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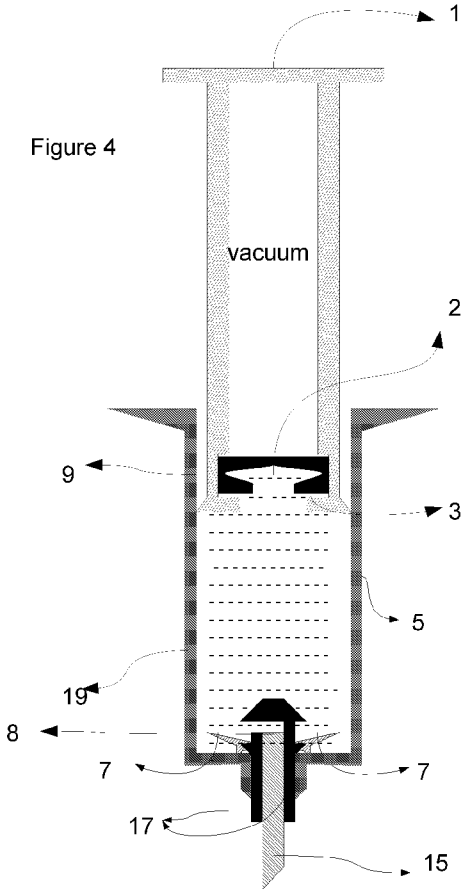
(54) Title: SYRINGE WITH NEEDLE RETRACTABLE INTO THE PLUNGER BY VACUUM

Figure 4



(57) Abstract: A plunger, clip and needle assembly that can be fitted to a conventional syringe barrel thereby allowing the needle assembly to automatically retract after use into a safety compartment located in the plunger, thus preventing re-use of the syringe and needle stick injuries. Retraction of the needle assembly is accomplished from minimal moving parts according to a simple design and requires the user to have no training, the creation of the retracting force is completely intuitive.

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SYRINGE WITH NEEDLE RETRACTABLE INTO THE PLUNGER BY VACUUM

This invention relates generally to a safety syringe of the type for use with a hollow needle. In particular the present invention relates to a hollow plunger and clip that can be fitted to a conventional syringe that uses separately fitted needle assemblies with various needle sizes according to the task. After use of the syringe the needle and assembly are retracted into a storage chamber, located in the plunger, thereby preventing accidental pricking after use and making the syringe so it cannot be re-used. The retraction of the needle and assembly is effected by a vacuum created prior to normal operation of the syringe. The retraction is effected automatically during normal operation of the syringe and requires no additional actions from the user of the syringe. A syringe of this general type is sometimes referred to as an "auto retractable safety syringe"; what is meant by this term is that the needle retracts within the body of the syringe automatically and not by any additional manual actions and furthermore the syringe and/or needle cannot be re-used.

It is well known that many dangerous communicable diseases are spread through contacting the body fluids of an infected person. After use of a syringe, residual body fluids are likely to remain on or within the syringe needle. For this reason, syringes are typically intended for a single use only. In order to be handled safely after use, the needle of a syringe must be covered to prevent it from accidentally pricking a person who is, for example, collecting the syringe for disposal, thereby releasing residual body fluids into such person. Typically, a protective cap is provided with the syringe, which after use of the syringe, can be used to cover the tip of the needle. However, it sometimes happens that persons attempting to cap a used needle miss the cap and accidentally stab themselves, resulting in potential exposure to communicable diseases. Further, spread of communicable and dangerous diseases is effected by drug-addicted individuals sharing and re-using needles and syringes intended for single use. There have been several attempts to address this problem by incorporating into syringes, mechanisms for retracting the needle into the syringe following use and thereby preventing re-use.

U.S. Patent No. 5,334,155 (Sobel, 2 August 1994) discloses a needle guard comprising an evacuated double walled protective sheath. Before use, the partial vacuum within the protective sheath causes the sheath to fold inwardly upon itself so that the needle extends beyond the protective sheath and may be used for injections. Subsequent to injection, the double wall of the protective sheath can be breached in one place so that the inside of the protective sheath reaches atmospheric pressure. The protective sheath then extends to cover the projecting needle. However, the protective sheath may interfere with use of the syringe as it may obstruct the view of the point the needle is to be inserted into the patient. In addition, it is inconvenient to use; after injection, the user must change the user's hand position on the syringe in order to breach the double wall and activate the sheath. In this manner activation of the safety mechanism is not automatic following injection of the medicament.

The protective safety device shown in U.S. Patent No. 5,188,614 (Hart, 23 February 1993) is a hollow cylindrical casing that encompasses the syringe. A dual component foaming agent is disposed at the downstream end of the casing. Following injection, the two components of the dual component foaming agent are mixed, creating an expanding foam mixture that forces the syringe back within the casing and encompasses the needle. However, this device suffers from the disadvantages that the casing may interfere with the use of the syringe in making injections as it is designed to fit over a conventional syringe thereby changing the size and feel of the device as compared to a conventional syringe. In addition, a considerable amount of material is necessary in order to make the protective sheath, increasing the expense of both making and disposing of the device.

U.S. Patent No. 6,193,695 (Rippstein, 27 February 2001) discloses a safety syringe comprising a vacuum chamber on the upstream side of the plunger head. Following injection of medicament, the plunger head engages the needle head, the ambient atmospheric pressure external to the needle head acts on the needle head, forcing the needle and plunger back against the vacuum into

the syringe body. The plunger arm may then be snapped off by the user to prohibit further use of the needle. This device suffers from the disadvantage that accidental re-extension of the needle is possible if the plunger arm is not snapped off by the user. A further disadvantage of this device is that if the user does not apply a constant injection force, there is the possibility that the plunger will retract under the vacuum before the medicament is completely injected, thereby causing the syringe to work in reverse especially when clearing an air bubble in the fluid.

U.S. Patent No. 6,413,236 (Van Dyke, 2 July 2002) discloses a safety syringe comprising a vacuum chamber on the upstream side of the plunger head. Following injection of medicament, the plunger head engages the needle head, and the ambient atmospheric pressure external to the needle head acts on the needle head, forcing the needle and plunger back against the vacuum into the syringe body. In this patent, in contrast to U.S. Patent No.6,193,695 , the needle is lodged in the syringe body at an angle so that the piercing tip end of the needle is pressed against the inner surface of the syringe prohibiting re-extension of the needle even though the plunger arm is fully extended outside the syringe body. However, this device still has the disadvantage that if the user does not apply a constant injection force, there is the possibility that the plunger will retract under the vacuum before the medicament is completely injected, thereby causing the syringe to work in reverse especially when clearing an air bubble in the fluid.

There are other designs where a vacuum is pre-formed at manufacturing stage in the plunger body. However this adds a manufacturing cost and there is a loss of vacuum over time which means the product has a shelf life and therefore cannot be described as totally reliable.

A syringe designed to provide an optimal solution to the problem of prevention of accidental needle pricking after the use of the syringe for injection would include the following characteristics:

1. The syringe mechanism should be relatively simple, in that it should be made from as few parts as possible, consistent with its design objectives, and should be simple to operate with no training required for use.

2 The syringe mechanism should reliably retract the needle so that accidental pricking is prevented.

3. The syringe should be as inexpensive to manufacture as possible.

4. There should be as little waste as possible from plastics and other materials on disposal.

5. Safety-related means should not appreciably interfere with the feel of the syringe in the Hand of the user.

6. Once the needle has been retracted, a reliable safety device should prevent the needle from becoming once again exposed.

It is at least an object of one or more aspects of the present invention to solve one or more of the above-mentioned problems and to provide an improved syringe with a retractable-needle that also achieves one or more of the objectives stated above as numbers 1 to 6.

According to a first aspect of the present invention, there is provided a plunger for a syringe, the plunger comprising a storage chamber for storing a needle assembly and means for creating a retracting vacuum within the storage chamber, wherein the retracting vacuum is operable to retract a needle assembly into the storage chamber.

Preferably the means for creating a retracting vacuum comprises a secondary plunger.

Preferably the secondary plunger is located within the storage chamber.

Preferably the secondary plunger is moveable, preferably between a first position and a second position in the storage chamber.

Preferably in the first position the secondary plunger is depressed[CT1] and substantially inside the storage chamber, preferably in the second position the secondary plunger is withdrawn and substantially outside the storage chamber.

Preferably in moving from the first position to the second position, the secondary plunger creates the retracting vacuum within the storage chamber.

Preferably the secondary plunger is one-use and preferably non-returnable from the second position.

Preferably the secondary plunger comprises a rod, and a plug.

Preferably in the first position the rod is retracted within the storage chamber and the plug is located at an upper end of the storage chamber, and in the second position the rod is released from the storage chamber [CT2]and the plug is located at a lower end of the storage chamber.

Preferably in the first position, the rod extends from the lower end of the storage chamber, preferably the rod extends by an amount sufficient to allow the rod to be grasped by a user.

Advantageously in the first position, the extension of the rod of the secondary plunger from the lower end of the storage chamber blocks any needle assembly from being mounted within a syringe before the rod has been removed. Therefore the retracting vacuum must be created before a needle assembly can be used in a syringe, thereby preventing incorrect use of the plunger of the invention. [A3]

Preferably a receiving chamber [CT4][A5]is located at the lower end of the storage chamber. Preferably the receiving chamber is operable to receive at least a part of the plug. More preferably, the receiving chamber is operable to receive at least a part of the plug upon movement from the first position to the second position.

Preferably in the second position at least a part of the plug is received in the receiving chamber, more preferably the plug expands into the receiving chamber. [CT6]

Preferably in the first position, the plug and rod are coupled together.

Preferably in the second position, the rod is released from the plug, therefore allowing full release of the rod. [A7]

Preferably the rod is released from the plug by expansion [CT8]of the plug into the receiving chamber. Preferably the rod is then removable from the plunger.

Preferably the plug comprises a socket in which an end of the rod is captivated, upon expansion of the plug into the receiving chamber, the socket deforms and the end of the rod is released.

Preferably therefore, the plug is formed from an expandable material, such as for example rubber.

Preferably, by movement of the rod and plug from the first to the second position, a retracting vacuum is created within the storage chamber, more preferably the rod enables a user to move the plug from the first position to the second position and create the retracting vacuum.

Preferably the plug, when located in the second position in the receiving chamber, seals the storage chamber, and therefore seals the retracting vacuum therein.

Preferably the storage chamber is sized so as to house the needle assembly without any needle protrusion from the plunger.

Preferably the storage chamber is sized to accommodate any needle size that may be used within the needle assembly.

According to a second aspect of the present invention, there is provided a barrel for a syringe comprising a fluid storage compartment, a plunger according to the first aspect of the present invention, and retaining means for a needle assembly. Preferably the retaining means for a needle assembly comprises a clip operable to mutually engage with a needle assembly, suitably when a needle assembly is inserted therein.

Preferably the clip is annular.

Preferably the clip comprises a release mechanism.

Preferably the release mechanism is operable to release the needle assembly from the retaining means and allow the needle assembly to move.

Preferably the plunger is operable to move between a first position and a second position, preferably the plunger is withdrawn in the first position, and depressed in the second position. Preferably in the withdrawn position the fluid storage compartment is filled with fluid. Preferably in the depressed position the fluid storage compartment is empty of fluid. [CT9]

[A10]

Preferably, movement of the plunger to the first position draws fluid into the fluid storage compartment. Preferably movement of the plunger from the first to the second position expels fluid from the fluid storage compartment.

Preferably the fluid movement into or out of the fluid storage compartment is via the needle assembly.

The fluid in the barrel may be a gas and/or liquid, preferably the fluid is a liquid, more preferably a liquid for providing a medical or cosmetic benefit, for example: relief from and/or treatment and/or therapy and/or diagnosis of a disease and/or ailment and/or condition. Alternatively, the liquid is for providing an anesthetic effect. [A11]

Preferably the release mechanism is activated when the plunger is depressed, in the second position. More preferably, the release mechanism is activated by pressure exerted thereon by the plunger when depressed.

According to a third aspect of the present invention, there is provided a syringe comprising a barrel according to a second aspect, a plunger according to the first aspect, and a needle assembly.

Preferably the needle assembly is operable to move between a first position, and a second position.

Preferably the first position is such that the needle assembly is extended and exposed. Preferably the second position is such that the needle assembly is retracted and protected. Preferably the needle assembly is protected within the storage chamber of the plunger.

Preferably the needle assembly is in the first position during use of the syringe, and preferably the needle assembly is in the second position after use of the syringe.

Preferably the needle assembly is moved between the first and second positions by the retracting vacuum within the storage chamber.

Preferably the retracting vacuum is created as described above in relation to the first aspect.

Preferably the retracting vacuum is exerted on the needle assembly after depression of the plunger.

Preferably, depression of the plunger allows the retracting vacuum to exert on the needle assembly by activation of the release mechanism, as described above in relation to the second aspect, and by removal of the plug from the receiving chamber. More preferably, full depression of the plunger allows the retracting vacuum to exert on the needle assembly.

Preferably both the release mechanism is activated and the plug is removed from the receiving chamber by the depression of the plunger, preferably both simultaneously. Preferably both actions must take place before the retracting vacuum is exerted on the needle assembly.

Preferably, the plug is removed from the receiving chamber by deformation of the plug such that it is no longer received within the receiving chamber. Preferably deformation of the plug is caused by the needle assembly engaging with the socket of the plug, said socket being empty after the removal of the rod therefrom before use of the syringe.

Preferably the needle assembly engages with the socket of the plug by pressure exerted thereon when the plunger is depressed.

Upon removal of the plug from the receiving chamber and activation of the needle assembly release mechanism, preferably the plug and needle assembly are engaged, and preferably the plug and needle assembly are moved from the first position to the second position, and are therefore retracted into the storage chamber of the plunger by the action of the retracting vacuum therein.

According to a fourth aspect of the present invention there is provided a needle assembly for use with the syringe according to the third aspect.

Preferably the needle assembly is sized to fit within the syringe, preferably within the barrel, more preferably within the storage chamber of the plunger.

Preferably the needle assembly is operable to be attached to the syringe, preferably attached to the barrel of the syringe. Preferably the needle assembly is attached to the syringe by engagement with the retaining means, more preferably by engagement with the retaining clip.

Preferably the needle assembly comprises a head and a needle.

Preferably the head comprises one or more protrusions. Preferably the protrusions are annular. Preferably the protrusions extend outwards from the head, preferably to form a channel. Preferably the channel is annular. Preferably the channel is operable to mutually engage the retaining means, more preferably the retaining means rests within the channel.

Preferably the one or more protrusions form a seal against the retaining means, thereby preventing loss of fluid during dispensing or failure to draw fluid in during filling of the barrel. Preferably the protrusions are formed from a sealing material, such as for example a rubber or plastic material.

Preferably the needle assembly further comprises a port for allowing fluid to be drawn into and dispensed from the barrel. Preferably the port is in fluid communication with the barrel and the needle.

Preferably the port extends into the head laterally such that when the plunger is fully depressed the port is exposed. Preferably therefore when the plunger is fully depressed, the fluid in fluid storage compartment can still exit the barrel. Preferably the port extends laterally through the head from one side to an opposing side.

Preferably the lateral port extends circumferentially around the head such that fluid in the fluid storage compartment can exit the barrel at any point on a side of the head.

Alternatively, the port extends into the head vertically. In such an embodiment, the head preferably comprises vertically aligned serrations, preferably the serrations are present on the outside of the head. Preferably therefore the head comprises a serrated circumference. Preferably therefore when the plunger is fully depressed, and the needle assembly enters the plug, the fluid in fluid storage compartment can travel up and over the head via the serrations and still exit the barrel. [A12]

Preferably the head of the needle assembly is sized so as to engage with the socket of the plug, such that when the plunger is depressed, preferably fully depressed, the head of the needle assembly is engaged within the socket of the plug.

According to a fifth aspect of the present invention, there is provided a kit for assembling a syringe according to the third aspect comprising:

(a) A plunger as defined in relation to the first aspect;
(b) A barrel as defined in relation to the second aspect;
(c) One or more needle assemblies as defined in relation to the fourth aspect.

Optionally, the kit may comprise various needle assemblies of different gauges and shapes for different applications.

Advantageously, the present invention proposes that the user can select different size needles without any modification required in order for the system to operate.[A13]

Optionally the kit may comprise one or more fluids for use with the syringe, the fluid being defined as hereinabove.

Further preferred features of the kit are as defined above in relation to the first, second, third, and fourth aspects.

Any of the above aspects and preferred features may be combined in any combination.

Advantageously, during normal use of the syringe, as the fluid is drawn into the fluid compartment and as it is dispensed from the fluid compartment by movement of the hollow plunger, the needle assembly is held outside the storage chamber of the hollow plunger and kept exposed by the retaining clip. However, as soon as all of the fluid is dispensed from the barrel and the plunger and is fully depressed in the second position, [CT14][A15]the plunger engages with the retaining clip and releases the needle assembly, which is then drawn into the hollow plunger by the retracting force of the vacuum thereon such that the needle and assembly are no longer exposed.

Advantageously, the present invention requires the user only to remove the rod from the plunger in order for the system to operate there are no additional movements or actions required by the user other than use of the syringe in a conventional manner.

Advantageously, the syringe of the present invention can only be used once.
Advantageously, the syringe of the present invention does not require a complex manufacturing process, or have a complex mechanism.

Some preferred embodiments of the present invention will now be described solely by way of example and with reference to the accompanying figures in which:

Figure 1 shows a cross sectional of one embodiment of a syringe prior to fitting the needle assembly.

Figure 2 shows a cross sectional of one embodiment of a syringe with the drawing stick nearly removed from the syringe, the stick has pulled the grommet from its start position as shown in figure 1 and thus created a vacuum.

Figure 3 shows a cross sectional of one embodiment of a syringe with the vacuum created the stick dispensed with and the needle assembly fitted and ready to use.

Figure 4 shows a cross sectional of one embodiment of a syringe with the vacuum created and the plunger withdrawn to an upward position so that the syringe barrel is filled with fluid.

Figure 5 shows a cross sectional of an embodiment of a syringe where all the fluid has been dispensed the plunger has reached its final position, the retaining clip has been released and the needle assembly has been drawn up into the plunger.

In Figure 1 a syringe assembly is shown prior to fitting the needle assembly a fluid plunger 1 is shown prior to use with the head of a drawing stick 11 securely attached into a chamber 2 of the grommet 3 in the starting position at the top of the plunger 1. The syringe barrel 5 cannot be fitted with a needle assembly to be held in place by the clips 7 because the drawing stick is occupying the position of the needle head. An expansion chamber 9 within the body of the hollow plunger 1 is shown empty as it would be at this stage of use of the syringe.

In Figure 2 a syringe assembly is shown where the user has withdrawn the stick 11 to a position where the grommet 3 has been drawn from its starting position towards the head of the hollow plunger 1 and come to rest in an expansion chamber 9. As the grommet 3 has been drawn into the expansion chamber 9 it has created a vacuum within the plunger 1. The expansion chamber 9 allows the grommet 3 to expand to such an extent that the internal

chamber 2 cannot maintain the grip on the stick 11 and it is shown partially withdrawn from the syringe assembly. The expansion chamber 9 is so designed that in allowing the grommet 3 to expand the vacuum force created is not great enough to retract the grommet from its position in the chamber 9.

In Figure 3 a needle 15 and head 17 collectively known as a needle assembly are shown fitted to the syringe barrel 5. The head 17 is held in place by the retaining clip 7 and cannot move upwards or downwards. The clip 7 also makes a gas and fluid seal between the head 17 and the inside of the syringe barrel 5 such that movement of the plunger 1 upwards will fill the barrel 5 with gas or fluid drawn in through the hollow needle 15 and in through the port 8 and a downwards movement of the plunger 1 will eject gas or fluid out through port 8 and the hollow needle 15.

In Figure 4 a syringe assembly is shown where fluid has been drawn into the syringe barrel 19 by an upwards movement of the plunger 1 this has caused fluid to be drawn in through the hollow needle 15 into the head of the assembly 17 and out into the barrel 19 via the port 8.

In Figure 5 the plunger 1 has been moved to its most forward position, this has dispensed all the contents of the barrel 5 out through the needle 15. When the plunger is in this position the needle assembly head 17 is pushed into the chamber 2 of the grommet 3, it also displaces the grommet 3 from its anchorage in the chamber 9. Simultaneously the plunger 1moves the retaining clip 7 outwards such that the needle head 17 is no longer retained, the retracting vacuum force acts upon the displaced grommet 3 that has now engaged the needle head 17 in the chamber 2 of the grommet 3. Since the retaining clip 7 is not now securing the needle head 17 the retracting vacuum force pulls the grommet 3 along with the needle head 17 and needle 15 up into the plunger 1 as shown in the drawing. The syringe cannot now be re-used and the needle cannot prick anybody.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A plunger for a syringe, the plunger comprising a storage chamber for storing a needle assembly and means for creating a retracting vacuum within the storage chamber, wherein the retracting vacuum is operable to retract a needle assembly into the storage chamber.

2. A plunger according to claim 1, wherein the means for creating a retracting vacuum comprises a secondary plunger located within the storage chamber.

3. A plunger according to claim 2, wherein the secondary plunger is moveable, preferably between a first position and a second position in the storage chamber.

4. A plunger according to claim 3, wherein in the first position the secondary plunger is depressed and substantially inside the storage chamber, and in the second position the secondary plunger is withdrawn and substantially outside the storage chamber.

5. A plunger according to any of claims 3 or 4, wherein in moving from the first position to the second position, the secondary plunger creates the retracting vacuum within the storage chamber.

6. A plunger according to any of claims 3-5, wherein the secondary plunger is non-returnable from the second position.

7. A plunger according to any of claims 2-6, wherein the secondary plunger comprises a rod, and a plug.

8. A plunger according to claim 7, wherein in the first position the rod is retracted within the storage chamber and the plug is located at an upper end of the storage chamber, and in the second position the rod is released from the storage chamber and the plug is located at a lower end of the storage chamber.

9. A plunger according to claim 8, wherein in the first position, the rod extends from the lower end of the storage chamber by an amount sufficient to allow the rod to be grasped by a user.

10. A plunger according to any of claims 8-9, wherein a receiving chamber is located at the lower end of the storage chamber and the receiving chamber is operable to receive at least a part of the plug.

11. A plunger according to claim 10, wherein the receiving chamber is operable to receive at least a part of the plug upon movement of the secondary plunger from the first position to the second position.

12. A plunger according to claim 11, wherein in the second position at least a part of the plug is received in the receiving chamber.

13. A plunger according to any of claims 7-12, wherein in the first position, the plug and rod are coupled together and in the second position, the rod is released from the plug.

14. A plunger according to claim 13, wherein the rod is released from the plug by expansion of the plug into the receiving chamber.

15. A plunger according to any of claims 7-14, wherein the plug comprises a socket in which an end of the rod is captivated.

16. A plunger according to claim 15, wherein upon expansion of the plug into the receiving chamber, the socket deforms and the end of the rod is released.

17. A plunger according to any of claims 7-16, wherein by movement of the rod and plug from the first to the second position, the retracting vacuum is created within the storage chamber.

18. A plunger according to any of claims 7-17, wherein the rod enables a user to move the plug from the first position to the second position and create the retracting vacuum.

19. A plunger according to any of claims 8-18, wherein in the second position, the plug seals the storage chamber, and seals the retracting vacuum therein.

20. A barrel for a syringe comprising a fluid storage compartment, a plunger according to any of claims 1-19, and retaining means for a needle assembly.

21. A barrel according to claim 20, wherein the retaining means for the needle assembly comprises a clip operable to mutually engage with the needle assembly when the needle assembly is inserted therein.

22. A barrel according to claim 21, wherein the clip comprises a release mechanism.

23. A barrel according to claim 22, wherein the release mechanism is operable to release the needle assembly from the retaining means and allow the needle assembly to move.

24. A barrel according to any of claims 20-23, wherein the plunger is operable to move between a first position and a second position.

25. A barrel according to claim 24, wherein the plunger is withdrawn in the first position, and depressed in the second position.

26. A barrel according to claim 25, wherein in the first withdrawn position the fluid storage compartment is filled with fluid and in the second depressed position the fluid storage compartment is empty of fluid.

27. A barrel according to any of claims 25 or 26, wherein the release mechanism is activated when the plunger is depressed, in the second position.

28. A barrel according to claim 27, wherein the release mechanism is activated by pressure exerted thereon by the plunger when depressed.

29. A syringe comprising a barrel according to any of claims 20-28, a plunger according to any of claims 1-19, and a needle assembly.

30. A syringe according to claim 29, wherein the needle assembly is operable to move between a first position, and a second position.

31. A syringe according to claim 30, wherein the first position is such that the needle assembly is extended and exposed, and the second position is such that the needle assembly is retracted and protected.

32. A syringe according to claim 31, wherein the needle assembly is protected within the storage chamber of the plunger.

33. A syringe according to any of claims 30-32, wherein the needle assembly is in the first position during use of the syringe, and the needle assembly is in the second position after use of the syringe.

34. A syringe according to any of claims 30-33, wherein the needle assembly is moved between the first and second positions by the retracting vacuum within the storage chamber.

35. A syringe according to claim 34, wherein the retracting vacuum is exerted on the needle assembly after depression of the plunger in the second position.

36. A syringe according to claim 35, wherein depression of the plunger in the second position allows the retracting vacuum to exert on the needle assembly by (i) activation of the release mechanism, and (ii) by removal of the plug from the receiving chamber.

37. A syringe according to claim 36, wherein both (i) and (ii) are achieved simultaneously by the depression of the plunger to the second position.

38. A syringe according to claims 36 or 37, wherein the plug is removed from the receiving chamber by deformation of the plug such that it is no longer received within the receiving chamber.

39. A syringe according to claim 38, wherein deformation of the plug is caused by the needle assembly engaging with the socket of the plug, said socket being empty after the removal of the rod therefrom before use of the syringe.

40. A syringe according to claim 39, wherein the needle assembly engages with the socket of the plug by pressure exerted thereon when the plunger is depressed in the second position.

41. A syringe according to any of claims 36-40, wherein upon removal of the plug from the receiving chamber and activation of the needle assembly release mechanism, the plug and needle assembly are engaged, and are moved from the first position to the second position, and are retracted into the storage chamber of the plunger by the action of the retracting vacuum therein.

42. A needle assembly for use with the syringe according to any of claims 29-41.

43. A needle assembly according to claim 42, wherein the needle assembly is sized to fit within the storage chamber of the plunger.

44. A needle assembly according to claims 42 or 43, wherein the needle assembly is operable to be attached to the syringe, by engagement with the retaining means.

45. A needle assembly according to any of claims 42-44, wherein the needle assembly comprises a head and a needle.

46. A needle assembly according to claim 45, wherein the head comprises one or more annular protrusions that extend outwards from the head to form an annular channel.

47. A needle assembly according to claim 46, wherein the channel is operable to mutually engage the retaining means.

48. A needle assembly according to claims 46 or 47, wherein the one or more annular protrusions form a seal against the retaining means, thereby preventing loss of fluid during dispensing or failure to draw fluid in during filling of the barrel.

49. A needle assembly according to any of claims 42-48, wherein the needle assembly further comprises a port for allowing fluid to be drawn into and dispensed from the barrel, and wherein the port is in fluid communication with the barrel and the needle.

50. A needle assembly according to claim 49, wherein the port extends laterally into a side of the head such that when the plunger is fully depressed the port is exposed.

51. A needle assembly according to claim 50, wherein the lateral port extends circumferentially around the head such that fluid in the fluid storage compartment can exit the barrel at any point on the side of the head.

52. A needle assembly according to claim 49, wherein the port extends vertically into the head.

53. A needle assembly according to claim 52, wherein the head comprises vertically aligned serrations present on an outer side of the head, such that when the plunger is fully depressed, and the needle assembly enters the plug, the fluid in fluid storage compartment can travel up and over the head via the serrations and still exit the barrel.

54. A needle assembly according to any of claims 45-53, wherein the head of the needle assembly is sized so as to engage with the

socket of the plug, such that when the plunger is depressed, the head of the needle assembly is engaged within the socket of the plug.

55. A kit for assembling a syringe according to any of claims 29-41 comprising:

(a) A plunger according to any of claims 1-19

(b) A barrel according to any of claims 20-28;

(c) One or more needle assemblies according to any of claims 42-54.

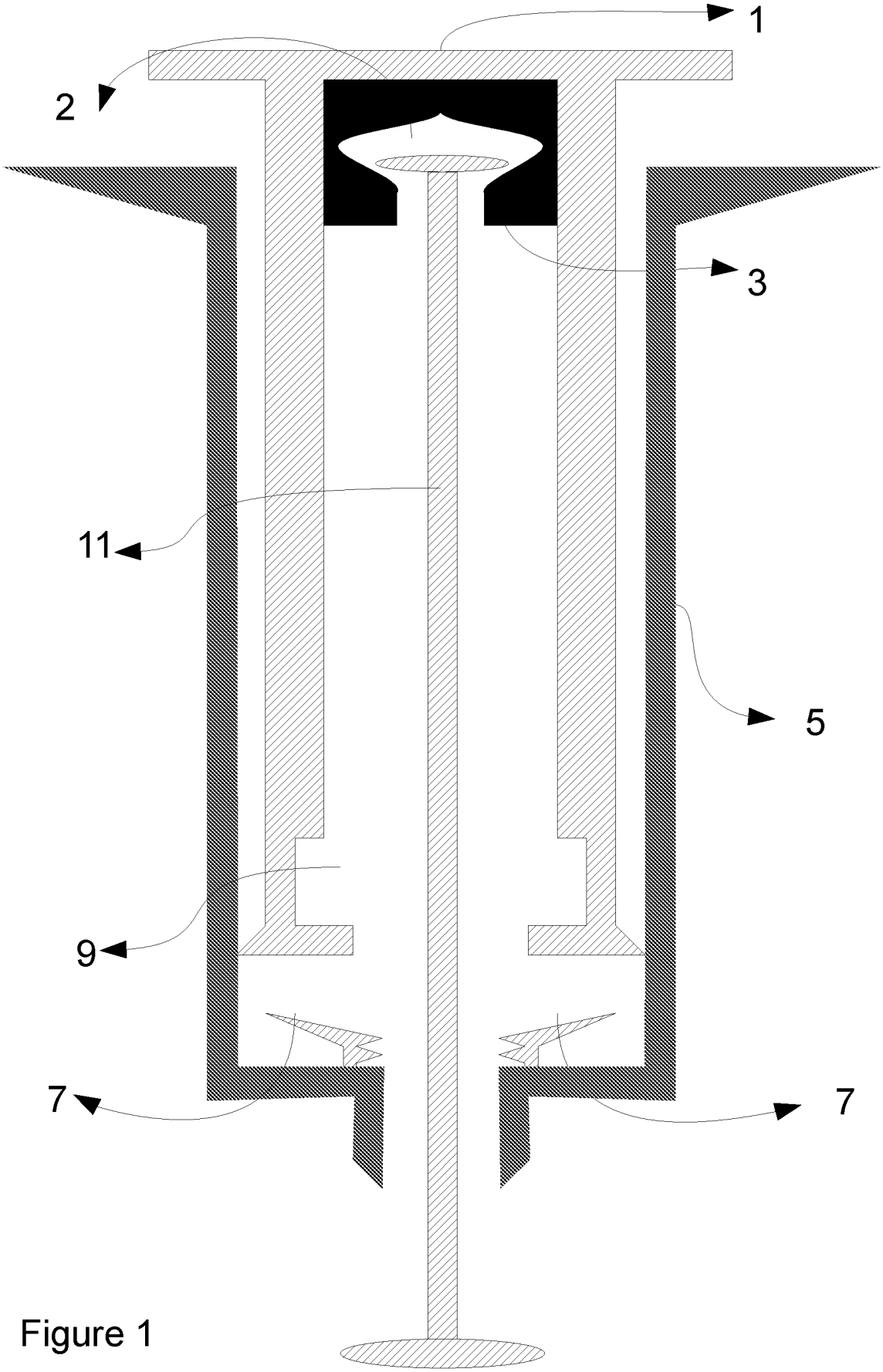

Figure 1

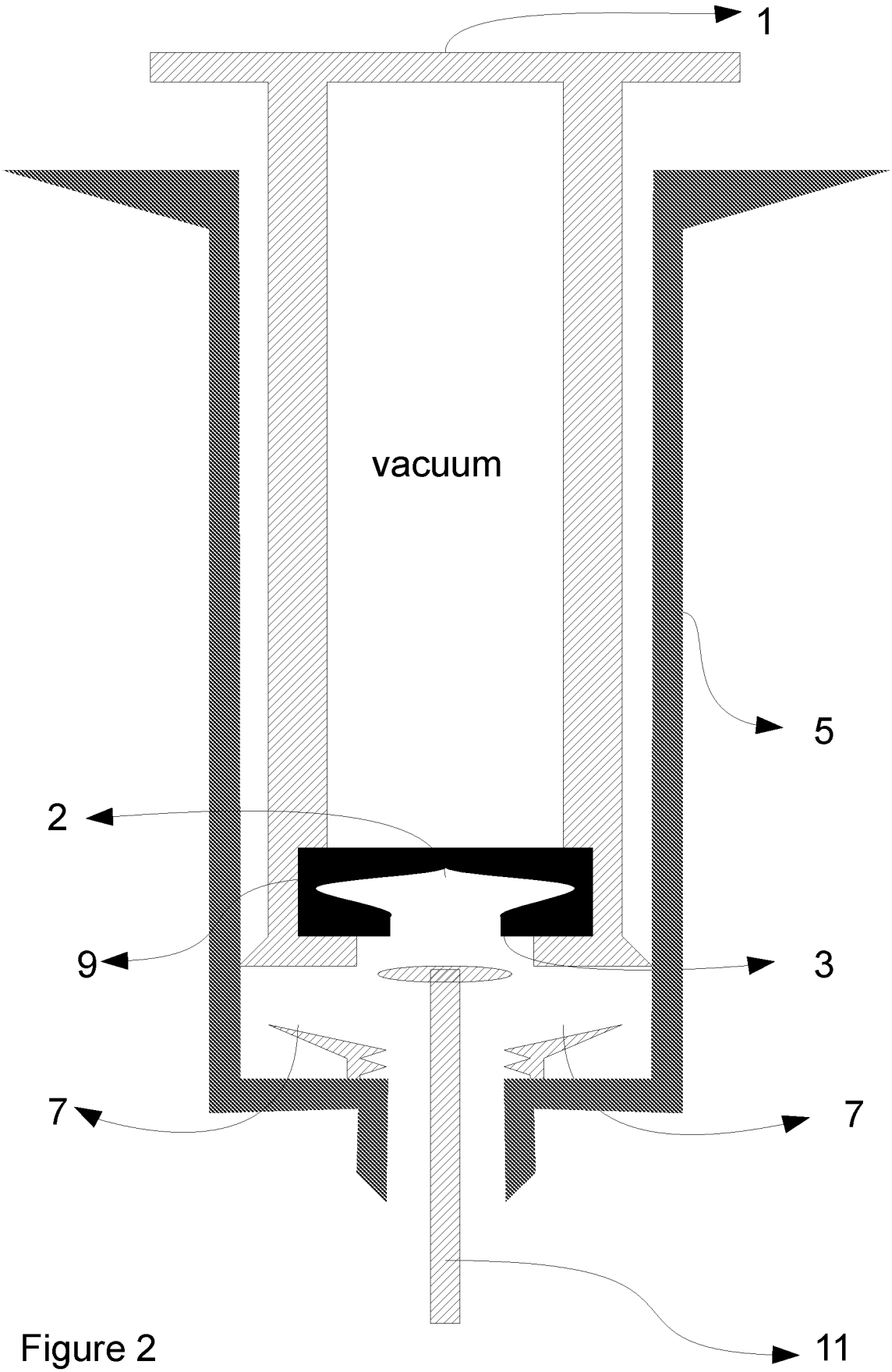

Figure 2

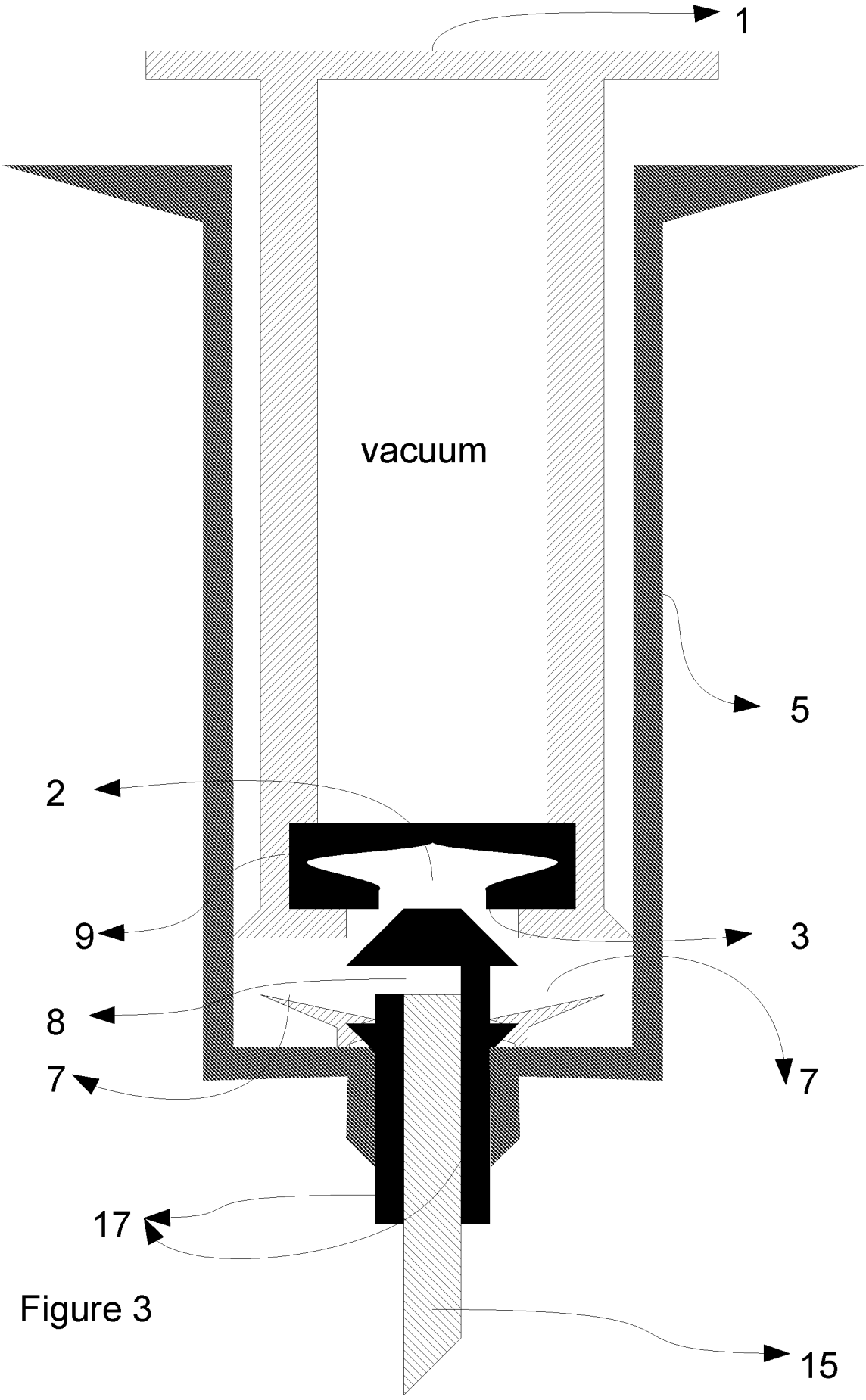

Figure 3

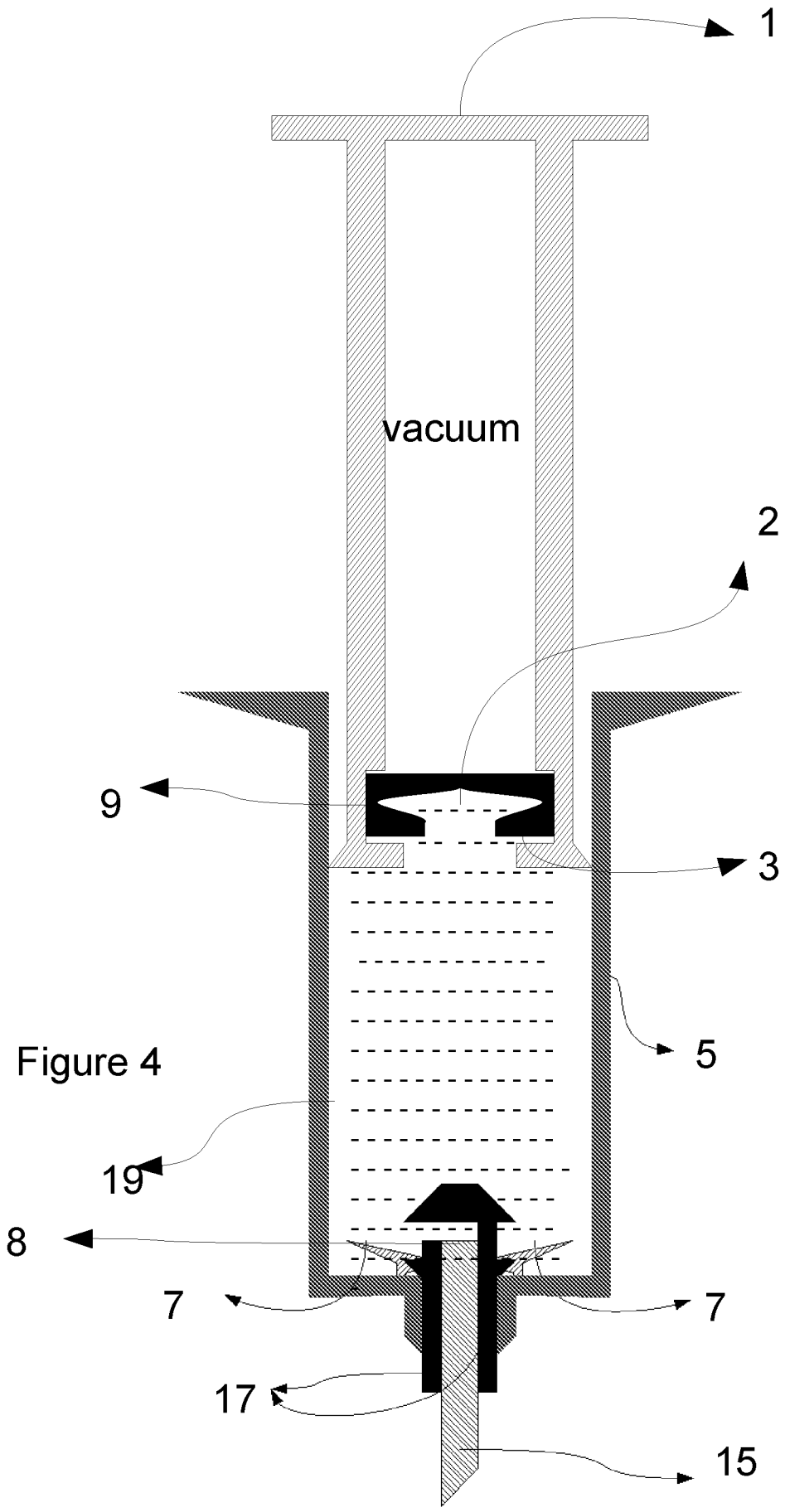

Figure 4

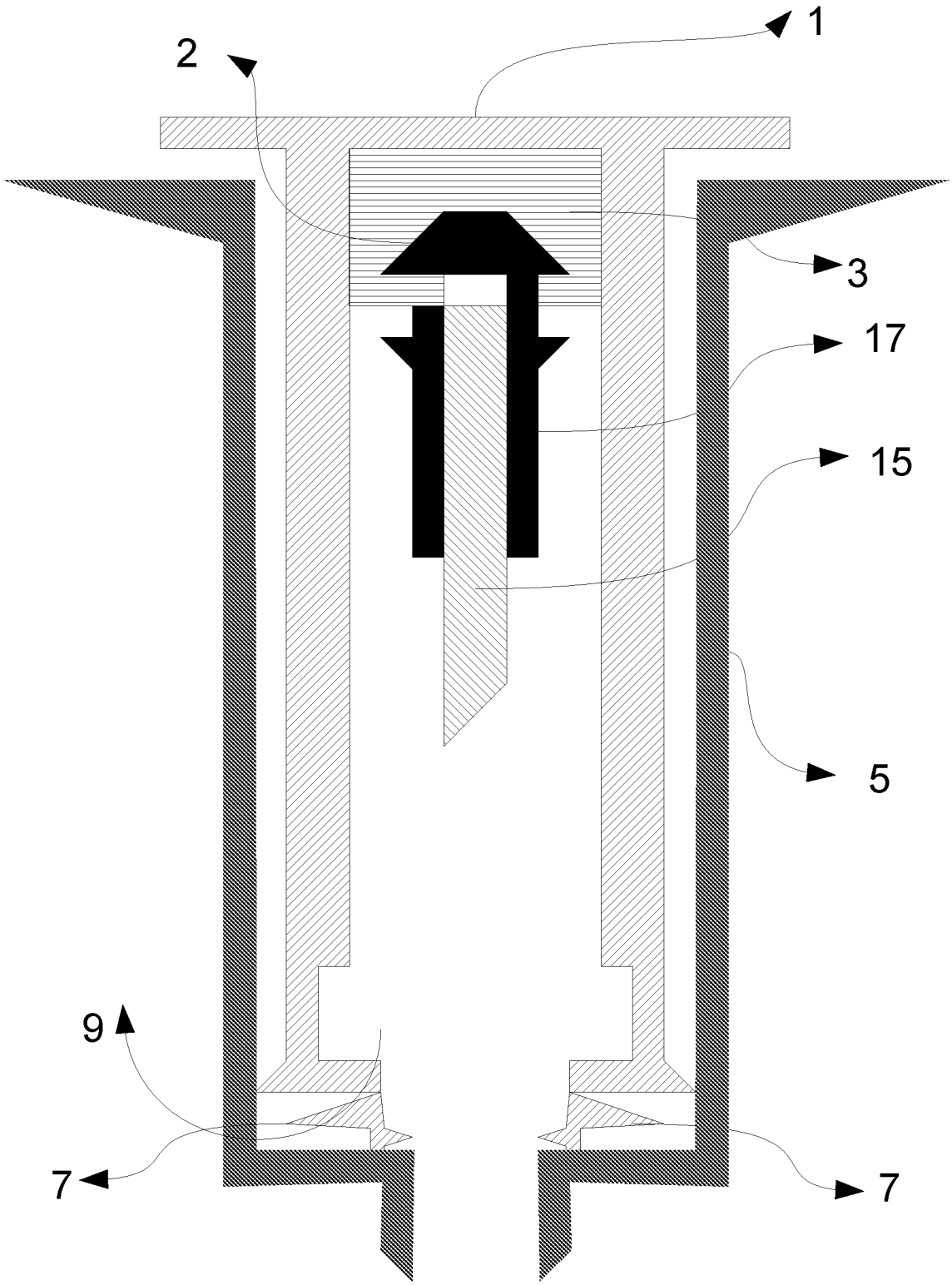

Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2015/051387

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M5/32 A61M5/34
ADD. A61M5/31

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)
A61M

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2012/151330 A1 (STRATEGIC PRODUCT DEV INC [US]; THERIAULT RICHARD H [US]; GODDARD ANDR) 8 November 2012 (2012-11-08)	1
Y	figures 1-7C	2-19
X	US 2004/087907 A1 (SMITH MARTIN E [US] ET AL) 6 May 2004 (2004-05-06) paragraphs [0008]-[0011]; claims 1-12, 17-19, 27, 36; figures 1-11	1
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Y	page 4 - page 21; figures 1-9	2-55

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

[X] See patent family annex.

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 August 2015	02/09/2015

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, Fax: (+31-70) 340-3016	Preller, D

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2015/051387

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Y	figures 1-8	2-55
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Y	figures 1-8	2-55
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