

Oct. 28, 1969

S. GRANT
HYPODERMIC SYRINGE

3,474,787

Filed April 3, 1968

5 Sheets-Sheet 1

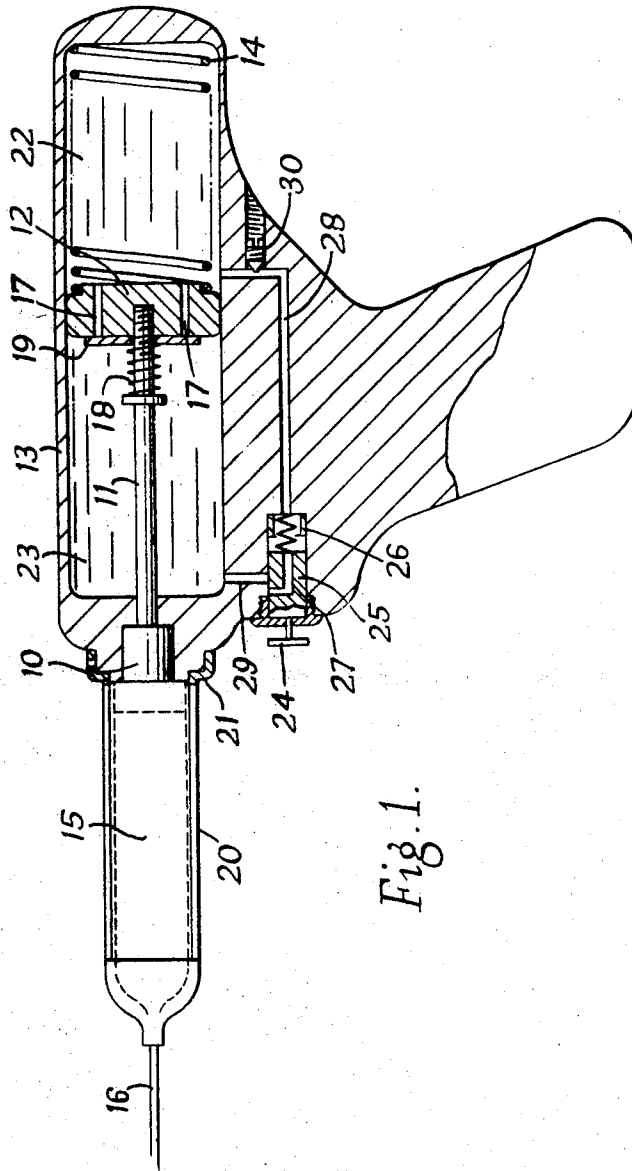


Fig. 1.

INVENTOR
SIDNEY GRANT
BY
Woodhams, Blanchard & Flynn
ATTORNEYS

Oct. 28, 1969

S. GRANT

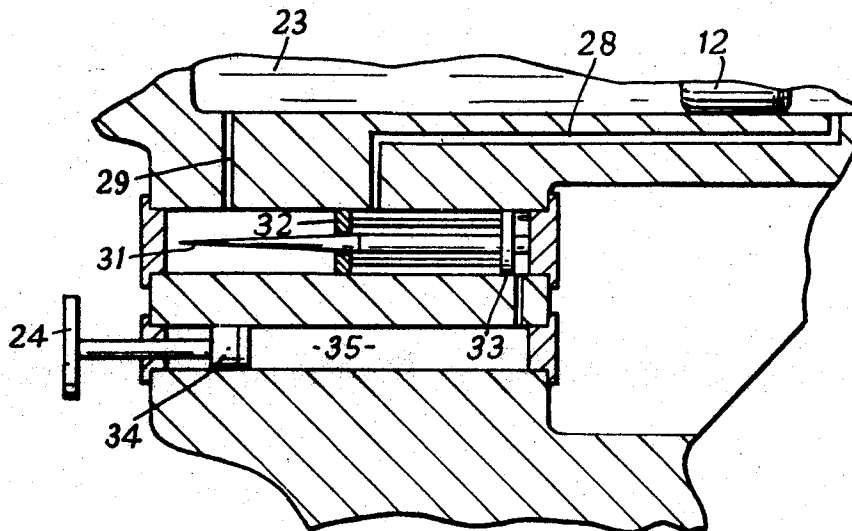
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Fig. 2.



INVENTOR

SIDNEY GRANT

BY

Woodhams, Blanchard & Flynn

ATTORNEYS

Oct. 28, 1969

S. GRANT

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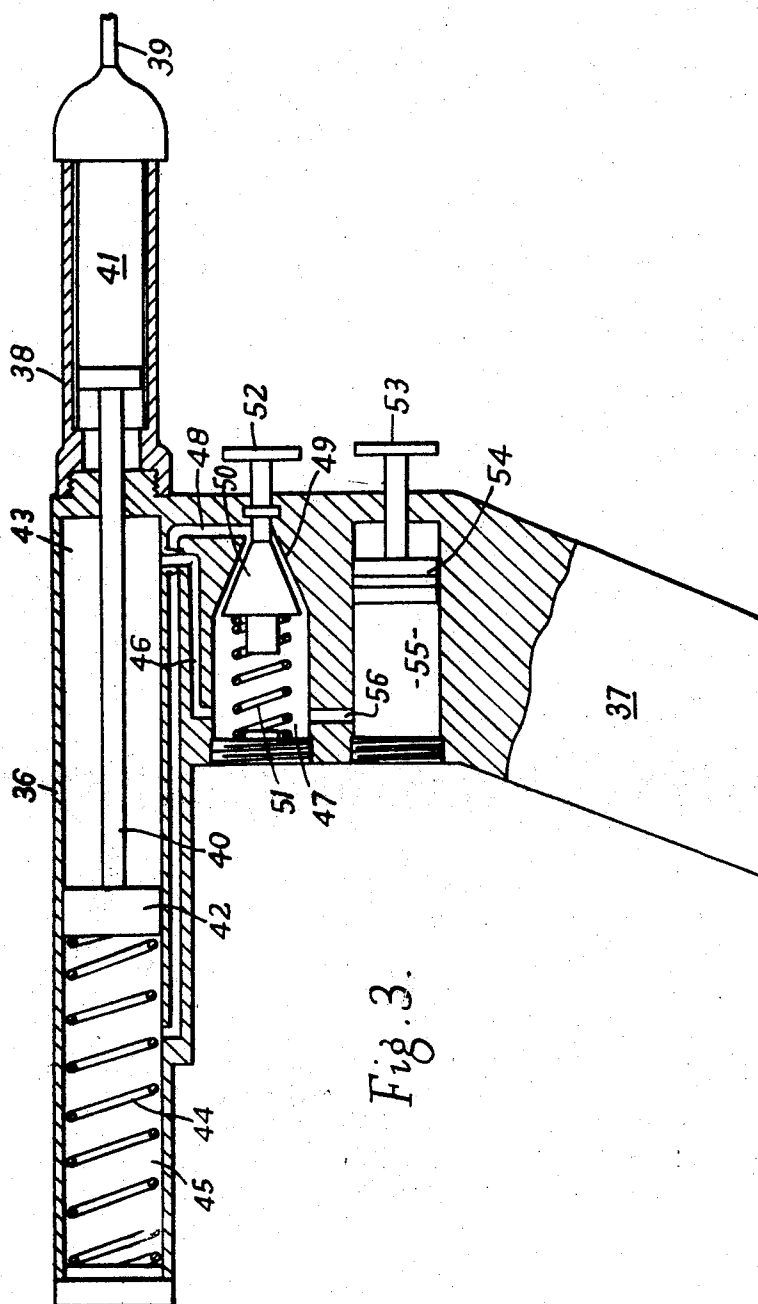


Fig. 3.

INVENTOR

SIDNEY GRANT

BY

Worthington, Blanchard & Flynn

ATTORNEYS

Oct. 28, 1969

S. GRANT

3,474,787

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Filed April 3, 1968

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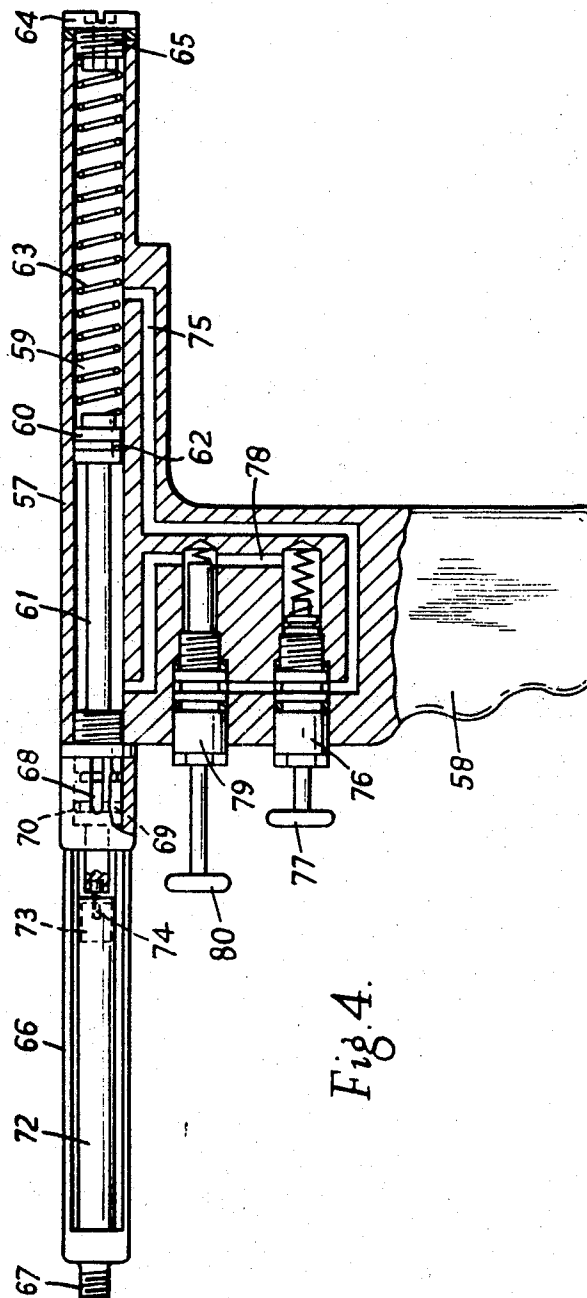


Fig. 4.

INVENTOR
SIDNEY GRANT
BY
Woodhams, Blanchard & Flynn
ATTORNEYS

Oct. 28, 1969

S. GRANT

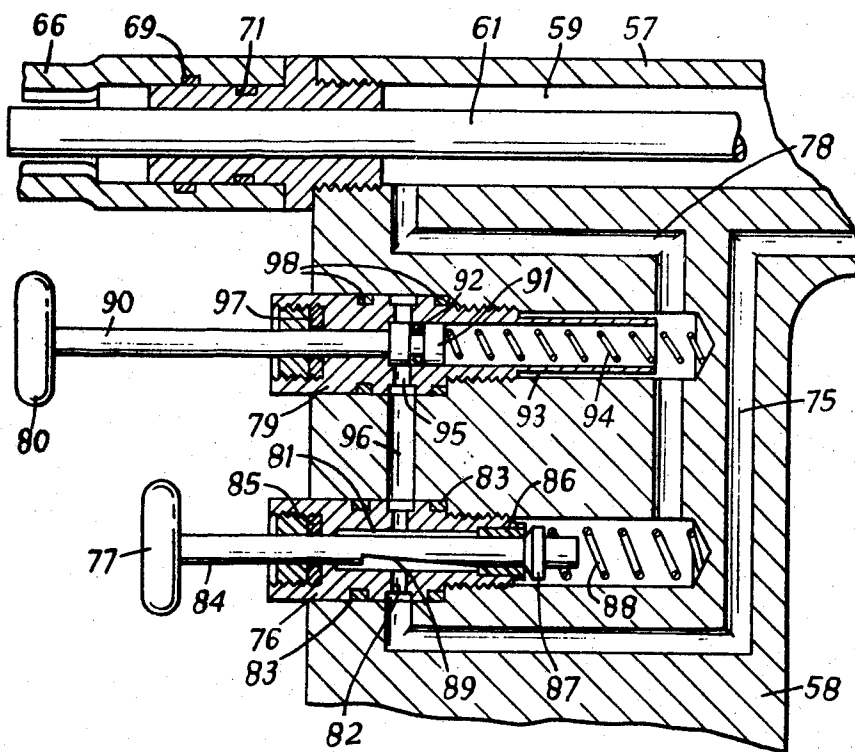
3,474,787

HYPODERMIC SYRINGE

Filed April 3, 1968

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Fig. 5.



INVENTOR

SIDNEY GRANT

BY

Woodhams, Blanchard & Fynn
ATTORNEYS

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3,474,787

HYPODERMIC SYRINGE

Sidney Grant, 37 Queen's Walk, London, England
Continuation-in-part of application Ser. No. 594,014,
Nov. 14, 1966. This application Apr. 3, 1968, Ser.
No. 718,606

Claims priority, application Germany, Apr. 5, 1967,
G 49,747

Int. Cl. A61m 5/18, 1/00

U.S. Cl. 128—218

13 Claims

ABSTRACT OF THE DISCLOSURE

A hypodermic syringe having a spring-driven plunger for displacing the contents of an ampoule; movement of the plunger being controlled by the flow of oil from the front side of a piston attached to the plunger to the rear side. This flow can be progressively increased from zero by means of a finger-operated valve in order to adjust the rate of injection. For aspiration the plunger can be withdrawn by forcing oil to the front side of the piston by means of a manually-operated ram.

Related application

This application is a continuation-in-part of my Application Ser. No. 594,014 filed on Nov. 14, 1966 for "Hypodermic Syringe" now abandoned.

Background of the invention

Conventional hypodermic syringes use ampoules which contain the dose to be injected and which have at one end a diaphragm which is punctured by the inner end of the needle and at the other end a stopper which also serves as a piston for forcing the contents of the ampoule out through the needle. Thus piston stopper is moved by means of a plunger which is driven by the operator of the syringe.

The operator has first to insert the needle in the correct position and then by gripping the flanges provided on the syringe he drives the plunger down to effect the injection. This requires not only skill in the handling of the syringe but also strength of grip and it is difficult to control the rate of injection when moving the plunger by hand.

In order to determine whether the needle has been correctly inserted it is usual to withdraw the plunger a short way in order to draw some body fluid through the needle into the ampoule. By this technique of aspiration it is possible to ascertain, for example, if the needle has been inserted into a vein since the blood drawn into the ampoule will be visible to the operator.

The present invention provides a hypodermic syringe which while of simple construction and easily operated by hand enables greater control to be exercised over the injection of the dose. It relieves the operator of the work of driving the plunger and enables him to exercise continuous control over the injection and thereby operate more efficiently while ensuring the comfort of the patient.

Summary of the invention

These results are achieved by the use of a spring to drive the plunger and a piston and cylinder system filled with fluid to control the movement of the plunger by the spring. The flow of fluid out of the cylinder to allow movement of the plunger is controlled by a manually-operable valve. Thus the invention consists in a hypodermic syringe having a body, an ampoule holder having an inner end attached to the body, a needle holder at the outer end of the ampoule holder, a plunger, spring means biasing the plunger towards the needle holder, a cylinder within the body, a piston attached to the plunger

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and fitted within the cylinder for axial movement therein, the piston and cylinder defining a first compartment, a second compartment within the body, a conduit connecting the first and second compartments, and a manually-operable valve in said conduit to control the flow of fluid between the compartments.

The rate of advance of the plunger under the action of the spring is controlled by the degree of opening of the valve while with the valve fully open the plunger can be pressed back against the spring and fluid will be drawn back into the first compartment.

To provide an accurate control over the fluid flow the valve preferably comprises a sleeve and a metering slide fitting closely within the sleeve and having a recess in its surface of greater axial length than the sleeve, the recess having a smaller end and a larger end and a progressively changing dimension between the ends, the slide being movable between a closed position in which no part of the recess extends beyond one end of the sleeve and an open position in which the smaller end of the recess extends beyond the said one end of the sleeve and the larger end of the recess projects beyond the other end of the sleeve.

Further objects, features, and advantages will appear from the following detailed description with reference to the drawings, in which:

FIG. 1 is a longitudinal section of a hypodermic syringe in accordance with the invention,

FIG. 2 shows on a larger scale a modified form of operating valve for a syringe in accordance with the invention,

FIG. 3 is a schematic longitudinal section of a second form of syringe in accordance with the invention,

FIG. 4 is a cross-section of a third form of syringe in accordance with the invention incorporating the improved valve, and

FIG. 5 is a detail of FIG. 4 on an enlarged scale.

Referring first to FIG. 1 of the drawing, the plunger 10 of the syringe is connected by a shaft 11 to a piston 12 in an oil-filled cylinder 13 the piston being in contact with a spring 14. When the spring is released the piston 12 and the plunger 10 are driven outwards by the spring, forcing fluid from the ampoule 15 through the needle 16. Channels 17 pass through the piston and the ends of these channels are closed on the outward stroke and while stationary by the pressure of the liquid and a spring 18 on a valve plate 19.

The ampoule holder 20 is detachable at position 21 to allow insertion of the ampoule and to allow the plunger to be pressed inwards.

When the plunger is pressed inwards the pressure of the fluid in the chamber 22 opens the valve plate 19 allowing free inward motion of the piston. When the piston has been depressed to the required position, the piston retains its position with the closure of the valve plate because of the pressure of fluid in chamber 23 balancing the pressure of the fluid in chamber 22 and the spring 14.

Depression of a button 24, which is connected to a valve block 25, as far as the stop 26 permits, causes a channel 27, which passes through the valve block and which is connected to the fluid in the chamber 22 by a channel 28, to align with a channel 29 which leads into the chamber 23. This connects a path between the fluids in chambers 22 and 23 by way of these channels. The pressures in the two chambers then become approximately equal and the excess pressure of spring 14 drives the piston on its outward stroke.

An adjustable screw 30 which passes into channel 28 restricts the flow of fluid in the channel causing a back-pressure and thereby controlling the speed of the plunger and rate of ejection of fluid from the ampoule.

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FIG. 2 shows an alternative form of operating valve which may be used in place of the valve 25. The valve has a fixed tapering pin or needle 31 co-operating with a movable aperture valve disc 32. Oil can pass freely from the passage 28 to the passage 29 when the plunger 10 is pressed back against the spring 14 since the pressure of the oil displaces the disc 32 to the left in the drawing, thus opening the annular passage through the disc around the tapering needle 31. Pressure of oil in the opposite direction tends to move the disc 32 towards the right and thus close the valve. Thus the needle 31 and disc 32 serve as a one-way or non-return valve and the elements 17 to 19 forming a non-return valve associated with the piston 12 can be omitted.

To release the piston 12 for movement by the spring 14 the disc 32 is displaced to the left by means of a piston 33 which is a close fit on the cylindrical stem of the needle 31 and can be displaced by pressure applied to the button 24 which moves a plunger 34 in an oil-filled chamber 35. The finger pressure exerted by the operator on the button 24 is thus transmitted hydraulically to the valve disc 32 to move it to the open position against the pressure of the oil in the chamber 23. The operator is in this case able to control the movement of the plunger 10 to some extent by the pressure on the button 24.

In a further modification the non-return valve associated with the piston 12 is formed by a cup-shaped seal attached to one face of the piston.

The syringe shown in FIG. 3 has a body 36 with a hand grip 37. An ampoule holder 38 is screwed on to the body 36 and supports the needle 39. A plunger rod 40 serves to eject the contents of a replaceable ampoule 41 through the needle 39. The inner end of the rod 40 carries a piston 42 which closes a cylinder 43 within the body 36. A spring 44 disposed in a reservoir chamber 45 and acting upon the piston 42 serves to drive the plunger rod 40 outwards to eject the contents of the ampoule. The cylinder 43 and reservoir chamber 45 are filled with oil.

The cylinder 43 is connected by a passage 46 to the rear end of a valve chamber 47, the forward end of which is connected by a passage 48 to the reservoir chamber 45. The valve chamber 47 has a conically-tapered valve seat 49 narrowing towards its forward end, and a similarly tapered member 50 is normally held in engagement with the valve seat 49 by a biasing spring 51 and by the pressure of oil in the rear end of the valve chamber 47 due to the action of the spring 44, through the piston 42, upon the oil in the cylinder 43. The valve member 50 can be moved rearwardly by finger pressure upon a button 52, the separation of the tapered valve member 50 from the seat 49 progressively opening a valve passage between the passages 46 and 48 and allowing oil to flow from the cylinder 43 to the reservoir chamber 45 as the plunger rod 40 is driven forward by the spring 44.

To reload the syringe the ampoule holder 38 is unscrewed from the body 36 and removed for the replacement of the spent ampoule by a fresh ampoule. The plunger rod 40 is pressed back into the body by pushing it against a hard surface and forces the oil from the reservoir chamber 45 back into the cylinder 43 through the valve, which is held open by pressure on the button 52. When pressure on the valve button 52 is released the syringe is locked in the loaded or cocked condition and the ampoule holder 38 with the new ampoule can be remounted.

Before carrying out an injection by pressing the button 52 it is desirable to withdraw the plunger 40 after insertion of the needle 39 to effect "aspiration," that is, the drawing of blood or other body fluid into the syringe. This can be done by depression of a button 53 which drives a piston 54 in a cylinder 55 and forces oil through a passage 56 into the valve chamber 47 and thence

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through the passage 46 into the cylinder 43, causing the rod 40 to be retracted.

The syringe of FIGS. 4 and 5 has a body 57 with a pistol-grip handle 58. Within the body 57 is a cylinder 59 in which is fitted a piston 60 attached to one end of a plunger rod 61. The piston 60 is fitted with an O-ring seal 62. A compression spring 63 acts between the piston 60 and a closure cap 64 at the rear end of the cylinder 59. The cap 64 has a fitting screw 65 which is removable to allow oil to be fed into the cylinder 59.

On the front end of the body 57 is a removable ampoule holder 66 which at its outer end has a threaded spigot 67 which serves to hold the needle (not shown) which is secured in conventional manner by a collet screwed on the spigot 67. The ampoule holder 66 has at its inner end an open slot 68 leading to an internal annular groove 69 which is engaged by a pin 70 on the body 57. A friction ring 71 (FIG. 5) on the body holds the holder 66 while allowing it to be turned to any desired angular position to set the tapered end of the needle to the desired position. The ampoule holder 66 holds an ampoule 72 which has a stopper 73 in its inner end. A hook 74 which is screwed into the end of the plunger rod 61 engages in the stopper 73 to allow retraction of the stopper by the plunger-rod for purposes of aspiration.

The cylinder 59 is divided by the piston 60 into front and rear compartments. The rear compartment is connected by a conduit or passage 75 to one side of a control valve 76 which is manually operable by depression of a button 77 by the finger. The other side of the valve 76 is connected by a conduit or passage 78 to the front compartment of the cylinder 59. An aspirating ram 79 operable by a finger button 80 communicates with the passage 78 and serves to force a quantity of oil into the front compartment to press the piston 60 back against the force of the spring 63.

Referring to FIG. 5, which shows the structure of the valve 76 and ram 79 in more detail, each is a removable unit which screws into the handle 58 of the body 57 and for convenience in manufacture and use they are made interchangeable. The body of the valve 76 has an internal chamber 81 which is in communication with the passage 75 in the handle 58 through ports 82. O-ring seals 83 serve to prevent leakage of oil around the valve body. The actuating button 77 is attached to one end of a metering slide 84 which passed through a packing 85 in the valve body, through the chamber 81 and through a closely-fitting sleeve 86 closing one end of the chamber. The slide 84, which is in the form of a cylindrical rod, has a flange 87 which seats lightly against the end of the sleeve 86 under the action of a return spring 88. The slide has a tapering recess 89 formed by cutting out a part of its surface. The recess is of progressively increasing depth away from the sleeve 86 and also of progressively increasing width. When the button 77 is depressed the narrow end of the recess 89 emerges from the end of the sleeve 86 and allows a restricted flow of oil from the front compartment to the rear compartment of the cylinder 59 by way of the passages 78 and 75. Further depression of the button 77 progressively increases the flow cross-section of the valve 76 and allows an increased rate of injection.

The button 80 of the ram 79 is mounted on a rod 90 whose other end carries a piston 91 fitted with an O-ring seal 92 and moving in a ram cylinder 93 against a return spring 94. The whole system is filled with oil and to allow displacement of the piston 60 in the cylinder 59 upon movement of the ram piston 91 and the rear face of the ram piston 91 is connected by way of ports 95 and a passage 96 to the passage 75 leading to the rear compartment of the cylinder 59. The rod 90 passes through a packing 97 and the body of the ram 79 is fitted with O-ring seals 98 on both sides of the ports 95.

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The syringe described is a simple and convenient hand-operated device which enables a dentist or other operator to carry out injections speedily and accurately. The actual injection of the liquid is effected by the spring which gives a smooth steady flow at a speed which is controllable by the user. This results in greater comfort for the patient, who feels the expansion due to the injection of liquid to a much smaller extent when this expansion is progressive.

I claim:

1. A hypodermic syringe, comprising:

housing means defining therein an opening which is substantially closed at opposite ends thereof;
means for mounting an ampoule and a needle on said housing means;

a piston movably disposed in said opening and defining first and second compartments on opposite sides thereof, said compartments being filled with fluid;

a plunger movably mounted on said housing means and connected to said piston for movement therewith;
spring means for urging said plunger in a first direction of movement;

conduit means connecting said first and second compartments for permitting flow of fluid therebetween; and

valve means associated with said conduit means for controlling flow of fluid between said first and second compartments, said valve means including manually-operable means for establishing communication and permitting flow between said compartments.

2. A hypodermic syringe according to claim 1, wherein said valve means includes a one-way valve allowing flow of fluid from said second to said first compartment upon movement of said plunger in a second direction in opposition to said spring means, said one-way valve preventing movement of said plunger in said first direction due to the urging of said spring means.

3. A hypodermic syringe according to claim 2, wherein said manually-operable means includes a passageway communicating between said first and second compartments and a manually-openable valve associated with said passageway for permitting flow of fluid between said compartments.

4. A hypodermic syringe according to claim 1, wherein said valve means includes a valve seat and a movable valve member positionable adjacent said seat, said valve member being maintained adjacent said seat for preventing flow through said valve means from said first compartment to said second compartment whenever the fluid pressure within the first compartment is greater than the fluid pressure within the second compartment whereby the plunger is normally prevented from being moved in said first direction by said spring means, said manually-operable means being selectively operable for permitting flow of fluid from said first compartment to said second compartment so that said spring means may move said plunger in said first direction.

5. A hypodermic syringe according to claim 4, wherein said manually-operable means includes a manually-actuated, movable member interconnected to said valve member for permitting same to be selectively moved away from said seat.

6. A hypodermic syringe according to claim 1, wherein the valve means comprises a needle valve, said needle

valve having a fixed tapered needle and a movable valve member having an aperture through which said needle passes, and said manually-operable means includes a manually-operable ram hydraulically coupled to said movable valve member to position said valve member for return flow through said valve.

7. A hypodermic syringe according to claim 1, further including a chamber connected to said first compartment and a manually-operable ram movable within the chamber to force fluid into the first compartment and thereby move the plunger in a second direction in opposition to said spring means.

8. A hypodermic syringe according to claim 7, wherein said ram divides said chamber into first and second subchambers with said first and second subchambers being in fluid communication with said first and second compartments, respectively.

9. A hypodermic syringe according to claim 1, wherein said plunger has a hook at its outer end for engagement in the body of a stopper closing the ampoule and serving for the displacement of the contents of the ampoule.

10. A hypodermic syringe according to claim 1, wherein the valve means comprises a metering slide movable axially through a closely fitting sleeve and having a recess in its surface of greater axial length than the sleeve, the recess extends beyond one end of the sleeve and an flow passage of progressively increasing cross-section whereby axial movement of the slide progressively changes the flow through the valve, the slide being movable between a closed position in which no part of the recess extends beyond one end of the sleeve and an open position in which the smaller end of the recess extends beyond the said one end of the sleeve and the larger end of the recess projects beyond the other end of the sleeve.

11. A hypodermic syringe according to claim 10, wherein the slide is spring biased toward the closed position.

12. A hypodermic syringe according to claim 10, further including a chamber and a manually-operable ram movably positioned within the chamber, the ram dividing the chamber into first and second subchambers with the first and second subchambers being in fluid communication with the first and second compartments, respectively, movement of said ram within the chamber in one direction causing fluid to be forced from the first subchamber into said first compartment whereby the plunger is moved in a second direction in opposition to said spring means.

13. A hypodermic syringe according to claim 1, further including second manually-operable means associated with said first compartment for causing movement of said plunger in a second direction in opposition to said spring means.

References Cited

UNITED STATES PATENTS

1,718,596	6/1929	Smith	128—218.1
2,784,704	3/1957	Meats	91—422 XR
3,330,279	7/1967	Sarnoff et al.	128—218.2

RICHARD A. GAUDET, Primary Examiner

M. F. MAJESTIC, Assistant Examiner