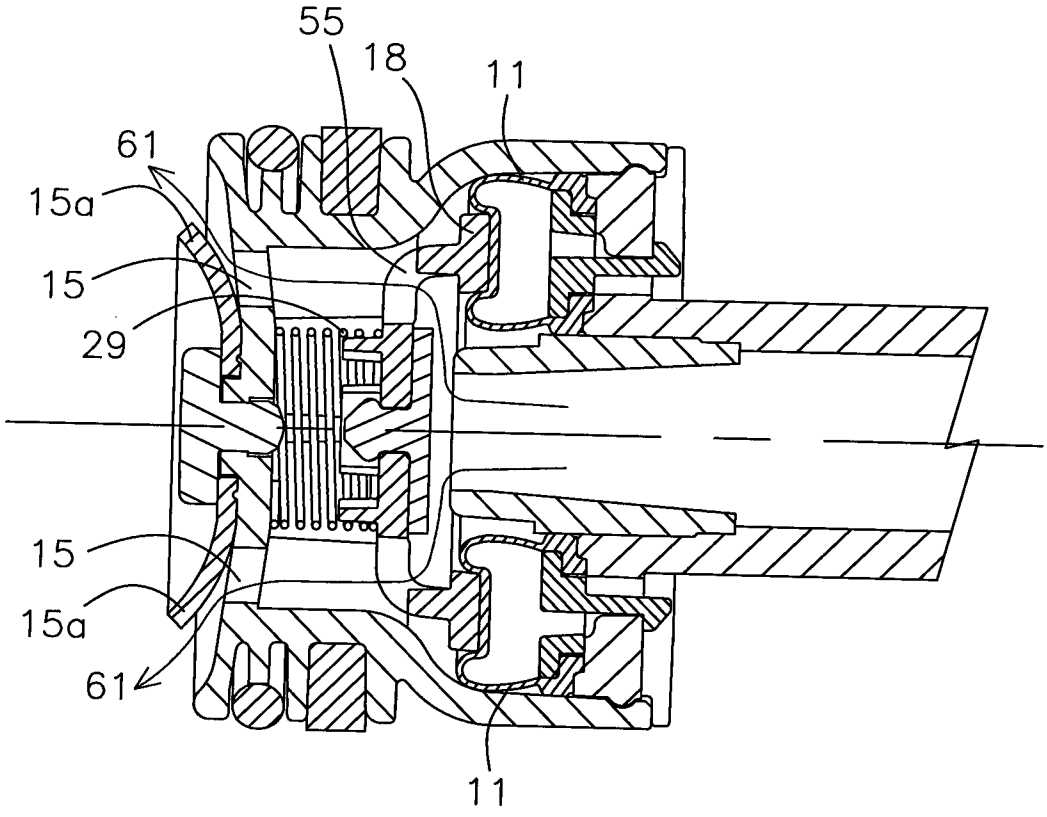


Figure 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2013/000050

A. CLASSIFICATION OF SUBJECT MATTER

B05B 9/00 (2006.01) F16K 11/00 (2006.01) A61D 7/00 (2006.01) B05B 1/00 (2006.01) B05D 1/00 (2006.01)

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)

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 practicable, search terms used)

WPI, EPODOC: Keywords (fluid applicator, valve, piston, pressure, limit, diaphragm & like terms)

Google Patent and Patent Lens Keywords: (fluid applicator, drench gun, valve, piston, pressure differential, reduced pressure, low pressure, diaphragm, barrel) and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

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

[X] See patent family 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 application or patent 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
7 June 2013	07 June 2013

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustralia.gov.au
Facsimile No.: +61 2 6283 7999

Authorised officer

Galvin Koh
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. 0262832985

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/NZ2013/000050**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010/098683 A2 (FORLONG & MAISEY LIMITED T/A INSTRUMENT) 02 September 2010 page 48, lines 3-10; FIGS 14-17	1 and 20
A	US 4674526 A (ATHANASSIU) 23 June 1987 FIGS 2 and 3	19
A	US 5322191 A (JOHNSON et al.) 21 June 1994 FIGS 1 and 2	1-20
A	EP 0080112 B1 (WELLCOME NEW ZEALAND LIMITED) 04 January 1989 page 4, line 59-page 5, line 55	6-18
A	US 3948285 A (FLYNN) 06 April 1976 FIG 2	1-20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2013/000050

Box No. 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.: **21**
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:
See Supplemental Box

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 No. 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:

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 additional fees, this Authority did not invite payment of additional fees.
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 and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Supplemental Box

Continuation of **Box II**

The claim 21 does not comply with Rule 6.2(a) because it relies on references to the drawings.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/NZ2013/000050**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
WO 2010/098683 A2	02 Sep 2010	AU 2010218507 A1	08 Sep 2011
		NZ 575252 A	30 Jun 2011
		US 2011315716 A1	29 Dec 2011
		WO 2010098683 A2	02 Sep 2010
US 4674526 A	23 Jun 1987	US 4674526 A	23 Jun 1987
US 5322191 A	21 Jun 1994	AU 3928793 A	24 Jan 1994
		AU 3930393 A	24 Jan 1994
		CA 2048529 A1	07 Mar 1992
		CA 2048569 A1	04 Oct 1992
		CA 2084805 A1	23 Oct 1993
		CA 2092758 A1	23 Dec 1993
		CA 2092760 A1	09 Dec 1993
		CA 2092761 A1	23 Dec 1993
		FR 2666644 A1	13 Mar 1992
		FR 2666645 A1	13 Mar 1992
		FR 2666645 B1	28 Apr 1995
		GB 2249268 A	06 May 1992
		GB 2249268 B	03 Aug 1994
		GB 2249734 A	20 May 1992
		IT MI912343 A1	07 Mar 1992
		IT 1251391 B	09 May 1995
		IT MI912660 A1	04 Oct 1992
		IT 1251661 B	19 May 1995
		JP H04263795 A	18 Sep 1992
		JP 2517502 B2	24 Jul 1996
		JP H0694395 A	05 Apr 1994
		US 5074437 A	24 Dec 1991
		US 5074437 B1	16 Dec 1997
		US 5150819 A	29 Sep 1992
		US 5238149 A	24 Aug 1993
		US 5292032 A	08 Mar 1994
		US 5305918 A	26 Apr 1994
		US 5305919 A	26 Apr 1994
		US 5305919 B1	16 Dec 1997

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/NZ2013/000050**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
		US 5318202 A	07 Jun 1994
		US 5322191 A	21 Jun 1994
		US 5332120 A	26 Jul 1994
		WO 9400210 A1	06 Jan 1994
		WO 9400244 A1	06 Jan 1994
EP 0080112 B1	04 Jan 1989	AR 229713 A1	31 Oct 1983
		AU 550343 B2	20 Mar 1986
		AU 9026882 A	02 Jun 1983
		BR 8206486 A	27 Sep 1983
		CA 1192799 A1	03 Sep 1985
		DK 505682 A	25 May 1983
		DK 160532 B	25 Mar 1991
		EP 0080112 A2	01 Jun 1983
		EP 0080112 B1	04 Jan 1989
		ES 8400864 A1	16 Feb 1984
		GB 2111392 A	06 Jul 1983
		GB 2111392 B	18 Dec 1985
		IE 56436 B1	31 Jul 1991
		JP S5894849 A	06 Jun 1983
		JP H0372299 B2	18 Nov 1991
		NZ 199049 A	13 Dec 1985
		NZ 201756 A	13 Dec 1985
		US 4552559 A	12 Nov 1985
		ZA 8208182 A	28 Sep 1983
US 3948285 A	06 Apr 1976	AU 8575975 A	21 Apr 1977
		JP S5187826 A	31 Jul 1976
		US 3948285 A	06 Apr 1976

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.