Title: IMPROVED GAS POWER SOURCE FOR A NEEDLE-LESS INJECTOR

Abstract

A needle-less injector (10) suitable for injecting liquid medication through a skin surface of a patient includes a housing (12), a driver (50), a pop valve (108) and a trigger. The housing containing the liquid medication and a gas storage chamber with the pop valve sealing the gas in the housing. The resistance sensitive trigger is coupled to the pop valve and is used to release the pop valve, such that it pops open into the gas storage chamber to release the gas to activate the driver to force the liquid medication out of the housing. The resistance sensitive trigger is activated upon application of a predetermined amount of pressure to the resistance sensitive trigger that is opposed by a predetermined amount of resistance. The predetermined amount of resistance results from the contact with the skin surface, and when this predetermined level is reached the liquid medication pierces the skin surface.
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IMPROVED GAS POWER SOURCE FOR A NEEDLE-LESS INJECTOR

RELATED APPLICATIONS

This application relates generally to U.S. Patent Application Serial No. 08/727,911 filed October 9, 1996, which is a continuation-in-part of U.S. Patent application Serial No. 08/719,459 filed September 25, 1996, now U.S. Patent No. 5,730,723, which is a continuation-in-part of U.S. Patent application Serial No. 08/541,470 filed October 10, 1995, now abandoned, all of which are hereby incorporated by reference.

FIELD OF THE INVENTION

This invention relates to improved gas power sources for a needle-less injector prior to an injection, and in particular, embodiments for providing gas power to a needle-less injector with greater reliability and at reduced manufacturing cost.

BACKGROUND OF THE INVENTION

Typically, needle-less medication injections are performed with "permanent gun" instruments, generally referred to as "jet injectors". These devices use either a compression spring or a compressed inert gas to propel the fluid medication (via a push rod plunger) through a small orifice (an injector nozzle) which rests perpendicular to and against the injection site. The fluid medication is generally accelerated at a high rate to a speed of between about 800 feet per second (fps) and 1,200 fps (approximately 244 and 366 meters per second, respectively). This causes the fluid to pierce through the skin surface without the use of a needle, resulting in the medication being deposited in a flower pattern under the skin.
surface. This method of medication delivery is referred to as a subcutaneous injection.

Conventional, reusable jet injectors are cumbersome and awkward to use. Preparing a typical, reusable jet injector for administering an injection requires several steps. For example, prior to each injection, the injector nozzle must be sterilized. The operator removes the delivery nozzle from the jet injector and boils the nozzle in water to assure a reasonable degree of sterilization. After the nozzle is cleaned, the user replaces it on the instrument and prepares the instrument for loading the medication which is to be injected into the skin. A concern often associated with the nozzle in these reusable systems is that, due to a relatively small opening (approximately .004" or less), the nozzle has a tendency to clog up if the device is left unused for a period of time or if the user does not clean the instrument each time after being used and prior to its reuse.

In addition, loading known reusable jet injectors with medication is a time consuming and delicate operation. First, an adapter which contains a needle is placed through the rubber septum of the medication vial. The nozzle of the jet injector is then mated to the needle adapter in the medication vial. The operator then proceeds to draw up medication into the delivery chamber of the jet injector. This operation may be repeated several times, until the trapped air in the delivery chamber is removed. When this pre-injection operation is complete, the operator selects an injection site and administers the injection.

However, a used and worn delivery orifice can slow down the delivery speed of the injected fluid, which results in inadequate penetration and causes
bruising of the skin at the injection site. In addition, the improper use of jet injectors creates bruising (subdermal hematoma) when the nozzle is not firmly pressed against the injection site. Bruising also may occur if the nozzle opening (orifice) is partially clogged or worn out.

Conventional jet injectors are also somewhat dangerous to use, since they can be discharged without being placed against the skin surface. With a fluid delivery speed of about 800 fps or higher, a jet injector could injure a person’s eye at a distance of up to 15 feet. It should also be noted that jet injectors which have not been properly sterilized are notorious for creating infections at the injection site. In addition, if a jet injector is not positioned properly against the injection site, the injection can be short of the measured dosage, thereby creating wetting on the skin surface, which leads to additional problems associated with improper dosage amounts.

Moreover, it should also be noted that compression spring propelled jet injectors do not offer linear delivery speeds (constant speed of the fluid being injected). In addition to this problem, spring propelled jet injectors with weak (e.g., deteriorated) springs often slow the fluid delivery speed down while the fluid is being administered into the skin which can result in improper fluid penetration. Reduced speed of the fluid can cause improper dosing and bruising at the injection site (referred to as subdermal hematoma).

In addition, if the inert gas is not quickly and properly expelled, the medication may be improperly administered like the springs. Conventional disposable needle-less injectors, such as those shown in U.S. Patents No. 4,913,699
to Parsons and U.S. Patent No. 5,009,637 to Newman et al. show a breakable tube that is shattered or cracked open by a side mounted trigger. Difficulties arise in the need to maintain tight tolerances on the breakable member, since minor changes in thickness can dramatically effect the pressure needed to deploy the gas from the gas chamber of the device. In addition, the broken shards of the breakable member are ejected at high speed when the gas is expelled and these shards can occasionally jam in between the plunger driver and the housing, thereby preventing proper operation of the needle-less injector. Attempts to prevent small shards from being formed would obviate some of this potential, but tend to make activation of the device more difficult.

SUMMARY OF THE DISCLOSURE

It is an object of an embodiment of the present invention to provide an improved gas power source for a needle-less injector, syringe or the like, that obviates for practical purposes, the above-mentioned limitations.

According to an embodiment of the present invention, a needle-less injector suitable for injecting liquid medication through a skin surface of a patient include a housing, a driver, a pop valve and a trigger. The housing containing the liquid medication and a gas storage chamber containing a gas. The driver that forces the medication out of the housing at a sufficient speed to pierce the skin surface of the patient. The pop valve is mounted in the housing to seal the gas in the housing. The resistance sensitive trigger is coupled to the pop valve and is used to release the pop valve, such that it pops open into the gas storage chamber of the housing, to release the gas to activate the driver to force the liquid medication out of the
housing. The resistance sensitive trigger is activated upon application of a predetermined amount of pressure to the resistance sensitive trigger that is opposed by a predetermined amount of resistance from the skin surface of the patient. The predetermined amount of resistance results from the housing having contact with the skin surface of the patient, and when this predetermined amount of resistance is reached the liquid medication is forced out of the housing by the driver to pierce the skin surface of the patient.

In further embodiments, the housing of the needle-less injector includes a face that is adapted to align the housing to produce the predetermined amount of resistance to allow for activation of the resistance sensitive trigger. Also, the resistance sensitive trigger is preferably coupled to the housing to permit axial movement of the resistance sensitive trigger along the housing. However, the fit tolerances between the housing and the resistance sensitive trigger are selected to permit activation of the resistance sensitive trigger when the housing is aligned between 0 and 10 degrees off an axis perpendicular to the skin surface of the patient. In addition, the resistance sensitive trigger is preferably positioned to be between the skin surface of the patient and an activating appendage (such as an hand, arm or the like) of a user when activating the driver the force the medication out from the housing.

In particular embodiments, the resistance sensitive trigger includes a resistance element that activates at a lower amount of pressure than the predetermined amount of resistance by the skin surface of the patient. For example, the resistance sensitive trigger includes a cap that is slidably attached to
the housing and the resistance element includes a spring coupled between the housing and the cap. Thus, upon application of the predetermined amount of pressure to the cap of the resistance sensitive trigger, the spring compresses when the opposing resistance from the skin surface of the patient reaches the predetermined amount of resistance to activate the driver to force the liquid medication out of the housing to pierce the skin surface of the patient.

According to further embodiments of the present invention, a compressed gas activated needle-less injector device is suitable for injecting liquid medication through the skin surface. The housing of the needle-less injector includes a main body portion, a pop valve and a chamber housing portion. The main body portion includes a first gas chamber, a passageway and a second gas chamber which is in gaseous communication with the first gas chamber through the passageway. The first gas chamber contains a pre-filled compressed gas, such as inert gas, that exits through the passageway. The second gas chamber partially contains the driver. The pressure of the compressed gas is sufficiently high to accelerate the liquid medication at a speed sufficient to pierce through the skin surface. The pop valve is mounted to block the passageway to prevent the flow of the compressed gas from the first gas chamber until needed. The pop valve is positioned in between the first gas chamber and the second gas chamber to open into the first gas chamber. The chamber housing portion is securely coupled to the main body portion and includes a liquid chamber and an orifice. In preferred embodiments, the liquid chamber holds the pre-filled and pre-measured liquid medication and is in fluid communication with the driver. The driver can be formed by a piston.
disposed and movable within the liquid chamber, and a plunger disposed and
movable within the liquid chamber along with the piston to force the liquid
medication out from the liquid chamber through the orifice. The orifice is formed
in one end of the chamber housing portion and is in fluid communication with the
liquid chamber. In operation, the compressed gas, when released from the first gas
chamber by the pop valve opening into the first gas chamber, pushes the liquid
forcing assembly, which in turn pushes the liquid medication out through the
orifice to pierce the skin surface of the user.

In the embodiment discussed above, the piston has a head which is
disposed within the second gas chamber. The head creates an air and fluid tight
seal so that the compressed gas released from the first gas chamber is trapped in the
second gas chamber.

In a further embodiment, the injector device is equipped with a lock bar and
an actuator for releasing the pop valve. In particular embodiments, the actuator is
slidably mounted through a side wall of the main body adjacent to the pop valve so
that when one end of the actuator is pushed in, the other end of the actuator
releases the lock bar on the pop valve to open it into the first gas chamber, thus
releasing the compressed gas into the second gas chamber. The resistance sensitive
trigger may include an incline ramp surface that pushes the actuator inward when
the resistance sensitive trigger is depressed. In preferred embodiments, a coil
spring is positioned between the resistance sensitive trigger and the main body
portion to bias the resistance sensitive trigger in an un-depressed state. A retainer,
such as a retainer ring, may be used to couple the resistance sensitive trigger to the
main body portion, and a protective cover, such as a screw-on cap may be used to cover the orifice to maintain sterility of the injection device.

Other features and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings which illustrate, by way of example, various features of embodiments of the invention.

**BRIEF DESCRIPTION OF THE DRAWINGS**

A detailed description of embodiments of the invention will be made with reference to the accompanying drawings, wherein like numerals designate corresponding parts in the several figures.

FIG. 1 is a cross-sectional diagram of an injector device according to an embodiment of the invention.

FIG. 2 is an enlarged partial cross-sectional diagram of a pop valve assembly of the gas power source according to an embodiment of the present invention.

FIG. 3 is an exploded view of the pop valve assembly shown in Fig. 2.

FIG. 4 is a top plan view of a lock bar used by the pop valve assembly shown in Fig. 2.

FIG. 5 is a top plan view of an actuator used by the pop valve assembly shown in Fig. 2.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

As shown in the drawings for purposes of illustration, the invention is embodied in an improved gas power source for a single-use needle-less injector
with medication prior to administration of an injection. Preferably, the device is used in conjunction with, or are attached to, a single-use disposable needle-less injector, such as that disclosed in U.S. Patent application Serial No. 08/719,459 filed September 25, 1996 and 08/727,911 filed October 9, 1996, which are herein incorporated by reference. However, it will be recognized that further embodiments of the invention may be used in multiple use needle-less injectors that utilize replaceable gas power sources after each use and in other devices that require an accurate gas discharge release or the like.

As shown in the drawings for purposes of illustration, the invention is embodied in a needle-less injector. In preferred embodiments of the present invention, a gas powered needle-less injector device is pre-loaded with medication and is adapted for a single use. Preferably, the needle-less injector is for use with human beings. However, it will be recognized that further embodiments of the invention may be used on animals or in other applications requiring needle-less injection, such as passing injectable substances through a porous membrane or the like.

A needle-less injection device according to an embodiment of the invention is embodied in a pen sized device. The needle-less injector device 10 according to an embodiment of the invention is useful for hypodermic injection of medication without piercing the skin (non-invasive) with a needle and represents an improvement over known devices by the use of an improved gas power source. The device 10 may be used as a single dose disposable injector to deliver a dosage of fluid medication. The preferred embodiment ensures precise delivery through
an orifice with the diameter of approximately .0032" (approximately 0.08 mm).

However, larger or smaller diameters may be used, as long as accurate penetration of the skin and delivery of the medication can be maintained. The fluid is linearly accelerated via pneumatic propulsion. Safety is maintained and inadvertent activation of the injection device 10 is avoided via a pressure (e.g., resistance) sensitive triggering feature which allows for proper tensioning of the nozzle and orifice at the injection site prior to automatic medication deployment. For example, activation of the injector device 10 will not occur until the injector is properly positioned to provide the required resistance from the skin surface of the patient to allow for sufficient tension and pressure to be applied to a trigger of the injector device 10 to activate it to deliver the dosage of medication. Improper positioning resulting in insufficient resistance by the skin surface of the patient will prevent the injector device from being inadvertently activated. For example, tight tolerances between a trigger cap and a housing can prevent the cap from sliding along the housing to trigger the device 10, if the device 10 is more than 10 degrees off of an axis perpendicular to the skin surface of the patient.

The device 10 utilizes prepackaging and precisely measured dosages for a variety of medical applications. However, alternative embodiments may be loaded prior to injection. The injector device 10 can be manufactured in various custom sizes for precise medication delivery over a wide range of medication types and dosage amounts. Preferred embodiments allow for a single injection in amounts that range from about 1/20th of one cubic centimeter (cc) to 1.0 cc. The type of injector device 10 is typically used on human patients. However, in alternative
embodiments, a larger injector device with larger medication capacity may be constructed and used on animals, such as livestock or the like.

FIG. 1 shows a needle-less injector device 10 according to an embodiment of the invention. The injector device 10 has a main body 12, a chamber housing 40, a cap 60, a piston 50, an actuating member 20, and a first gas chamber 18. The main body 12 includes a first body portion 13 integrally connected to a second body portion 19 (main body 12, first body portion 13, and second body portion 19 may be a single unit in design and manufacturing). In the preferred embodiment of the device 10, the second body portion 19 has a slightly larger diameter than that of the first body portion 13. A flange 27 is formed due to a larger diameter of the second body portion 19, and may be used in conjunction with a recess 29 to support a safety clip 30 to prevent actuation of the device during shipment or prior to use. The first body portion 13 and the second body portion 19 each has an elongated cylindrical shape. However, in alternative embodiments, other shapes such as rectangular, triangular or the like may be used. The main body 12 also has an elongated cavity 17 centrally disposed along the length of the first body portion 13 and partially along the length of the second body portion 19. The elongated cavity 17 forms an opening which is located on the end of the main body 12, opposite of the second body portion 19. The elongated cavity 17 has a cylindrical shape with substantially the same diameter. However, in alternative embodiments, other shapes such as rectangular, triangular or the like may be used. The diameter of the elongated cavity 17 gradually tapers off as the elongated cavity 17 nears the second body portion 19. The smaller diameter portions of the elongated cavity 17
limits the backward movement of the piston 50 and tends to increase the rate of acceleration when the jet injection device 10 is first activated. In alternative embodiments, the smaller diameter portions of the elongated cavity are omitted and a hard stop 100 is used to limit rearward movement of the piston 50. This has the advantage of minimizing the volume available for escaping gases from the first gas chamber 18 to expand into the elongated cavity 17 prior to moving the piston 50 forward.

The second body portion 19 includes an actuator passageway 102 and the first gas chamber 18 for storing compressed inert gas, such as carbon dioxide. However, alternative embodiments may use other gases or a gas/liquid combination. The elongated cavity 17 (i.e., containing a second gas chamber 14) and the first gas chamber 18 are coupled together to provide gaseous communication with each other through a passageway 104. The first gas chamber 18 of the second body portion 19 has an opening on the opposite end of the passageway 104, through which compressed gas is pre-filled into the first gas chamber 18. A retention groove 28 (preferably ring shaped) is formed around the inner diameter of the first gas chamber 18 near the end of the large opening in the first gas chamber 18. A chamber plug 26 is disposed within the opening of the first gas chamber 18 to seal in the compressed inert gas, once the gas has been loaded. The chamber plug 26 forms an air tight seal in the first gas chamber 18 by engaging the retention groove 28. The retention groove 28 also prevents the chamber plug 26 from detaching itself from the second body portion 19 due to the presence of compressed gas in the first gas chamber 18. The chamber plug 26 is
configured and sized to firmly fit into the opening of the first gas chamber 18. In alternative embodiments, instead of the retention groove 28, the inner surface of the first gas chamber may be threaded so that the chamber plug 26 (with corresponding outer threads) may be screwed into the first gas chamber 18.

Alternatively, the first gas chamber 18 may be a sealed compartment in which compressed gas is injected through a valve. A seal may also be obtained by using an adhesive or other suitable materials to hold the chamber plug 26. The chamber plug 26 may be made of any suitable rigid materials, such as plastic, rubber, ceramic, metal, composites and the like.

Although the main body 12 may be made of plastic by, such process as an injection molding, other suitable materials, such as ceramic, glass, metal, composites or the like, may be used. In addition, the first body portion 13 and the second body portion 19 may be formed together as one injection mold or may be formed from separate portions coupled together by adhesives, welding, snap fits or the like. In preferred embodiments, the chamber plug 26 would be plastic welded, glued or otherwise secured in the first gas chamber 18 immediately after the first gas chamber is filled with gas. In alternative embodiment, the first gas chamber 18 is filled with a piece of solid carbon dioxide, which expands to form a gas after the first gas chamber 18 is sealed by the chamber plug 26.

Inside the passageway 104 is a larger diameter counter bore 106 extending from the first gas chamber 18 towards the elongated cavity 17 to act as a recess for a pop valve 108 and associated components forming a pop valve assembly. The pop valve 108 includes a top portion 110 and a neck portion 112. The top portion
110 has a diameter greater than the diameter of the counter bore 106 to block off the passageway 104 once the pop valve 108 is seated. The top portion 110 may also include a peripheral recess 114 to receive an O-ring or the like, to assist in blocking off and sealing the passageway 104 when the pop valve is seated. The wall 116 of the first gas chamber 18 near the counter bore 106 and the bottom of the top portion 110 of the pop valve 108 should have the same shape to permit a good seal. For example, preferred embodiments have the wall 116 and the bottom of the top portion 110 are tapered. In further embodiments, the wall 116 may include a circular recess 115 having a diameter smaller than the top portion 110, but larger than the neck portion 112, of the pop valve 108 to receive an O-ring 117 or the like for a better seal. In preferred embodiments, both the top portion 110 and the wall 116 include an O-ring for an optimal seal. However, alternative embodiments may use only one O-ring seal on either member or other sealing methods that prevent gas from leaking out the passageway 104 through the pop valve 108 at the wall 116.

The neck portion 112 of the pop valve 108 includes a lock recess 118 near the end of the neck portion 112 opposite the top portion 110 of the pop valve 108. The neck portion 112 is long enough to extend down the passageway 104 so that the lock recess 118 can engage with a lock bar 120 (see Fig. 4) that holds the pop valve 108 in the sealed position in passageway 104. In some embodiments, the lock bar 120 is included inside of the second body portion 19 forming the passageway 104. In preferred embodiments, as shown in Figs. 1-3, a plug 109 forms the passageway 104, counter bore 106 and actuator passageway 102 that
holds the lock bar 120 (as well as the other components of the pop valve assembly). However, in alternative embodiments, the lock bar 120 engages the lock recess 118 and is held in position against the end wall of the elongated cavity 17 forming the opening to the passageway 104.

The counter bore 106 has an inside diameter that is larger than the diameter of the neck portion 112 to accommodate a spring 122 that presses against the stop end 123 of the counter bore 106 and the top portion 110 of the pop valve 108. The spring 122 will force (or eject) the pop valve 108 out of the passageway 104 and the counter bore 106 into the first gas chamber 18 to allow the gas to flow through the passageway 104 into the elongated cavity 17 when the lock bar 120 is not holding the pop valve 108 in place. Alternatively, the pop valve 108 may be ejected, but still remain connected to the plug 109, passageway 104, counter bore 106, and/or wall 116 to prevent the pop valve 108 from bouncing around the interior of the first gas chamber and to minimize the likelihood of the pop valve 108 re-seating after activation of the needle-less device 10. Opening the pop valve 108 into the gas chamber prevents shards from being formed and/or the pop valve 108 from being ejected into the elongated chamber 17 where it could possibly jam or interfere with the operation of the piston 50.

In its normal position, the top portion 110 of the pop valve 108 blocks the gas flow from the first gas chamber 18 into the elongated cavity 17. When the lock bar 120 is released from the lock recess 118 of the neck portion 112 of the pop valve 108, the spring 122 pushes up (and preferably ejects) the pop valve 108 (including the top portion 110 and neck portion 112) out of the passageway 104.
and counter bore 106. In preferred embodiments, a metal spring, made of music wire or the like, with a loaded force of 4.5 lbs/in2 may be used. However, in alternative embodiments, other elastic or expansive materials, such as foam rubber, leaf springs, gas pillows or the like may be used in place of the spring 122 or different spring tensions may be used.

The ejection is also facilitated by gases rushing out the passageway 104 around the opening formed between the top portion 110 of the pop valve 108 and the wall 116. In addition, the shape of the pop valve 108 also makes it unlikely to re-seat, once the pop valve 108 is ejected from the passageway 104 and counter bore 106. Upon opening of the pop valve 108, the compressed gas from the first gas chamber 18 is released into the elongated cavity 17. More specifically, the compressed gas is released into a second gas chamber 14, which is a part of the elongated cavity 17. The pop valve 108 is preferably released by removing the lock bar 120 from the lock recess 118 in the neck portion 112 of the pop valve 108, but the lock bar 120 should be attached firmly enough to withstand the pressure exerted by the compressed air in the first gas chamber 18 or a shock from a drop. In addition, the lock bar 120 should resist being released until the injector device 10 is placed in contact with the skin of a patient and sufficient resistance is encountered to permit the injector device 10 to be activated by applying sufficient pressure to disengage the lock bar 120 to release the pop valve 108.

The actuator passageway 102 is typically formed on the side wall of the main body 12 and extends from the outer to the inner surface of the second body portion 19 at a slightly slanted angle. It may also extend into a plug 109 that is
formed as an insert into the second body portion 19. However, other
configurations may be used, such as a perpendicular orientation or the like. The
actuator passageway 102 is adapted and configured to hold an actuator 124 (see
Fig. 5), which protrudes through the actuator passageway 102. In the preferred
embodiment, the actuator 124 is a rod (or bar) with a horseshoe type end 126 that
has a recess 128 having the same diameter (or slightly larger than) the neck portion
112 of the pop valve 108. The actuator 124 has preferably the sufficiently same
cross-section and diameter as the actuator passageway 102 to firmly fit inside the
actuator passageway 102 to provide a sufficiently tight air and fluid seal to not
hinder with the effective performance of the injection device 10. However, there
may be some clearance between the actuator 124 and the passageway 102 to bleed-
out excess gas pressure over a time period once the injector device 10 has been
used. In addition, the actuator 124 and the passageway 102 may be formed of a
rectangular rod shape or other suitable shapes. The actuator 124 may be made of
resilient plastic or other suitable materials. Preferably, the actuator passageway
102 is long enough to permit the actuator 124 to move the lock bar 120 back to
release the pop valve 108, but short enough to prevent the recess 128 of the
actuator 124 from engaging the recess 118 of the neck portion 112 before the pop
valve 108 is opened. Alternatively, the actuator 124 may include a shoulder 129
(see Figs. 2 and 3) that engages with the plug 109 to prevent the recess 128 of the
actuator 124 from engaging with the recess 118 on the neck portion of the pop
valve 108.

In preferred embodiments, the lock bar 120 also has a horseshoe end 130
and a recess 132 (see Fig. 4) that fits the lock recess 118 in the neck portion 112 of the pop valve 108. In addition, the horseshoe end 130 of the lock bar 120 is connected to the horseshoe end 126 of the actuator 124 by one or more dowels 134 to facilitate assembly of the pop valve assembly. Alternatively, the lock bar 120 and actuator 124 may be formed as a single piece with a keyhole shape opening, or the like, to remove the assembly step with the dowels.

In further embodiments, the first gas chamber 18 may be formed as a separate insertable gas chamber to permit filling and assembly away from the device 10. This would improve storage and manufacturing. In this situation, the completed first gas chamber (including a pop valve 108 with lock bar 120 in the recess 118 of the neck portion 112 and a spring between the counter bore 106 and the top portion 110 of the pop valve 108) is glued, threaded or snap fitted into the second body portion 19. The second body portion 19 could include a channel or cut-out along its length extending to the actuator passageway 102 to permit the first gas chamber 18 to be seated with an already mounted actuator 124 in place.

The chamber housing 40 includes an elongated tubular body 43, a neck portion 45 and a liquid chamber 41 for storing and holding, for example, liquid medication (not shown). The chamber housing 40 has an orifice 42 (or nozzle) at one end and has an opening configured to receive the piston 50 at the other end. The orifice 42 is centrally positioned on an injector face 49. The injector face 49 has a flat surface, except that the center region around the orifice 42 is raised slightly. The raised surface around the orifice 42 provides firm contact against a receiving surface, such as the skin surface (not shown). This helps to insure that
the injector is properly positioned and will not be activated until sufficient pressure is applied to the injector device 10.

The outer diameter of the neck portion 45 is smaller than the outer diameter of the elongated tubular body 43 which forms a shoulder portion 47 where the two parts join together. The shoulder portion 47 rests on the surface of the opening formed by the elongated cavity 17 of the main body 12. However, the outer diameter of the neck portion 45 is substantially the same as the inner diameter of the elongated cavity 17 of the main body 12 so that the neck portion 45 firmly fits inside the elongated cavity 17. To firmly engage the neck portion 45 of the chamber housing 40 with the elongated cavity 17 of the main body, the middle section of the neck portion 45 may have a slightly larger outer diameter that fits into a groove 15 formed inside the elongated cavity 17. Once coupled together, the chamber housing 40 cannot be released from the main body 12, unless extreme force is applied. In alternative embodiments, the raised outer diameter of the neck portion is altered to form threads on the outer diameter of the neck portion 45 and matching threads are formed inside the elongated cavity 17 to screw-in the chamber housing 40. This provides the advantage of being able to assemble the device 10 when needed or just prior to giving an injection. Also, the device 10 can be disassembled as desired. This assembly option allows the user to select a variety of different medications or dosages while minimizing the number of complete injectors 10 that must be carried or stocked. In addition, a user could store the chamber housing 40 in different environments, such as a refrigerator for perishable medications and minimizes the refrigerated storage space, since the rest
of the device 10 does not require refrigeration. It would also facilitate manufacture of the device 10, since the device 10 and the chamber housing 40 may be manufactured at different times.

Further, the main body 12 and the chamber housing 40 may be attached and sealed together by any suitable method, such as adhesives, welding or the like. A ring joint 48, in the form of a plastic weld fillet, is also used to further reinforce the attachment of the chamber housing 40 to the main body 12. In the preferred embodiment, the ring joint 48 abuts against the shoulder portion 47 and the opening surface of the elongated cavity 17. The ring joint 48 provides additional strength to securely hold the chamber housing 40 in the main body 12. Although not shown in the drawings, an O-ring may be placed between the shoulder portion 47 of the chamber housing 40 and the opening surface of the elongated cavity 17 to provide an additional air and fluid tight seal.

For easy measuring and observation of the amount of medication in the liquid chamber 41, the elongated tubular body 43 includes graduations so that the user can determine the amount of medication contained in the injector device 10.

The chamber housing 40 can be formed of glass or other suitable materials, such as plastic, ceramic, polycarbonate or the like. In the preferred embodiment, the chamber housing 40 is transparent so that the liquid medication and the various moving parts in the liquid chamber 41 can be visually examined. Also, the chamber housing 40 is disposable. However, in alternative embodiments, the chamber housing may be recycled, if desired.

A cap 60 may be mounted on the end of the chamber housing 40 to cover
the orifice 42. The cap 60 provides and maintains sterility of the injection
device 10 and prevents an accidental discharge of the liquid medication disposed
inside the liquid chamber 41 from shock, evaporation or seepage. Threads 44 for
mounting the cap 60 are on the outer surface of the end portion of the chamber
housing 40. The cap 60 has matching threads 62 on the inner surface so that the
cap 60 can be screwed-on at the end portion of the chamber housing 40. Once
screwed-on, the cap 60 provides an air and fluid tight seal around the orifice to
prevent any foreign material from being introduced into the liquid chamber 41. In
alternative embodiments, the cap 60 and the end portion of the chamber housing 40
can be configured so that the cap 60 is snapped-on instead of screwed-on. The cap
60 may be made of any suitably rigid material, such as plastic polymers, rubber,
ceramic or the like.

The piston 50 has an elongated cylindrical body 51 with an indented front
surface 52 at one end and a head 54 at the opposite end. The head 54 includes a
rear surface 55, which is preferably concave. In alternative embodiments, the front
and rear surfaces may be flat, or have other suitable shapes. The elongated
cylindrical body 51 of the piston 50 is disposed inside the liquid chamber 41 for
sliding movement along its length. In preferred embodiments the elongated
cylindrical body 51 has substantially the same outer diameter as the diameter of the
liquid chamber 41 to provide free sliding movement along the length of the liquid
chamber 41. Due to an air and fluid tight seal around a plunger 56, the air and
fluid tight seal around the piston 50 may not be necessary. The head 54 of the
piston 50 has substantially the same outer diameter as the inner diameter of the
elongated cavity 17 to form an air and fluid tight seal with a minimal friction
between the head 54 and the walls of the elongated cavity 17. The space defined
between the head 54 and the back wall of the elongated cavity 17 is the second gas
chamber 14. The head 54 is disposed inside the elongated cavity 17 so that the
compressed gas introduced in the second gas chamber 14 expands the head 54
against the wall surface of elongated cavity 17, providing an additional seal, so that
the compressed gas introduced into the second gas chamber 14 pushes the piston
50 forward.

Where the lower portion 82 of the head 54 makes contact with the neck
portion 45 of the chamber housing 40, the shapes of both portions may be
configured to match each other. In the preferred embodiment, the end surface 80
of the neck portion 45 forms a concave surface while the lower portion 82 of the
head 54 forms a convex surface. The matching shapes assist in delivering
substantially all of the medication to the injection site. However, in alternative
embodiments, other suitable shapes, such as a flat surface, may be used, and the
piston 50 may be made of any suitable material such as plastic, glass, ceramic,
metal, composites or the like.

Also disposed inside the liquid chamber 41 is a plunger 56. The plunger 56
has an outer diameter which is substantially the same as the inner diameter of the
liquid chamber 41 to form an air and fluid tight seal. The plunger 56 is disposed
between the piston 50 and the orifice 42. The medication is situated in front of the
plunger 56 (i.e., between the orifice 42 and the plunger 56) so that the forward
movement of the plunger 56 forces the liquid medication toward the orifice 42.
The front surface of the plunger 56 may be configured to match the opening defined by an orifice guide 46. In preferred embodiments, the front surface of the plunger 56 has a convex surface to match the concave shape of the orifice guide 46, whose vertex is the orifice 42. The shape of the orifice guide 46 focuses and increases the speed of liquid medication as it exits the orifice 42. The matching shapes of the orifice guide 46 and the plunger 56 tend to minimize the waste of medication, since most of the medication is forced out through the orifice 42. The shape of the rear surface of the plunger 56 matches the front surface 52 of the piston 50. The similarly shaped configuration provides for an even distribution of the pressure on the rear of the plunger 56 when the piston 50 moves forward. This tends to minimize jams or distortion as the plunger 56 is driven forward. The plunger 56 is generally made of rubber or other suitable materials, such as plastic, composites or the like. In alternative embodiments, the plunger 56 and the piston 50 formed as and integrated piece either by attaching the plunger 56 to the piston 50 or by molding the piston assembly to include the plunger 56.

A resistance sensitive trigger includes an actuating member 20 that is an elongated tubular member that slides over the second body portion 19 of the main body 12. The actuating member 20 has a trigger portion 22, a raised rail 76 (see FIG. 2), and a retainer slot 25. The actuating member 20 is enclosed at one end and has an opening at the other end. On the inner surface of the enclosed end, there is a spring surface 23 for holding or mounting a coil spring or resilient member 24. The resistance sensitive trigger also includes a coil spring or resilient member 24 that is positioned between a spring surface 23 and the chamber plug 26.
and provides a resilient bias toward the rear end. The proper use of the injection
device 10 requires that the injector device 10 be positioned substantially
perpendicular to the skin surface before the medication is injected into the injection
site. Therefore, the tension strength of the coil spring or resilient member 24
should be sufficiently strong to prevent accidental triggering when the injection
device 10 is not properly positioned. Typically, a minimum applied pressure of
2.2 lbs/in² (1.0 kg/2.5 cm²) is required to discharge the injector. However, slight
lower or higher minimums may be required depending on the skin of the patient or
where the injection is to be administered. In alternative embodiments, alternate
resistance elements or resilient members may be used instead of the coil spring or
resilient member 24, such as deformable rubber or plastic, strain gauges or the like.
In further alternative embodiments, the coil spring or resilient member 24 may be
omitted from between the spring surface 23 and the chamber plug 26. For
instance, a spring or resilient member may be placed to bear between the lock bar
120 and the second body portion 19 and/or elongated cavity 17 and this opposes
movement of the actuator 124 as the cap 120 is pushed down to administer an
injection. Preferably, the force required to overcome the force of the spring is
equivalent to the force required to overcome the coil spring or resilient member 24
between the spring surface 23 and the chamber plug 26. Use of a spring or resilient
member in this location can simplify manufacturing. It also tends to directly
inhibit dislodging of the lock bar during transportation and during accidental drops
prior to use.

In the front opening of the actuating member 20, there is a retainer slot 25
for mounting a retainer 75. The retainer slot 25 is formed around the inner circumference of the actuating member 20, extending from one side of the raised rail 76 to the other side. The retainer 75, which is in a form of a thin circular rod, is mounted into the retainer slot 25. The circumferential length of the retainer 75 is substantially equal to that of the retainer slot 25. When the actuating member 20 is installed onto the second body portion 19, the retainer 75 generally rests against the flange 27. This prevents the actuating member 20 from detaching itself from the second body portion 19 due to rearward force exerted by the coil spring 24. The retainer 75 may be made of plastic or other suitable materials such as metal or the like. In alternative embodiments, the retainer 75 and the actuating member 20 may be formed as one integral member by molding process or other suitable processes. The actuating member 20 is typically made of plastic or other suitably rigid and resilient materials, such as glass, composite, ceramic or metal. The trigger portion 22 is on the outer end surface of the actuating member 20. It preferably forms a concave surface and is coated with a textured material to prevent depressing force, such as from a thumb, from slipping.

The raised rail 76 extends along the length of the outer surface of the actuating member 20. A conduit 78 is formed along the length of the raised rail 76. The cross-sectional shape and dimension of the conduit is configured to accommodate the protruding portion of the actuator 124. The raised rail 76 has a thickness which varies along its length. The thickness of the raised rail 76 is thinner near the opening of the actuating member 20. Toward the rear portion of the actuating member 20 where an actuator 124 is situated, a gradually inclined
region 21 is formed on the inner surface of the raised rail 76. When the actuating member 20 is not depressed, the actuator 124 rests on the flat thinner inner surface of the raised rail 76. This is the normal state of the injection device 10 prior to injection. When the actuating member 20 is depressed, the actuating member 20 moves forward, and the inclined region 21 forces the actuator 124 toward the center of the second body portion 19. The inward movement of the actuator 124 causes the ends of the horseshoe end 126 to push the lock bar 120 out of the lock recess 118 of the neck portion 112 of the pop valve 108 as the recess 128 surrounds the neck portion 112 to release the pop valve 108, which in turns releases the compressed gas in the first gas chamber 18. The raised rail 76 can be formed as integral part of the actuating member by a molding process or other suitable processes.

The second body portion 19 includes three splines and the actuating member 20 includes corresponding three spline slots adapted to slidably receive the splines of the second body portion 19. The splines and spline slots are provided to assist the actuating member 20 to slide along the second body portion as the actuating member 20 is depressed to deliver an injection. The splines and spline slots substantially prevent the actuator member 20 from rotating about the second body portion 19 to avoid jamming of the actuating member 20 during an injection.

The splines and spline slots also prevent rotational movement of the actuating member 20 about the second body portion 19 when the cap 60 is removed or threaded onto the chamber housing 40. This limits the amount of torsional stress placed on the actuator 124 in the passageway 102 during an injection or when
removing or threading the cap 60 onto the chamber housing 40. In alternative embodiments, a different number of splines and spline slots may be used. Also, if the actuator 124 is sufficiently strong enough the splines and spline slots may be eliminated. In further alternatives, the splines and/or spline slots may be coated with a lubricant or formed from materials with low frictional coefficients to facilitate sliding movement of the actuating member 20 along the second body portion 19. In preferred embodiments, the splines and splines have a rectangular cross-section. However, in alternative embodiments, the splines and spline slots may have other cross-sections, such as triangular, saw tooth, dove tail or the like, to resist rotational movement of the actuating member 20 about the second body portion 19.

The operation of the needle-less injector device according to the preferred embodiment will now be discussed. Initially at the manufacturing facility, the injection device is pre-filled with medication in the liquid chamber 41 and is pre-filled with compressed gas in the first gas chamber 18. The user (or an operator) unscrews (or unsnaps) the cap 60 from the main body 12, thus revealing the orifice 42 of the injector device 10. The user then positions the injector device 10 perpendicularly against the skin surface to provide firm and secure contact of the orifice 42 against the skin surface. The injector device 10 requires the device 10 to be properly oriented and in contact with the skin of the patient, since the injector device 10 is designed so that it cannot be activated or discharged without the device 10 being placed against the skin surface. Otherwise, with a fluid delivery speed of about 800 fps or higher, a jet injector could injure a person’s eye or other
part of the body. In addition, if the jet injector were not positioned properly against the injection site, and the injection device were activated, the dosage can be short of the measured dosage, thereby creating wetting on the skin surface, which leads to additional problems associated with improper dosage amounts.

As the trigger portion 22 of the actuating member 20 is depressed, the skin surface of the patient resists the pressure being applied to the actuating member 20 of the resistance sensitive trigger and the coil spring 24 is compressed between the chamber plug 26 and the spring surface 23. Sufficient pressure (generally a minimum of 2.2 lbs/in² (1.0 kg/2.5 cm²)) must be applied at the trigger portion 22 to overcome the tension of the coil spring 24. Concurrently, as the inclined region 21 pushes against the actuator 124, the actuator 124 is pushed inward toward the center axis of the main body 12. As the actuating member 20 is pressed further against the skin surface, the actuator 124 pushes against and disengages the lock bar 120, releasing the pop valve 108 so that the spring 122 moves the pop valve 108 out of the way of the passageway 104 into the first gas chamber 18. This exposes the opening of the passageway 104, and the compressed gas stored in the first gas chamber 18 is released into second gas chamber 14. When sufficient pressure is built up inside the second gas chamber 14, the piston 50 is pushed forward so that it slides forward in the liquid chamber 41. The seal around the head 54 of the piston 50 substantially prevents any gas from leaking into the other parts of the elongated cavity. The forward movement of the piston 50 causes the front surface 52 of the piston 50 to make contact with the rear surface of the plunger 56, to move the plunger 56 forward. As the plunger 56 moves forward, the
liquid medication exits from the orifice 42 at a high speed and penetrates the skin surface at the injection site.

While the description above refers to particular embodiments of the present invention, it will be understood that many modifications may be made without departing from the spirit thereof. The accompanying claims are intended to cover such modifications as would fall within the true scope and spirit of the present invention.

The presently disclosed embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims, rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.
WHAT IS CLAIMED IS:

1. A needle-less injector suitable for injecting liquid medication through a skin surface of a patient, the needle-less injector comprising:
   a housing containing the liquid medication and a gas storage chamber containing a gas;
   a driver that forces the medication out of the housing at a sufficient speed to pierce the skin surface of the patient;
   a pop valve mounted in the housing to seal the gas in the housing;
   a resistance sensitive trigger coupled to the pop valve and which releases the pop valve, such that it pops open into the gas storage chamber of the housing, to release the gas to activate the driver to force the liquid medication out of the housing upon application of a predetermined amount of pressure to the resistance sensitive trigger that is opposed by a predetermined amount of resistance from the skin surface of the patient resulting from the housing having contact with the skin surface of the patient such that the forced out liquid medication will pierce the skin surface of the patient.

2. The needle-less injector in accordance with claim 1, further including a face on the housing for contacting the skin surface of the patient and align an orientation of the housing to produce the predetermined amount of resistance to allow for activation of the resistance sensitive trigger.
3. The needle-less injector in accordance with claim 1, wherein the resistance sensitive trigger is coupled to the housing to permit axial movement of the resistance sensitive trigger along the housing, wherein relative sizes of the housing and the resistance sensitive trigger permit activation of the resistance sensitive trigger when the housing is aligned between 0 and 15 degrees off an axis perpendicular to the skin surface of the patient.

4. The needle-less injector in accordance with claim 1, wherein the resistance sensitive trigger is positioned to be between the skin surface of the patient and an activating appendage of a user when activating the driver to force the medication out of the housing.

5. The needle-less injector in accordance with claim 1, wherein the resistance sensitive trigger includes a resistance element that activates at a lower amount of pressure than the predetermined amount of resistance by the skin surface of the patient.

6. The needle-less injector in accordance with claim 5, wherein the resistance sensitive trigger includes a cap slidably attached to the housing and wherein the resistance element includes a spring coupled between the housing and the cap, wherein upon application of the predetermined amount of pressure to the cap of the resistance sensitive trigger the spring compresses, when the opposing resistance from the skin surface of the patient reaches the predetermined amount of
resistance, to activate the driver to force the liquid medication out of the housing to pierce the skin surface of the patient.

7. The needle-less injector in accordance with claim 7, the housing of the needle-less injector further including:

a main body portion having the gas storage chamber, a passageway and a second gas chamber in gaseous communication with the first gas chamber through the passageway, wherein the gas storage chamber contains a pre-filled compressed gas, and wherein the second gas chamber partially contains the driver;

the pop valve is mounted to block the passageway to prevent the flow of the compressed gas from the gas storage chamber until opened and released into the gas storage chamber, wherein the pop valve is positioned in between the gas storage chamber and the second gas chamber; and

a chamber housing portion coupled to the main body portion, the chamber housing including:

a liquid chamber that holds the liquid medication, the liquid chamber being in fluid communication with the driver;

an orifice formed in one end of the chamber housing portion, the orifice being in fluid communication with the liquid chamber,

wherein when the compressed gas is released from the gas storage chamber when the pop valve is released into the gas storage chamber, the compressed gas pushes the driver which in turn pushes the liquid medication out through the orifice to pierce the skin surface of the patient.
8. The needle-less injector in accordance with claim 8, wherein the driver includes:
   a piston disposed and movable within the liquid chamber; and
   a plunger disposed and movable within the liquid chamber along with the piston to force the liquid medication out from the liquid chamber through the orifice.

9. The needle-less injector in accordance with claim 9, wherein the piston includes a head disposed within the second gas chamber and creates an air and fluid tight seal so that the compressed gas released from the gas storage chamber is trapped in the second gas chamber.

10. The needle-less injector in accordance with claim 8, wherein the liquid chamber is a hollow and pre-filled with a pre-measured amount of the liquid medication.

11. The needle-less injector in accordance with claim 8, wherein the gas storage chamber is pre-filled with compressed gas to a pressure sufficient to accelerate the liquid medication at a speed sufficient to pierce through the skin surface of the patient.

12. The needle-less injector in accordance with claim 8, wherein the compressed gas is inert gas.
13. A compressed gas activated needle-less injector device suitable for injecting a liquid medication through the skin surface, the device comprising:

a main body having a first gas chamber, a passageway and an elongated cavity in gaseous communication with the first gas chamber through the passageway, wherein the first gas chamber contains a pre-filled compressed gas;

a pop valve mounted to block the passageway to prevent the flow of the compressed gas from the first gas chamber until opened and released, wherein the pop valve is positioned in between the first gas chamber and the elongated cavity to open into the first gas chamber; and

a chamber housing coupled to the main body, the chamber housing comprising:

a liquid chamber that holds the liquid medication;

a liquid forcing assembly disposed within the liquid chamber that forces the liquid medication out from the liquid chamber; and

an orifice formed in one end of the chamber housing and in fluid communication with the liquid chamber,

wherein when the pop valve is permanently released into the first gas chamber and away from blocking the passageway, compressed gas is released from the first gas chamber into the elongated cavity and the compressed gas pushes the liquid forcing assembly which in turn pushes the liquid medication out through the orifice into the skin surface.
14. A needle-less injector device according to claim 14, wherein the
liquid forcing assembly includes:

a piston disposed and movable within the liquid chamber; and

a plunger disposed and movable within the liquid chamber along

with the piston to force the liquid medication out from the liquid chamber through

the orifice.

15. A needle-less injector device according to claim 15, wherein the
piston includes a head disposed within the elongated cavity and creates an air and

fluid tight seal to define a second gas chamber so that the compressed gas released

from the first gas chamber is trapped in the second gas chamber.

16. A needle-less injector device according to claim 14, wherein the
liquid chamber is pre-filled with a pre-measured amount of the liquid medication.

17. A needle-less injector device according to claim 14, wherein the
pre-filled with compressed gas in the first gas chamber is at a pressure sufficient to
accelerate the liquid medication at a speed sufficient to pierce through the skin
surface.

18. A needle-less injector device according to claim 14, wherein the
compressed gas is inert gas.
19. A needle-less injector device according to claim 14, further comprising a lock bar attached to the pop valve and an actuator for permanently releasing the lock bar of the pop valve, wherein the actuator is slidably mounted through a side wall of the main body adjacent to the pop valve so that when one end of the actuator is pushed in, the other end of the actuator permanently detaches a lock bar from the pop valve to open and release the pop valve from blocking the passageway to release the compressed gas into the second gas chamber.

20. A needle-less injector device according to claim 20, further including an actuating member mounted on the main body, the actuating member comprising an actuating assembly to force the actuator inward.

21. A needle-less injector device according to claim 21, wherein the actuating assembly includes an inclined surface that pushes the actuator inward as the actuating member is depressed.

22. A needle-less injector device according to claim 21, further including a coil spring positioned between the actuating member and the main body to bias the actuating member in an un-depressed state.

23. A needle-less injector device according to claim 21, wherein the actuating member further has a retainer device coupled to the main body to mount the actuating member on the main body.
24. A needle-less injector device according to claim 14, wherein a protective cover covers the orifice defined by the chamber housing.

25. A needle-less injector device according to claim 14, wherein the injector device only injects a single dose of the liquid medication.
AMENDED CLAIMS

[received by the International Bureau on 23 March 2000 (23.03.00);
original claims 7-12 and 14-25 replaced by amended claims;
remaining claims unchanged (5 pages)]

resistance, to activate the driver to force the liquid medication out of the housing to
pierce the skin surface of the patient.

7. The needle-less injector in accordance with claim 1, the housing of

the needle-less injector further including:

a main body portion having the gas storage chamber, a passageway and a
second gas chamber in gaseous communication with the first gas chamber through
the passageway. wherein the gas storage chamber contains a pre-filled compressed
gas, and wherein the second gas chamber partially contains the driver;

the pop valve is mounted to block the passageway to prevent the flow of the
compressed gas from the gas storage chamber until opened and released into the gas
storage chamber, wherein the pop valve is positioned in between the gas storage
chamber and the second gas chamber; and

a chamber housing portion coupled to the main body portion, the chamber

housing including:

a liquid chamber that holds the liquid medication, the liquid
chamber being in fluid communication with the driver;

an orifice formed in one end of the chamber housing portion, the
orifice being in fluid communication with the liquid chamber,

wherein when the compressed gas is released from the gas storage chamber
when the pop valve is released into the gas storage chamber, the compressed gas
pushes the driver which in turn pushes the liquid medication out through the orifice
to pierce the skin surface of the patient

AMENDED SHEET (ARTICLE 19)
8. The needle-less injector in accordance with claim 7, wherein the driver includes:
   a piston disposed and movable within the liquid chamber; and
   a plunger disposed and movable within the liquid chamber along with
   the piston to force the liquid medication out from the liquid chamber through
   the orifice.

9. The needle-less injector in accordance with claim 8, wherein the piston includes a head disposed within the second gas chamber and creates an air
   and fluid tight seal so that the compressed gas released from the gas storage chamber
   is trapped in the second gas chamber.

10. The needle-less injector in accordance with claim 7, wherein the liquid chamber is hollow and pre-filled with a pre-measured amount of the liquid
    medication.

11. The needle-less injector in accordance with claim 7, wherein the gas storage chamber is pre-filled with compressed gas to a pressure sufficient to
    accelerate the liquid medication at a speed sufficient to pierce through the skin
    surface of the patient.

12. The needle-less injector in accordance with claim 7, wherein the compressed gas is inert gas.
14. A needle-less injector device according to claim 13, wherein the liquid forcing assembly includes:

    a piston disposed and movable within the liquid chamber; and

    a plunger disposed and movable within the liquid chamber along with

the piston to force the liquid medication out from the liquid chamber through
the orifice.

15. A needle-less injector device according to claim 14, wherein the piston includes a head disposed within the elongated cavity and creates an air and fluid tight seal to define a second gas chamber so that the compressed gas released from the first gas chamber is trapped in the second gas chamber.

16. A needle-less injector device according to claim 13, wherein the liquid chamber is pre-filled with a pre-measured amount of the liquid medication.

17. A needle-less injector device according to claim 13, wherein the pre-filled compressed gas in the first gas chamber is at a pressure sufficient to accelerate the liquid medication at a speed sufficient to pierce through the skin surface.

18. A needle-less injector device according to claim 13, wherein the compressed gas is inert gas.
19. A needle-less injector device according to claim 13, further comprising a lock bar attached to the pop valve and an actuator for permanently releasing the lock bar of the pop valve, wherein the actuator is slidably mounted through a side wall of the main body adjacent to the pop valve so that when one end of the actuator is pushed in, the other end of the actuator permanently detaches a lock bar from the pop valve to open and release the pop valve from blocking the passageway to release the compressed gas into the second gas chamber.

20. A needle-less injector device according to claim 19, further including an actuating member mounted on the main body. The actuating member comprising an actuating assembly to force the actuator inward.

21. A needle-less injector device according to claim 20, wherein the actuating assembly includes an inclined surface that pushes the actuator inward as the actuating member is depressed.

22. A needle-less injector device according to claim 20, further including a coil spring positioned between the actuating member and the main body to bias the actuating member in an un-depressed state.

23. A needle-less injector device according to claim 20, wherein the actuating member further has a retainer device coupled to the main body to mount the actuating member on the main body.
24. A needle-less injector device according to claim 13, wherein a protective cover covers the orifice defined by the chamber housing.

25. A needle-less injector device according to claim 13, wherein the injector device only injects a single dose of the liquid medication.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61M5/30

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)
IP C 7 A61M F16K

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

X

* 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

** 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

"Z" document member of the same patent family

Date of the actual completion of the international search
16 February 2000

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 MV Rijswijk

Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Date of mailing of the international search report
25/02/2000

Authorized officer
Jameson, P
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INTERNATIONAL SEARCH REPORT

Box I  Observations where certain claims were found unsearchable (Continuation of item 1 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. X Claims Nos.: 7-12, 14-25 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:
   I have not searched the claims dependant on themselves or claims dependant on such claims.

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 II  Observations where unity of invention is lacking (Continuation of item 2 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 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.
Continuation of Box I.2

Claims Nos.: 7-12, 14-25

I have not searched the claims dependant on themselves or claims dependant on such claims.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.
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