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3,433,223 ASPIRATING CARTRIDGE SYRINGE WITH GAS ACTUATION

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ABSTRACT OF THE DISCLOSURE

Hypodermic syringe adapted to be actuated by fluid pressure power means for effecting the delivery of liquid material from the syringe through the needle, the syringe being adapted to receive a disposable cartridge containing the liquid to be injected and having a closure at one end adapted to be punctured by the hypodermic needle and having a free piston at its other end, mechanism being provided for controllably delivering the fluid pressure to the free piston. The fluid pressure power means includes a source of expandable fluid under pressure, with mechanism for recycling or recompressing the pressure fluid. Provision is also made for aspirating action in advance of making an injection under the influence of the fluid pressure power.

The present application is a continuation-in-part of my applications Ser. No. 509,517 filed Nov. 24, 1965, and Ser. No. 559,703 filed Apr. 28, 1966, both now abandoned.

This invention relates to hypodermic syringes for injecting pharmaceuticals or other liquids into tissues, veins, or arteries. The invention is concerned with several important improvements including a novel arrangement for manual control of the syringe, a novel power means for ejecting the contents of the syringe to supplant the hand force customarily employed for this purpose, and a novel arrangement providing for aspiration by the syringe in advance of the injection. The invention is of especial advantage in making possible the achievement of all of these improvements in a single instrument, as will further appear.

Although various features of the invention have wide applicability in the fields of medicine and dentistry, one use in which the invention is especially advantageous is for the administration of local anesthetic in connection with dentistry.

It is recognized that the use of hypodermic syringes, notably in the field of dentistry, presents a number of problems, some of which are psychological and some physical. Indeed, in the field of dentistry, although the hand actuated syringe is almost universally used throughout the world, nevertheless such a syringe remains a symbol of fear and pain to many patients. In many cases this results in over stimulation of the adrenals which in many instances has caused the patient to go into syncope with the loss of consciousness even before being touched with the syringe.

In addition to adverse psychological factors of the well-known hand operated syringe, the hand operated syringe also has certain definite physical disadvantages. For example, the "spread grasp" of the hand required for expelling the material being administered by the syringe is not conducive to steady control of the instrument with respect to needle insertion in the tissue. For this reason, many operators prefer to initially employ the "pen grasp" during insertion in the tissue for more precise control, after which the operator must change the position of his hand to assume the "spread grasp" in order

to accomplish the injection. It is difficult to make this transition from one grasp to the other without moving or twisting the syringe. Such movements of the hand in changing from one grasp to the other produces unfavorable psychological reaction as well as physical discomfort to the patient, and can, in fact, be quite painful if the instrument is not carefully controlled. Moreover, the "spread grasp" is conducive to unintentional squirting or dripping of the medicine or anesthetic prior to the time that the needle is actually introduced into the tissue which is definitely undesirable because of the bitter and disagreeable taste of anesthetic solutions.

A major object of the present invention is to eliminate the foregoing disadvantages of the prior art manually operated syringe. Thus, the invention contemplates the provision of a syringe which does not even resemble in general appearance the well-known hand actuated syringe, thereby eliminating much of the adverse psychological influences above referred to.

In addition, the instrument provided in accordance with the present invention incorporates power actuating means in place of the hand actuated plunger of the prior art syringes, thereby eliminating the necessity for employment of the basically awkward "spread grasp" required with prior syringes.

It is also an object of the present invention to provide a hypodermic syringe which may conveniently be held in the "pen grasp" for both insertion of the needle into the tissue and the control of the instrument during the injection, and for this purpose the instrument of the present invention preferably incorporates a control element located intermediate the ends of the instrument and operable by a finger of the hand (i.e., either by the thumb or by one of the other four digits of the hand) without requiring shift of the hand from one position to another.

A still further object of the invention is to provide a syringe in which it is unnecessary to utilize an elongated plunger or piston rod to transmit the force applied by the hand of the doctor to the ejecting piston in the cartridge. With existing designs plungers of this type often contact the ejecting piston unevenly, and therefore result in the application of greater force to one side of the ejecting piston than the other, causing the walls of the ejecting piston to vibrate during its travel down the cartridge, resulting in what patients describe as a "scrunchy" sound. The present invention completely eliminates this problem.

In considering still another aspect of the invention it is pointed out that while provision for aspirating is not required for all purposes, for many purposes it is preferred and for some purposes it is essential to provide for aspiration through the hypodermic needle just prior to injection. This enables the operator to determine whether the tip of the needle has been inserted into a vein or artery, which is desired or essential for some purposes but is undesirable for other purposes, so that in either case it is important for the operator to be able to determine whether or not the needle has penetrated a blood vessel.

Aspiration for the foregoing purposes is a well-known technique and in the well-known manual aspirating syringes the manual plunger is customarily withdrawn slightly just after insertion of the needle into the tissues so that if the needle has entered a blood vessel a small amount or globule of blood will be aspirated through the needle into the syringe. The wall of the syringe is customarily made of transparent material so that such a globule of blood may be observed.

The present invention not only provides the advantages already brought out above but further makes possible achieving those advantages in a syringe which is also capable of aspiration prior to making an injection. More-

over, the invention provides a novel aspirating arrangement in which it is not necessary to withdraw the manual plunger in order to effect aspiration. Indeed, in the instrument of the invention aspiration is effected by motion of the operating element in the same direction as used to effect the injection.

In accordance with the invention the aspiration arrangement automatically assures that aspiration will precede the making of an injection

A still further object is to provide a finger control for a hypodermic syringe which not only provides for aspiration but also for starting and stopping of the power means and thus of the flow of the injection liquid in the syringe, as well as for precise control over the rate of flow of the pharmaceutical into the tissue.

How the foregoing objects and advantages are obtained, together with others which are explained later, will appear more fully from the following description referring to the accompanying drawings in which:

FIGURE 1 is a longitudinal sectional view through one form of the instrument according to the invention;

FIGURE 2 is an enlarged transverse sectional view as compared to FIGURE 1 and taken as indicated by the section line 2—2 of FIGURE 1;

FIGURE 3 is a sectional view through certain parts of the instrument shown in FIGURES 1 and 2 assembled with a recycling device;

FIGURE 4 is a longitudinal sectional view through an instrument representing a modification of the instrument of FIGURES 1 through 3;

FIGURES 5 and 6 are similar sectional views of the instrument of FIGURE 4 but showing certain control and operating parts in different positions; and

FIGURES 7 and 8 are transverse sectional views taken as indicated by section lines 7—7 and 8—8 on FIGURES 4 and 5, respectively.

In connection with two of the embodiments illustrated in the drawings it is mentioned that the embodiment of FIGURES 1 to 3 inclusive is especially suited to types of injections which do not require initial aspiration, examples of such types being the administration of local anesthetics in dentistry, and various intramuscular injections for instance, in the administration of insulin. The embodiment of FIGURES 4 to 8 provides the advantages of the embodiment of FIGURES 1 to 3 but in addition the embodiment of FIGURES 4 to 8 further provides for aspiration in a novel manner as fully explained hereinafter. Thus the embodiment of FIGURES 4 to 8 may be used not only for injections of the types mentioned just above, if aspiration is preferred, but in addition the embodiment of FIGURES 4 to 8 may also be employed for many other types of injections where aspiration is important or essential.

Turning now to the embodiment illustrated in FIGURES 1 through 3 inclusive, it is first noted that the instrument is adapted to the employment of cartridges of presently known type, namely a cartridge such as indicated at 61 having a free piston 62 in one end and having a puncturable diaphragm 55 at the other end. Such a cartridge permits arresting the motion of the parts and thus for the making of multiple injections from a given cartridge and controlling the rate of flow during the injection. The cartridge is received in the housing part 78 having at its left end the ferrule 79 for cooperation with the mounting of a needle 80, the inlet or inner end of which is adapted to penetrate the diaphragm 55 of the cartridge.

The righthand portion of the elongated housing, as indicated at 81, is adapted to receive the elongated piston 82 having a sealing ring 83 near its righthand end, and the lefthand end of which is adapted to abut the free piston 62 of the cartridge when the parts are assembled by the bayonet connection 84. The righthand end of the housing part 81 is open and threaded to cooperate with the cap member 85 containing a chamber 86 for receiving

a propellant material or actuating pressure fluid. This charge may be replenished if desired through a puncturable diaphragm such as indicated at 87.

In a typical case, this actuating fluid may comprise one of the well-known synthetic fluorocarbons having a low boiling point, for instance monochlorodifluoromethane, a source of which is known to the trade as "Freon 22" marketed by E. I. du Pont de Nemours & Co. This material introduced initially in liquid form will establish an internal pressure of approximately 135 p.s.i. at 76° F.

The cap 85 has a central bore extended from the chamber 86 to the righthand end of the cylinder within the housing part 81 so as to communicate the pressure in the chamber 86 to the righthand end of the elongated piston 82 and thereby drive that piston to the left against the free piston 62 thus effecting discharge of the material to be injected.

As seen in FIGURES 1 and 2 the central portion of the piston, between the lines indicated at 88 and 89 in FIGURE 1 is diametrically slotted, the slot being of tapered form as appears in FIGURE 2, in order to receive the tapered or wedge element 90 which is normally urged into wedging engagement in the slot in the piston 82 by means of the compression spring 91 which may be adjusted by the screw 92. The wedge element 90 may be released by means of a finger button 93. This arrangement provides for arresting the motion of the parts and thus for the making of multiple injections from a given cartridge and controlling the rate of flow during the injection.

In connection with the embodiment of FIGURES 1 to 3 it is to be noted that the invention contemplates a recycling system in connection with the power section of the syringe, namely the section incorporating the housing part 81, the elongated piston 82 and the cap 85 with the propellant charge therein. FIGURE 3 illustrates a preferred technique and equipment to be employed in connection with the recycling of the power section of this instrument. Thus it will be seen that the power section is positioned at the right in FIGURE 3 with the bayonet connection parts 84 associated with a tube or sleeve 94, as indicated at 84a. This sleeve 94 constitutes an extension from the cylinder 95 having a piston 96 therein with a piston rod or stem 97 projecting into the sleeve 94 to the position where it may abut the lefthand end of the elongated piston 82 of the power section of the instrument.

At the lefthand end of the cylinder 95 a cap 98 is provided, having an air pressure or other fluid pressure supply line 99 associated therewith for introduction of pressure fluid into the cylinder 95 back of the piston 96. An accumulator chamber 100 is also desirably connected with the righthand end of the cylinder 95 as by means of the pipe 101.

By the apparatus just described, after the piston 82 has been moved to the left when viewed as in FIGURE 1 so as to drive the free piston 62 into the cartridge, and when it is desired to recycle the syringe, the power section is separated from the cartridge section of the instrument and the power section is then placed into cooperative relation with the recycling mechanism as shown in FIGURE 3, whereupon by the introduction of pressure from the supply line 99 into the cylinder 95 the elongated piston of the power section of the syringe may be driven back into the housing part 81, thereby recycling the Freon 22 (E. I. du Pont de Nemours & Co.) or other propellant from vapor to liquid phase in the chamber 86 and thus preparing the instrument for reuse. In this way a given charge of the Freon or other propellant may readily be reused many times.

The instrument of FIGURES 1 through 3 inclusive is capable of employment in situations where a multiplicity of injections are to be made from a given charge. It is to be noted, however, if desired, the various parts may be proportioned to accept cartridges designed for single injections rather than multiple injections. In all cases var-

ious parts of the equipment are also readily capable of sterilization for reuse.

In FIGURES 4 through 8 another embodiment is illustrated, the instrument here shown being in many respects similar to that shown in FIGURES 1 through 3. As in FIGURES 1 through 3, the instrument of FIGURES 4 through 8 is one in which the pressure fluid may be recycled, for instance by a recycling mechanism of the kind illustrated in FIGURE 3.

The instrument of FIGURES 4 through 8 also incorporates another feature of importance, namely a system providing for aspiration prior to the making of an injection.

As seen particularly in FIGURES 4 and 5, the instrument includes tubular members 102 and 103, having a bayonet connection 104 therebetween. The member 102 has a cylindrical chamber therein adapted to receive a cartridge comprising a cylinder 105 having a free piston 106 in one end and having a puncturable diaphragm 107 at the opposite end.

The left end of the member 102 is provided with a threaded cap member 108 adapted to receive a cup 109, the cup being shiftable within the member 108 and being normally urged toward the right as viewed in FIGURES 4 and 5 by means of a coil spring 110, the range of movement of the cup being shown by comparison of FIGURES 4 and 5.

The tubular member 103 of the assembly is adapted to receive the piston 111 having a sealing ring 112 toward its righthand end and having at its lefthand end a harpoon 113 designed to penetrate the free piston 106. With this in mind the free piston 106 is advantageously formed of rubber, so that the material will give as the harpoon enters the material.

At the righthand end of the tubular member 103 a cap 114 is provided, this cap being adapted to contain a charge of pressure fluid of the type hereinabove mentioned. A plug 115, formed of material which may be penetrated by a charging needle is provided at the extremity of the cap 114, so that when needed, additional pressure fluid may be introduced into the pressure chamber.

When the pressure chamber is charged, the pressure thereof will act against the righthand end of the piston 111, thereby urging the piston 111 to the left, as in the embodiment of FIGURES 1 through 3 described above. The motion of the piston 111 is adapted to be controlled by a brake 116 (see also FIGURE 7) of semi-cylindrical shape positioned on the underside of the piston 111 and mounted in a bore provided in a cylindrical part 117 formed at the lower side of the tubular member 103. This brake shoe 116 is urged upwardly against the lower surface of the piston 111 by means of compression spring 118 which reacts against an adjustable screw plug 119.

The brake shoe 116 is controlled by a brake rod 120 which extends upwardly through an axial slot formed in the piston 111, the upper or free end of the brake rod 120 being exposed outside of the tubular member 103 in position to be contacted by the operating element or lever 121. When the lever 121 is pressed downwardly, for instance as illustrated in FIGURE 6, the brake rod 120 is depressed, thereby displacing the brake shoe 116 from the lower surface of the piston 111, and thus releasing the piston for movement toward the left when viewed as in FIGURES 4 through 6, under the influence of the pressure fluid behind the piston.

Lever 121 is mounted by means of a pivot 122 the ends of which are supported in apertured lugs 123-123 projecting from the tubular member 103.

Lever 121 is further provided with an actuating finger 124 which is received in a socket formed at the upper side of a push rod 125 which is mounted for reciprocation or shifting movement lengthwise of the instrument within a groove or slot formed in the inner surface of the tubular member 103. Preferably the push rod 125 and the

slot in which it works are so shaped as to restrain outward dislodgement of the push rod, while permitting its longitudinal motion.

The push rod 125 is positioned so that its left-hand end will engage the righthand end of the cylinder 105 of the cartridge inserted into the tubular member 102. The purpose of this arrangement will be described shortly below.

Attention is now called to the lefthand end of FIGURE 5 where there is shown a hypodermic needle 126 mounted by means of a cap 127, with the inner end of the needle 126 penetrating the diaphragm 107 at the left end of the cartridge. Attention is also called to the fact that the tubular member 102 is provided with an elongated aperture 128 in a sidewall thereof through which the cartridge is visible. With the cylinder 105 of the cartridge formed of transparent material, as is customary, the aperture 128 in the tubular member 102 serves, in effect, as a window through which the interior of the cartridge may be observed.

The purpose and operation of various parts of the device as described above and illustrated in FIGURES 4 through 8, is as follows:

First, with the two tubular members 102 and 103 of the instrument separated (by disconnection of the bayonet joint 104) and in the absence of the hypodermic needle 126, an anesthetic cartridge is inserted into the tubular member 102 in the position indicated in FIGURE 4. The two tubular parts of the assembly are then brought together, and the bayonet joint 104 appropriately fastened. During this assembly, the harpoon 113 penetrates the free piston 106, at which time the assembly of parts appears as shown in FIGURE 4.

The hypodermic needle 126 is then inserted and fastened in place by means of the screw cap 127, and during this insertion the inner end of the needle penetrates the diaphragm 107, and the instrument is now ready for use. When the two parts of the casing are assembled it will be seen that the pressure fluid in the capsule 114 reacts between the free piston and the cartridge on the one hand and the part 103 of the casing on the other hand, and further that the piston 111 is operatively interposed between the free piston and the charge of the pressure fluid.

When used, the needle is of course inserted in the target area of the tissue, and in doing this, the instrument may be handled in the manner described above, namely by employing the "pen grasp." The operating element or lever 121 may then be actuated, for instance by the thumb, or within the grasp of the hand, without requiring shift in position of the hand. The initial motion of the lever 121, for instance the motion from the position shown in FIGURE 4 to the position shown in FIGURE 5 will shift the push rod 125 to the left and thereby shift the cylinder 105 of the cartridge to the left, for instance from the position shown in FIGURE 4 to the position shown in FIGURE 5, the spring 110 being compressed during this action. Moreover, at this time, because of the penetration of the harpoon 113 in the rubber of the free piston 106, the free piston is retained in its initial position. The action just described results in reduction of pressure within the cartridge and, in consequence an aspiration effect through the needle 126 into the left end of the cartridge. In the event that the needle has been positioned in a blood vessel, for instance in a vein, this aspirating effect will draw into the cartridge a small globule of blood, for instance as indicated at B in FIGURE 5. This globule is visible through the transparent cylinder 105 and through the window 128 in the tubular member 102, and thereby, the operator is apprised of the positioning of the needle within a blood vessel.

As above mentioned, an instrument of this kind may be employed for various different purposes, for some of which it is desired that the needle be positioned within a blood vessel and for others of which it is not desired that the needle be positioned within a blood vessel. In the

former case, the aspiration of the globule of blood will at once advise the operator that the needle is properly positioned to proceed with the injection. In the latter case, the aspiration of the globule of blood will advise the operator that the needle is not properly positioned, and the operator may then release the lever 121 and thereafter reposition the needle so as to locate it in the tissue exteriorly of the blood vessels.

In the event of either type of use, after the operator has determined that the needle is positioned as intended, the operator may then further depress the lever 121, in consequence of which the brake rod 120 is engaged and displaced, thus releasing the braking action of the brake shoe 116 against the piston 111, so that the piston will be moved under the influence of the fluid pressure behind it, thereby advancing the free piston 106 into the cylinder 105 of the cartridge and thus injecting the charge of the cartridge through the needle into the target area.

This control arrangement provides for selective incremental expansion of the pressure fluid and thus for controlled injection of the material in the cartridge so that if desired multiple injections may be made from a single cartridge.

If desired the operator may use the instrument of FIGURES 4 through 8 in the making of several injections, the quantity of material injected being readily controlled by release and re-engagement of the brake shoe 116. A spent cartridge may readily be removed by separation of the two tubular parts of the instrument 102 and 103, thereby permitting removal of the spent cartridge from the open end of the tubular member 102. The free piston 106 of a spent cartridge may also be readily removed from the harpoon 113. The pressure fluid in the instrument may then be recycled in the manner described above with reference to FIGURE 3. To avoid striking the tip of the harpoon 113 during recycling, the end of the piston rod 97 (see FIGURE 3) may be provided with a recess or bore accommodating the harpoon 113, so that the recycling pressure will then be transmitted directly from the end of the piston rod 97 to the end of the piston 111 of the instrument.

In the instrument of FIGURES 4 through 8 inclusive, it is thus possible to effect aspiration in advance of the injection. Indeed this instrument assures that aspiration will be effected in advance of injection. In this connection it will be observed that the operating element or lever 121 has a normal sense or direction of motion which automatically provides sequentially for aspiration and then for injection.

It is to be noted in connection with both embodiments of the instrument that provision is made for operation or control with the instrument held in the hand by the pen type grip. Thus the control may be operated by pressing on the control element with the thumb or one or more of the other fingers. In both embodiments illustrated and described the control element is positioned in general in a region intermediate the ends of the elongated instrument, thereby providing ready accessibility by a finger or fingers of the hand in which the instrument is held. And in all cases, no change in position of the instrument is needed for insertion of the needle and for subsequent actuation to deliver the injection, nor is any change in position of the hand even needed to effect aspiration with embodiment of FIGURES 4 through 8.

Both embodiments of the syringe as disclosed are also of special advantage in being capable of employment of cartridges of a type now widely available.

Cartridges available in a variety of types and containing a variety of materials may be used, many of such cartridges having either a glass or plastic case, with a well-known type of rubber diaphragm for needle puncturing, and having a free piston at the opposite end.

For use as a propellant, certain Freon gases other

than that mentioned may be used, as may also certain Genetrons (General Chemical Div.) and Ucons (Carbide and Carbon Chemicals Co.). Another specific example of an appropriate material is dichlorodifluoromethane which is available under the trade name Freon 12 (E. I. du Pont de Nemours & Co.).

Various of these fluorocarbons are colorless, almost odorless, nonflammable and virtually non-toxic so they are highly suitable to use in the medical field without hazard.

I claim:

1. A hypodermic syringe comprising a tubular body for receiving a piston and cylinder type cartridge having a transparent cylinder wall and containing material to be injected, the tubular body having a window providing for observation of a cartridge received in the tubular body and the tubular body having means for mounting a hypodermic needle in position to penetrate the cartridge, means for advancing the cylinder of a cartridge received in the tubular body and for concurrently restraining the piston as against advancement to thereby provide for reduction of pressure in the cartridge and thus effect aspiration through the needle, and means for advancing the piston into the cylinder and thus effect expulsion of the material to be injected from the cartridge through the needle.

2. A construction according to claim 1 in which the means for advancing the piston includes a source of pressure fluid and means for controllably applying the pressure of the fluid to the piston to effect advancement thereof in the cylinder.

3. A construction according to claim 1 and further including a common operating element for the means for advancing the cylinder and the means for advancing the piston.

4. A construction according to claim 3 in which the operating element is mounted for movement in one direction for operating the syringe, the construction further including means providing for sequential advancement of the cylinder and then of the piston by movement of the operating element in said one direction.

5. A hypodermic syringe having a chamber for receiving a disposable cartridge having a closure at one end adapted to be penetrated by a hypodermic needle and having a free piston at its other end, the cartridge further having a transparent cylinder enclosing the material to be injected, the syringe chamber providing for visual observation of the cartridge received therein and having means for mounting a hypodermic needle in position to penetrate said cartridge closure, mechanism connected with the free piston and providing alternatively for relative advancement and withdrawal of the piston with respect to the cylinder of the cartridge received in the syringe chamber, an operating element for the syringe mounted for movement in one direction for operating the syringe, and means providing for sequential relative withdrawal and then advancement of the piston with respect to the cylinder by movement of the operating element in said one direction.

6. A hypodermic syringe comprising an elongated housing with means for mounting a hypodermic needle at one end thereof, the housing forming a chamber for receiving a disposable injection liquid cartridge having at one end a closure adapted to be penetrated by a needle mounted on the housing and having a free piston at its other end, fluid pressure power means separate from the cartridge but adapted to act on the free piston to deliver said liquid from the cartridge through the needle, the power means including a source of expandable pressure fluid in the housing of the syringe between the cartridge and the end of the housing remote from the needle, and control means providing for selective incremental expansion of the pressure fluid and thus for regulation of the delivery of said liquid from the cartridge under the action of said power means.

7. A syringe according to claim 6 in which the power means includes a piston device operatively interposed be-

tween the free piston of the cartridge and the pressure fluid of said source and in which the control means comprises a manually releasable brake for controllably restraining motion of the piston device.

8. A syringe according to claim 6 and further including means for controllably retracting the free piston of the cartridge to effect aspiration.

9. A hypodermic syringe comprising an elongated housing having a chamber for receiving a disposable injection liquid cartridge having at one end a closure adapted to be penetrated by a hypodermic needle and having a free piston at the other end, the housing being formed of two separable and interengageable parts, a first part of the housing having means for mounting a hypodermic needle at the end thereof remote from the other part in a position to penetrate said closure, fluid pressure power means for advancing the free piston of the cartridge, the power means being mounted in the second part of the housing to be separable with said second part when it is separated from the first part of the housing, the power means including a source of expandable pressure fluid, and manual control means mounted on said second part of the housing and providing for selective incremental expansion of the pressure fluid and thus for regulation of the delivery of said liquid from the cartridge under the action of said power means.

10. A syringe according to claim 9 in which the power means further includes a piston device operatively interposed between the free piston of the cartridge and the pressure fluid of said source when the two parts of the housing are interengaged, when the two parts of the housing are separated said piston device being accessible to provide for recompression of the pressure fluid of said source by applying force to the piston device.

11. A syringe according to claim 9 in which the power means further includes a piston device operatively interposed between the free piston of the cartridge and the pressure fluid of said source when the two parts of the housing are interengaged, and the control means comprises a manually releasable brake for controllably restraining motion of the piston device.

12. A hypodermic syringe comprising an elongated housing formed of first and second separable and interengageable parts, the first part having a chamber for receiving a disposable injection liquid cartridge having at one end a closure adapted to be penetrated by a hypodermic needle and having a free piston at the other end

and the first part of the housing further including means for mounting a hypodermic needle at the end thereof remote from the second part in a position to penetrate said closure, fluid pressure power means for advancing the free piston of the cartridge including a charge of expandable pressure fluid behind the free piston arranged to react between the free piston and the second part of the housing when the two parts of the housing are interengaged, and manual control means providing for selective incremental delivery of said liquid from the cartridge under the influence of the pressure fluid.

13. A hypodermic syringe according to claim 12 in which the power means for advancing the free piston includes a power piston operatively interposed between the free piston and the charge of pressure fluid and further in which the manual control means includes a releasable brake for the reciprocation of the power piston, the brake being biased to brake-applied position, and the power piston being accessible when the two parts of the casing are separated and being movable to recycle the pressure fluid.

14. A hypodermic syringe comprising an elongated housing having an open end; a cartridge fitting within the housing and containing the material to be injected; a hypodermic needle at the end of the housing opposite said open end; a free piston in the cartridge forming a chamber for the material to be injected; a hollow closure member adapted to be removably secured to said open end of the housing; a power piston in said closure member; a propellant compartment; means for establishing communication between the propellant compartment and the rear face of the power piston; and brake mechanism for controlling the movement of said power piston under the influence of said propellant, said power piston being adapted to move the free piston to discharge the material to be injected.

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