NEEDLELESS SEQUENTIAL DOSING SYRINGE

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                        222/471

References Cited

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

FOREIGN PATENTS OR APPLICATIONS
1,186,571 8/1959 France.................. 128/218 L

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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
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 unwieldy 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 syringing 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 expel 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

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; ratcheted 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 fingers holds on the syringe which engage the slotted pin imparting the reciprocating motion to said pin.

Turning to the drawing, FIG. 1 is an isometric drawing of the syringe 10 of the present invention showing body 11 which contains ratchet piston chamber 11a and medicament chamber 11b joined to 11a at 11c; 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 11a 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 11a, 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 11a 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 slidable mounted in slot 50 in chamber 11a. Finger holds 15 are pivotally mounted around points 17 on bracket 16 attached to chamber 11a.

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 11a by unscrewing threads 37. As joining means 19 is being detached from chamber 11a, the force of the gas will force plate 27 downward as chamber 11a 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 11a, 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 11b may be detached form chamber 11a 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 11b 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 11b 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 11b 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 12a 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.

1 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
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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 a pivoting mounted finger held 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 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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