United States Patent

Lussier

[15] **3,695,266**

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[54] **NEEDLELESS SEQUENTIAL DOSING SYRINGE**

[72] Inventor: **Maurice G. Lussier,** 222 Maple St., Lynn, Mass. 01904

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[52] **U.S. Cl.**.....**128/173 H,** 128/218 C, 222/471

[51] **Int. Cl.**.....**A61m 5/22,** A61m 5/30

[58] **Field of Search**.....128/173 H, 218 R, 218 C; 222/471

[56] **References Cited**

UNITED STATES PATENTS

2,605,763 8/1952 Smoot.....128/173 H

2,800,903 7/1957 Smoot.....128/173 H

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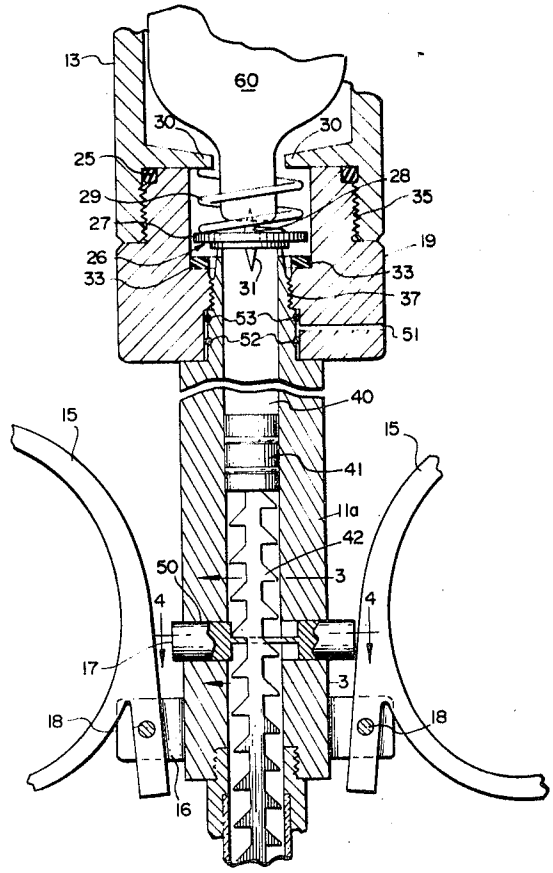
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Primary Examiner—Richard A. Gaudet
Assistant Examiner—G. F. Dunne
Attorney—Philip G. Kiely

[57] **ABSTRACT**

This invention relates to a needleless syringe for the application of a plurality of sequential doses of medicament in rapid succession without reloading, wherein the driving force is a pressurized fluid.

9 Claims, 5 Drawing Figures



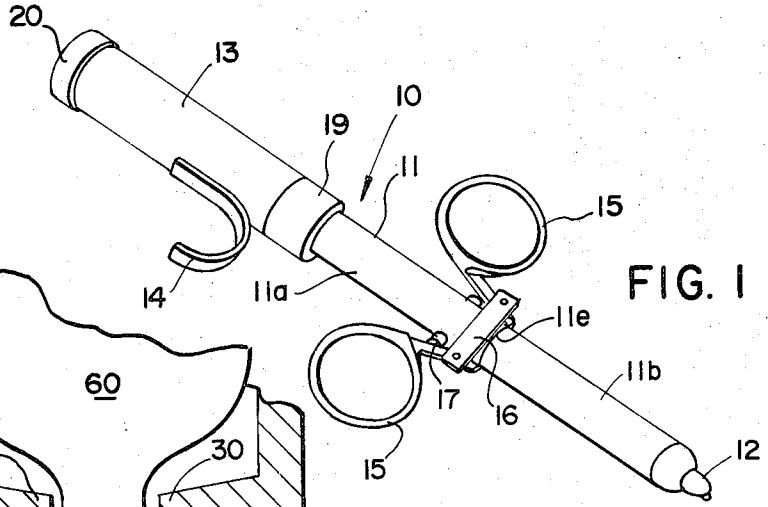


FIG. 1

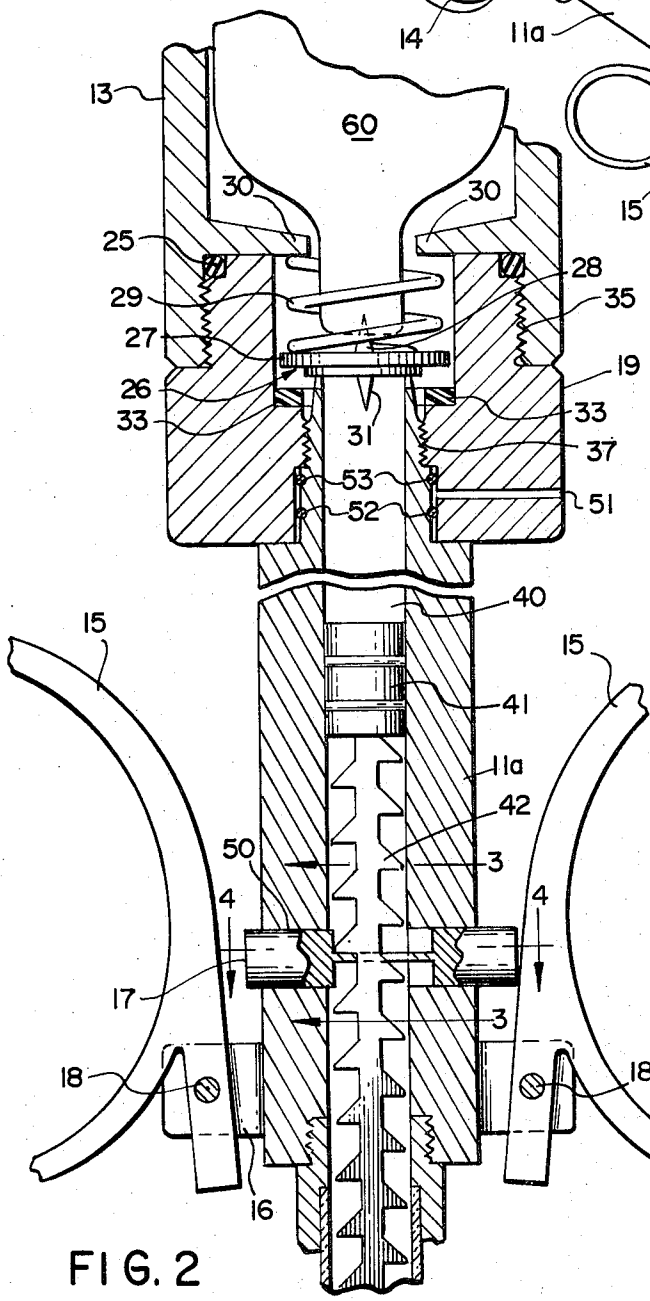


FIG. 2

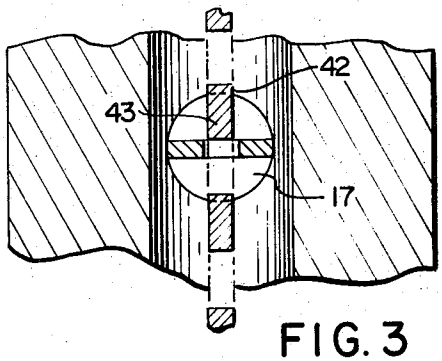


FIG. 3

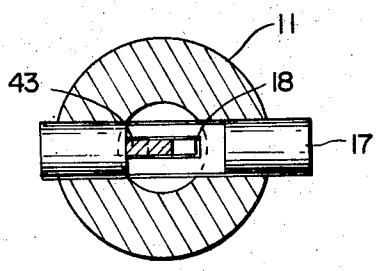


FIG. 4

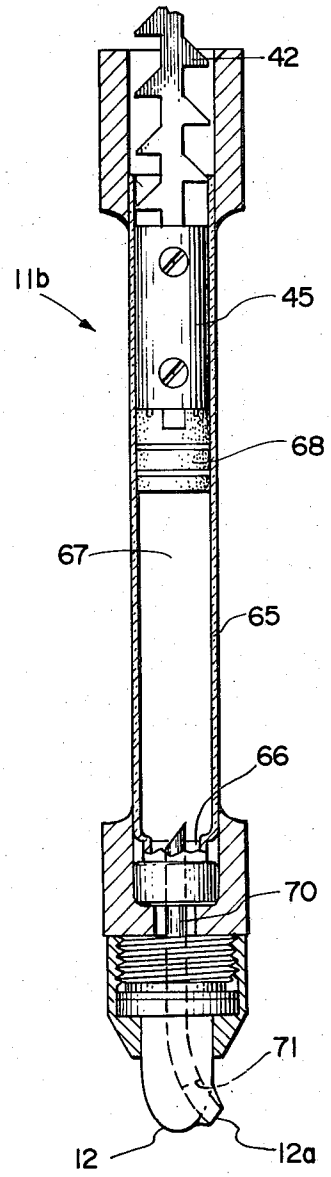


FIG. 5

NEEDLELESS SEQUENTIAL DOSING SYRINGE

BACKGROUND OF THE INVENTION

This invention relates to hypodermic syringes for injecting pharmaceuticals and other liquids into tissues, veins or arteries, or onto the surface of the skin and, more particularly, to syringes by which pharmaceuticals and medicaments can be injected through the skin without the aid of a skin penetrating needle.

While needleless syringes have widespread utility in the fields of medicine and dentistry, such devices have been found to be particularly advantageous in the administration of local anesthetic in connection with dentistry. The insertion of needles into the mouth tissue of the patient is painful, and because of the unweildly construction of many conventional syringes, are awkward to operate, which may result in additional pain or discomfort to the patient.

The needleless syringe, on the other hand, avoids the pain aspects of the injection but introduces or retains other problems. For example, a widely accepted type of syringe employs a spring as the force-exerting means to project the medication; in this case the anesthetic, from the syringe into the patient's tissue. A device of the spring loaded type is described in U.S. Pat. No. 2,821,981. The primary disadvantages of such devices are the bulkiness of the syringe and the necessity of withdrawing it from the mouth to withdraw the spring to its retracted position. Since several injections are usually administered for dental treatments, operation of such a syringe is time-consuming. Since the operator must repeatedly remove the work area from his field of vision during retraction of the piston, this may result in disposition of the anesthetic in areas other than those desired.

Various syringes have been employed which avoid the problem of spring retraction by employing a compressed gas as the driving force for expelling the medication. For example, U.S. Pat. No. 2,645,223 discloses a gas-actuated syringe wherein a rotatable ball valve releases the pressurized gas to drive a piston against the medicament with sufficient force to expel said medicament. A combination of lugs and passages can be adjusted to determine the length of the piston's travel and, thus, the amount of medicament expelled. A similar device is shown in U.S. Pat. No. 2,605,763 wherein the valving means employs a spring-loaded gas release mechanism.

However, the prior art devices suffered from a number of deficiencies. For example, adequate valving means generally have not been available to shut off the gas supply while a new supply of medication is introduced into the syringe, or it may be difficult or impossible to maintain sterile conditions in the syringe while reloading the device. Thus, the utilization of prior art gas actuated syringes has generally been limited to the use of a single charge of gas to a single charge of medicament, and if one was exhausted before the other, both must be discarded which is a wasteful procedure.

A novel device has now been found which is not susceptible to the deficiencies of the prior art.

SUMMARY OF THE INVENTION

A novel device has now been found which is comfortably handled in accordance with conventional syringe from procedures, with which physicians and dentists are readily familiar and which will provide repeated and rapid discharges of the medicament without withdrawing the device form the work area, e.g., the mouth. Similarly, the gas chamber can readily be sealed off from the propelling means and the medicament chamber to permit the opening of the syringe and replacement of an exhausted charge of medicament or a different kind of medicament. Conversely, if the propelling gas supply is exhausted before all the medicament has been expelled, the communication means between the gas supply chamber and the rest of the syringe can be closed off and the gas supply replenished. The means for determining the dosage can also be readily exchanged without disturbing sterility of the medicament or loss of propellant.

Specifically, the novel device of the present invention comprises a syringe having a housing, propellant fluid containing and delivering means; a medicament chamber, a piston adapted to be driven by said gas into the medicament chamber with sufficient force to expell a quantity of said medicament, whereby the increment of medicament delivered is determined by the distance traveled by the piston, said distance being determined by the spacing of teeth on the piston which engage and disengage stopping means. More specifically, it has now been found that a plurality of measured dosages of medicament can be delivered rapidly and accurately by employing an elongated piston or driving means having a plurality of opposed, offset teeth or steps which are alternately engageable by holding means, preferably in the form of a pin movable substantially perpendicular to the path of the piston, whereby the actuation of the holding means to release the piston to deliver a quantity of medication by releasing one step on the piston, also serves to move said holding means into position to engage the next following opposed, offset step which will move into the engageable position with the holding means as the piston advances, thus preventing the piston from traveling further than the distance between said opposed steps. The distance between said steps is determined with respect to the quantity of medicament to be delivered.

The above-mentioned holding means is adapted to be rapidly moved back and forth by action of the fingers holding the syringe thereby permitting the delivery of a number of dosages rapidly by successively engaging and releasing the opposed offset steps on the piston.

Novel sealing means, including bleeding means, permits the closing off of the gas supply portion of the syringe and dismantling the syringe to replace the medicament supply or the piston.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of the syringe of the present invention,

FIG. 2 is an enlarged cross-sectional view showing the central portion of the syringe;

FIG. 3 is a fragmentary cross-sectional view taken along line 3—3;

FIG. 4 is a fragmentary cross-sectional view taken along line 4—4; and

FIG. 5 is an enlarged cross-sectional view showing the delivery end of the syringe.

DETAILED DESCRIPTION OF THE INVENTION

DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to a syringe, particularly adapted for use as a needleless syringe, wherein repeated, premeasured doses are rapidly delivered by said syringe. Specifically, the syringe comprises pressurized fluid driving means, preferably sufficient to impart velocities to the medicament sufficient to inject said medicament through the tissues; racheted piston means adapted to be driven by said fluid driving means; the teeth on said piston being opposed and offset; engaging means for said teeth comprising a pin having a slot therein, movable from a first to a second position in reciprocating fashion and adapted to alternately engage the teeth on the piston, thus permitting the piston to advance the distance between adjacent opposed steps each time said pin is actuated; wherein the distance between said teeth determines the dosage delivered. The piston acts upon a chamber containing medicament with sufficient velocity to expel a portion of the medicament contained therein. Preferably, the medicament is retained in a conventional sterile cartridge and does not contact the surrounding chamber on the piston.

More specifically, the piston is disposed within the slotted pin, and the slot and teeth so arranged that a tooth or step must engage the pin at either end of the slot. Thus, while the pin engages one step or tooth in a first position, and the pin is moved perpendicular to the axis of the piston from said first position, the first tooth will be disengaged, the pressurized fluid force on the piston will advance the piston through the pin until the next adjacent and opposed step engages the opposite side of the slot, thus halting the forward motion of the piston until the pin is again actuated by returning it to the first position repeating the operation. A series of doses of medicament can be expelled by moving said pin from a first to a second position to said first position and so on, thus advancing the piston in a measured, step-wise fashion. The quantity of medicament expelled is determined by the distance between adjacent steps on the piston. A piston with pre-selected distances between steps is selected for employment with the syringe to deliver a pre-selected dosage of medicament.

Preferably, the pin is actuated by the action of the fingers of the operator alternately exerting pressure on finger holds on the syringe which engage the slotted pin imparting the reciprocating motion to said pin.

Turning to the drawing, FIG. **1** is a side elevational drawing of the syringe **10** of the present invention showing body **11** which contains rachet piston chamber **11***a* and medicament chamber **11***b* joined to **11***a* at **11***c*; nozzle **12** shown for employment as a needleless syringe and preferably rotatable in a 360° arc, and pressurized fluid chamber **13**. The syringe is hand held by thumb hold **14** and opposed finger holds **15** pivotally secured to body **11** by mounting means **16** and adapted to engage the ends of pin **17** as it protrudes from body **11**, and alternately move said pin from a first to a second position as the finger holds **15** are alternately moved towards and away from body **11**. Intermediate body **11** and pressurized fluid chamber **13** is joining means **19** which contains puncturing means of the pressurized fluid which is contained in a flask. Also contained therein and which will be discussed below are venting means and sealing means permitting the separation of the units without loss of the pressurized fluid.

FIG. **2** illustrates a portion of pressurized fluid chamber **13**, chamber **11**a and joining means **19**. In the configuration shown, flask **60** containing gas under pressure has been punctured, the syringe in the "open" attitude, i.e., gas is impinging on the driving means and the syringe is thus operative.

As shown in FIG. **2**, flask **60** has been inserted into chamber **13** through the end closed by cap **20**. The engagement of joining means **19** and chamber **13** with sealing means **25** prevents any gas leakage. As the flask **60** is urged downward by cap **20**, it contacts piercing means **26** comprising plate **27** and piercing cannula **28** which is centered by means of spring **29**.

When the contact between flask **60** and piercing means **26** has urged piercing means **26** to its furthest point, i.e., when it contacts the end of piston chamber **11***a*, the piercing cannula **28** punctures flask **60** releasing the pressurized gas contained therein. The pressurized gas can then pass into chamber **40** through aperture **31** in the wall of chamber **11**a where it impinges on floating piston **41** which frictionally engages the walls of chamber **40** in a gas-tight relationship and which engages the upper end of piston **42** with sufficient force to expel the medicament when a step on piston **42** is disengaged and acts on the medicament chamber.

Piston **42** has a plurality of opposed, offset teeth or steps **42** thereon adapted to engage an inner edge of pin **17** slidably mounted in slot **50** in chamber **11***a*. Finger holds **15** are pivotally mounted around points **17** on bracket **16** attached to chamber **11***a*.

The relationship of piston **42** to pin **17** is also shown in FIG. **3** which is a horizontal view taken along line **3—3**, and in FIG. **4** which is a vertical view looking down on the syringe, along line **4—4**. Piston **42** passes through slot **18** in pin **17** and engages the pin at the edge of the slot. As pin **17** is moved horizontally, that is in a direction transverse to the axis of chamber **40** and direction of travel of piston **42**, tooth **43** will disengage from the edge of pin **17** and, because of the pressure exerted on it from floating piston **41**, will move through slot **18** until the next step, on the opposite side of piston **42** engages the side of pin **17** thus stopping the forward motion of piston **42**. Piston **42**, by virtue of the driving force which has advanced it the described single step, acts on the medicament to expel an amount from the syringe corresponding to increment between steps. Thus, the distance between steps will determine the dosage delivered, and pistons with a variety of distances between steps can be employed interchangeably depending upon the medicament employed and the dosage desired.

As was described above, the flask **60** was inserted into chamber **13** and then screwed onto joining means **19** which was already attached to body **11**. Alternatively, the three pieces may be assembled in several combinations. HOwever, once the fluid container is punctured, joining means **19** cannot be removed from chamber **13** without loss of gas.

As stated above, the medicament may be replaced, piston **42** retracted to its starting position and the flask of pressurized gas may be replaced without interfering with sterility or the operativeness of the remaining portions of the syringe. For example, in order to detach the pressurized driving means form the syringe, for example, to replace the medicament and retract piston **42**, chamber **13** and joining means **19** would be detached as a unit from chamber **11***a b*by unscrewing threads **37**. As joining means **19** is being detached from chamber **11***a*, the force of the gas will force plate **27** downward as chamber **11***a* is, in essence, being retracted, until it engages sealing means **33**, e.g., an O-ring, thus shutting off the gas supply from the rest of the syringe and maintaining the gas within the chamber **13**. Upper sealing means **53** and lower sealing means **52** prevent leakage of gas from the syringe during operation. As joining means **19** is being detached from chamber **11***a*, venting means **51** will pass upper sealing means **53**, thus permitting residual gas remaining in chamber **40** to be discharged to the atmosphere. No gas will be lost from pressurized fluid chamber **13** because, as stated above, plate **26** in association with sealing means **33** seals off pressurized fluid chamber **13**.

With the gas vented above floating from **41**, medicament chamber **11***b* may be detached form chamber **11***a* and piston **42** may be retracted from its extended position by exerting a force against piston **42** moving it, as well as floating piston **41**, up into chamber **40** where it will be ready to again be used with a new charge of medicament.

Floating piston **41** has been shown as a separate unit. It should be understood that it may comprise an integral part of piston **42** if desired. However, piston **41** must make a gas-tight engagement with the walls of chamber **40**, as by the O-ring shown in FIG. **2**. If pistons **41** and **42** are separate, it is only necessary to replace piston **42** for dispensing different dosages.

FIG. **5** is a cross-sectional view of the lower portion or delivery end of the syringe showing medicament chamber **11**b containing therein, in the embodiment shown, an ampule **65** containing medicament **67** retained in walls of e.g., glass, and, on the lower end, membrane **66** and on the upper end, piston type stopper **68** preferably of rubber and adapted to slidably engage the walls of ampule **65** in response to pressure applied by actuating rod **45** mounted on the end of piston **42** and of such dimensions to fit within the walls of ampule **65** as the medicament is expelled and stopper **68** moves downward towards the opposite end.

As shown in FIG. **5**, actuating rod **45** is shown as attached to piston **42** by screws. It should also be understood that actuating rod **45** may comprise an integral part of piston **42** or may be attached by quick release means known to the art.

Medicament chamber **11***b* may be secured to the device by any suitable means such as by screw threads or, preferably by bayonet joining means for quick release. It should be noted that a gas-tight system is not required since the pressurized gas is retained behind the floating piston **41** and does not enter the part of the device housing piston **42** or the medicament.

An ampule can be inserted into chamber **11***b* and the chamber rejoined to the device. This action will cause membrane **66** to be punctured by cannula **70**. However, no medicament will be expelled from the device until pressure is applied because of the extremely small dimensions of perforated plate **71**, which provides for the fine spray expelled under sufficient pressure to penetrate human tissues. After passing through plate **71**, the medicament exits through orifice **12***a* in nozzle **12**, which is preferably rotatable in a 360° angle simplifying operation of the syringe.

The ampules or medicament containing cartridges, as described herein, are conventional and known to the art.

The driving force has been described primarily in terms of a pressurized or liquified gas. The term gas is intended to include air, nitrogen, freon, carbon dioxide and the like. It should also be understood that instead of retaining the fluid in a flask or cartridge, as illustrated, suitable valving means may be mounted on chamber **13** and pressurized directly with a suitable fluid from a large source of said fluid.

The syringe of the present invention may be composed of any suitable material capable of withstanding the pressures and stresses involved. The preferred material is stainless steel.

I claim:

1. A device for injecting liquid medicament which comprises a housing which includes:
- pressurized fluid means;
- means for retaining a medicament;
- means for driving said medicament from said device, said pressurized fluid means acting on said driving means;
- said driving means comprising an elongated piston having a plurality of opposed, offset teeth thereon; and
- stopping means adapted to engage and disengage said teeth in sequence, said stopping means comprising a pin perpendicular to said piston and having a slot therein, said piston passing through said slot whereby said teeth sequentially engage alternate edges of said pin as said pin moves in reciprocating motion.

2. A device as defined in claim **1** which includes:
- a pressurized fluid chamber;
- propelling means adapted to be driven by said pressurized fluid;
- a medicament chamber;
- said propelling means adapted to act on medicament retained in said medicament chamber dispensing it from said device;
- said propelling means comprising an elongated piston having a plurality of opposed, offset steps thereon; and
- stopping means adapted to alternately engage and disengage from said steps thereby providing for incremental advancement of said piston, said stopping means comprising a pin perpendicular to said piston and having a slot therein, said piston passing through said slot whereby said steps sequentially engage alternate edges of said pin as said pin moves in reciprocating motion.

3. A device as defined in claim **2** which includes means for sealing said pressurized fluid chamber from the rest of said device.

4. A device as defined in claim **1** wherein said pressurized fluid is retained in a flask and said pressurized

fluid chamber includes piercing means for releasing fluid from said flask.

5. A device as defined in claim 1 wherein said medicament retaining means comprises an ampule-receiving chamber and said piston is adapted to exert dispensing pressure thereon.

6. A device as defined in claim 1 which includes a nozzle for dispensing said medicament, said nozzle rotatable in a 360° arc.

7. A device as defined in claim 1 which includes a gas-tight floating piston communicating between said elongated piston and said pressurized fluid means.

8. A device as defined in claim 1 which includes pivotally mounted finger holds adapted to act on said pin.

9. A device for injecting liquid medicament which comprises a housing which includes:

pressurized fluid means;

means for retaining a medicament;

means for driving said medicament from said device, said pressurized fluid means acting on said driving means;

said driving means comprising an elongated piston having a plurality of opposed, offset teeth thereon; and

stopping means adapted to engage and disengage said teeth in sequence;

said pressurized fluid means comprises a chamber retaining therein a flask containing a gas under pressure; means associated with said chamber adapted to pierce one wall of said flask to permit gas to escape therefrom; said piercing means including sealing means adapted to seal said chamber when detached from said device to prevent substantial escape of gas therefrom; said sealing means comprising a spring loaded plate adapted to be forced against the aperture of said chamber closing said aperture by the pressure of the gas in said chamber; venting means associated with said chamber adapted to be actuated on said detachment; said piston being contained in a housing and passing through a slot in a pin disposed transversely to said piston and extending through opposed walls of said housing; said teeth adapted to sequentially engage alternate edges of said pin as said pin moves in reciprocating motion in response to manual actuation thereof; a floating piston intermediate said chamber and said piston, said floating piston being substantially gas-tight; whereby said pressurized gas acts on said floating piston which in turn acts on said piston, said piston adapted to engage one e end of an ampule containing medicament; piercing for said ampule associated with discharging means; nozzle means associated with said discharging means, whereby said piston upon advancing will displace a given amount of medicament from said ampule, discharging said medicament from the device through said nozzle.

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