

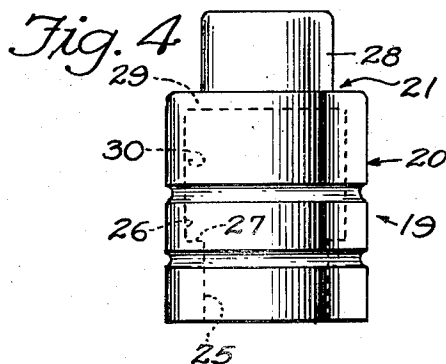
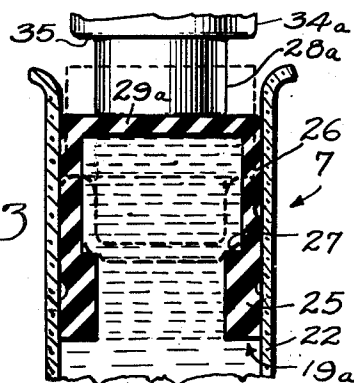
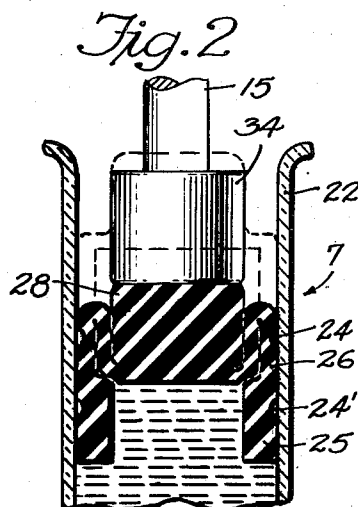
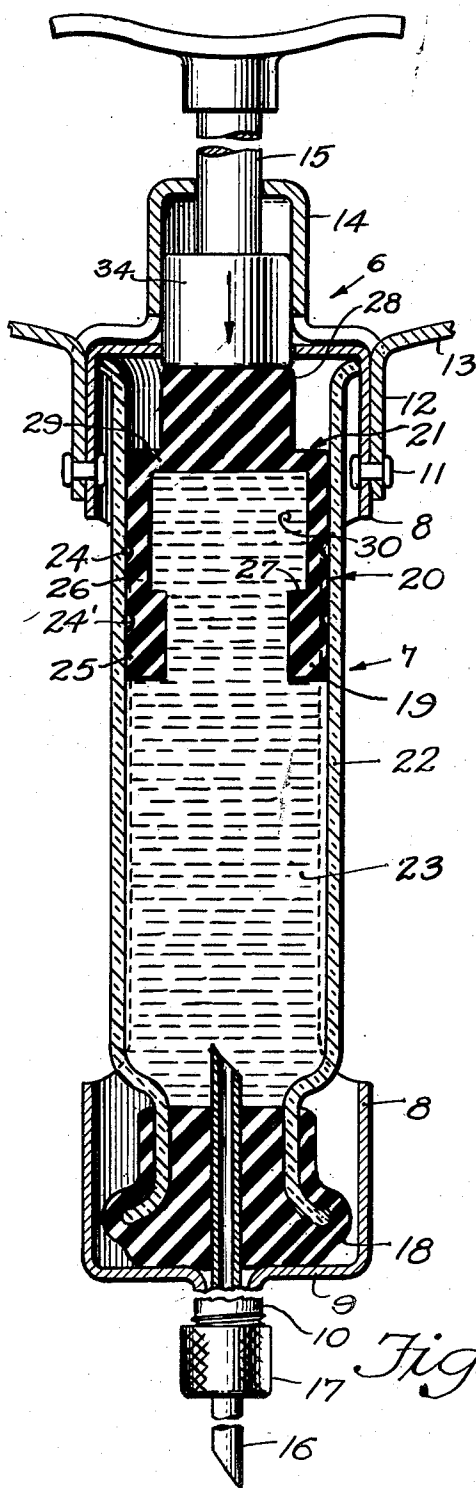
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2,554,744

HYPODERMIC SYRINGE

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HYPODERMIC SYRINGE

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7 Claims. (Cl. 128—218)

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This invention relates to hypodermic syringes of the type disclosed in my pending application Serial No. 80,044, filed March 7, 1949, now Patent No. 2,526,365, dated October 17, 1950, of which the present application is a continuation in part. In this type of syringe, the barrel of a medicine ampule becomes the cylinder of the syringe and the stopper of the ampule (of yieldable material such as rubber) becomes the piston of the syringe. Movement is transmitted to the piston from a plunger by pressure contact between the end of the plunger and the piston, and without any connection between the plunger and the piston by means of which the piston could be withdrawn by the plunger. Accordingly, the conventional syringe of this type can be operated only to inject fluid from the syringe into a patient, and is not reversely operable to withdraw fluid from the patient into the syringe. Such withdrawal operation is a desirable characteristic, since, in the injection of some medicaments, it is necessary to avoid injection into a blood vessel. This is imperative in the case of anesthetics such as the morphine and cocaine derivatives, since injection of such anesthetics into a blood vessel can result in death.

The common method of testing to determine whether the needle of the syringe has entered a blood vessel is to advance the piston only a slight distance and then to withdraw it to the beginning of its stroke. In the event that the needle has entered a blood vessel, blood will be drawn back into the syringe and will, by its characteristic red color, warn the operator of that fact. But such an operation requires a connection between the plunger and the piston by which the withdrawal movement may be transmitted to the piston. One prior proposal has been to utilize a claw in the form of a cork screw for engaging the piston and connecting it to the end of the plunger. However, such devices have not proven satisfactory, and there has for many years existed a definite need for a reversely operable syringe of relatively simple yet fully dependable construction and operation. The primary object of my invention is to provide such a syringe.

Another object is to provide an improved form of the syringe disclosed in the above identified pending application.

In contrast to prior proposals such as that referred to above, my invention embodies the concept of providing a piston assembly including a main piston and an auxiliary piston (or its equivalent, such as a diaphragm) carried by the main piston and adapted to coact with the

plunger which is adapted to initially transmit to the auxiliary piston a limited movement while the main piston remains stationary and, when the limit of such movement has been reached, to transmit movement to the main piston. The invention also provides means acting yieldingly between the auxiliary piston and the main piston to retract the auxiliary piston and plunger to their initial positions when the pressure on the plunger is released. It is this retracting movement of the auxiliary piston which functions to apply suction which results in the withdrawal of fluid from the patient's body into the syringe, and the range of limited movement of the auxiliary piston is just sufficient to provide an adequate withdrawal capacity to assure the passage of a body fluid through the hollow needle of the syringe back into the transparent barrel. A further characteristic of the invention is the balancing of the force of the yielding retracting means against the frictional grip of the cylinder upon the main piston so that the former cannot overcome the latter and transmit movement to the main piston prior to the movement of the auxiliary piston to its full range of movement relative to the main piston.

When its contents are exhausted, the medicament ampule is of course discarded. In many cases the contents of an ampule may be used up in a single injection. The cost of the ampule with its stoppers is added to the cost of the medicament, and it is a fundamental requirement that the cost of the ampule and the stoppers be held at a minimum. Accordingly, a further object of the invention is to provide a syringe embodying the features pointed out above in a construction that is relatively simple and inexpensive, sufficiently so that the cylinder and piston portion of the syringe (the ampule) may be discarded after one full stroke of the piston.

A further object is to provide, as a renewable part of a syringe having the features discussed above, a novel and improved medicament ampule stopper functioning as a reversely operable piston, without the necessity for the use of means to establish a physical connection between the stopper and the syringe plunger.

Other objects will become apparent in the ensuing specifications and appended drawings in which:

Fig. 1 is a longitudinal sectional view through a syringe embodying the invention;

Fig. 2 is a sectional view through a portion of the same showing a different position of operation;

Fig. 3 is a sectional view through a portion of the syringe embodying a modified form of the invention; and

Fig. 4 is a side view of the stopper-piston.

As an example of a preferred form in which the invention may be embodied, I have shown in Figs. 1 and 2 a syringe embodying a holder, indicated generally at 6, and a medicament ampule indicated generally at 7. The holder 6 includes a barrel 8 having one end closed by an end wall 9 having a needle receiving neck 10, and having its opposite end open to receive the ampule 7. To the open end of the barrel 8 is hinged, upon trunnions 11, a yoke 12 having projecting finger grips 13 and a bearing 14 in which is slidably mounted a plunger 15. The conventional hypodermic needle 16 is mounted in a cap 17 which is threaded onto the neck 10. The needle 16 is adapted to pierce the stopper 18 (of soft rubber or equivalent material) which seals one end of the ampule 7. The foregoing features are conventional features of the type of syringe which incorporates the ampule as an operative part thereof.

In such a conventional syringe, there is ordinarily a plain solid rubber stopper normally closing the ampule opposite the stopper 18 and adapted to function as a piston. Instead of this plain rubber stopper, my invention provides a stopper-piston 19 which is generally cup shaped, including in general, a main body member in the form of an annular cylindrical, lateral wall member 20 and an end member 21 closing the outer extremity of the stopper. Lateral wall portion 20 has a cylindrical outer wall to fit the inner wall of the cylindrical barrel 22 of the ampule. The diameter of the outer wall of lateral member 20, in its unstressed condition, is at least as great, and preferably a trifle greater than the diameter of the inner wall of barrel 22, whereby lateral member 20, when installed within barrel 22, will frictionally engage the inner wall of barrel 22 (preferably under some compression) sufficiently to establish a tight hermetic seal between the stopper-piston and the barrel. Such seal must be adequate to prevent any escape of liquid and to protect the body of medicament 23 within the ampule against contamination; and must be sufficient to establish a substantial frictional grip of lateral member 20 upon the wall of barrel 22, for a purpose which will be explained hereinafter. The hermetic seal is made more effective by utilizing a pair of axially spaced annular grooves 24, 24' in the outer wall of lateral member 20.

Lateral member 20 includes, at the open end of the stopper-piston, a relatively thick annular collar 25 and, between collar 25 and end member 21, a relatively thin intermediate wall portion 26. Defined between collar 25 and intermediate wall portion 26 is a shoulder 27 of offset form. A cavity 30 is defined within the inner wall of thin wall portion 26, between shoulder 27 and end member 21.

End member 21 includes a relatively thick, cylindrical central button element 28 functioning as an auxiliary piston, and a relatively thin peripheral diaphragm element 29 which connects button element 28 to the end of the relatively thin intermediate wall portion 26.

The diameter of button element 28 is less than the internal diameter of thin cylindrical wall portion 26 by an amount approximately equal to the thickness of diaphragm 29. This makes it possible for the button element 28 to be projected into the cavity 30 under pressure applied thereto

by plunger 15, so as to function as an auxiliary piston, which term will hereinafter be used in referring to button element 28. In moving into cavity 30, auxiliary piston 28 will draw diaphragm 29 with it into the cavity, diaphragm 29 being accommodated between the periphery of auxiliary piston 28 and thin lateral wall member 26 as indicated in Fig. 2. The end portion of lateral wall member 26 will also be folded back within itself and drawn into the cavity 30 by the pull of diaphragm 29, after the latter has stretched to a point where its resistance to further stretch matches the resistance of lateral wall member 26 to being thus infolded. Wall member 26 is sufficiently thin to yield to the pull of diaphragm 29 tending to double it back inside itself. This makes it possible for the auxiliary piston 28 to travel its full stroke to the point where it contacts shoulder 27.

An inner limit of movement of auxiliary piston 28 into cavity 30 is determined by engagement of the inner side of auxiliary piston 28 against shoulder 27. Since the inner wall of collar member 25 is approximately as small or smaller in diameter than the peripheral diameter of auxiliary piston 28, it will be impossible for the latter to move beyond shoulder 27.

In the operation of the syringe, plunger 15 is pressed against auxiliary piston 28, projecting the same into cavity 30 so as to expel from cavity 30 the liquid contained therein. The volume of cavity 30 is such that the amount of liquid injected into the patient will not be sufficiently great to cause injury, and yet is such that a corresponding volume of blood, drawn back through the needle 16, will enter the barrel 22 of the ampule sufficiently to become plainly visible through the transparent wall thereof.

In the operation of the syringe, the ampule is first installed in the syringe barrel 8 in the conventional manner, with needle 16 piercing stopper 17 and with plunger 15 in position to engage stopper-piston 19. After customary sterilizing measures have been observed, the needle is inserted into the body of the patient, and pressure is applied to plunger 15, such pressure being transmitted from head 34 thereof to auxiliary piston 28 of stopper-piston 19. The plunger is carefully pressed inwardly a distance not greater than the axial distance between auxiliary piston 28 and shoulder 27. During this initial stroke, the frictional engagement of lateral body member 20 of stopper-piston 19 against the inner wall of cylinder 22 will maintain the forward portion of stopper-piston 19 stationary within ampule barrel 22 while auxiliary piston 28 is pushed into cavity 30. The thickened collar member 25 provides a resistance to radial compression which insures adequate outward pressure thereof against the inner wall of cylinder 22, so as to insure the gripping of the ampule barrel 22 sufficiently to immobilize collar member 25 within ampule barrel 22 during this initial stage of operation. As auxiliary piston 28 is pushed into cavity 30, annular diaphragm 29 will be stretched and drawn into the cavity and a portion of the thin lateral wall member 26 will likewise be drawn into cavity 30, being folded in upon itself, under the tension applied to it through diaphragm 29.

The engagement of auxiliary piston 28 with shoulder 27 establishes a limit for this initial stroke of plunger 15, which limit may be readily detected, through the sensitive fingers of a surgeon, by the increase in resistance to forward

movement which is thereby developed in the plunger.

When the limit of the initial plunger stroke has been determined, the operator releases the pressure on plunger 15, whereupon the tension that has been established in stopper-piston 19 by the deformation thereof will cause the parts 26, 28, 29 to spring back to their initial positions, establishing suction in cavity 30 which will cause a sufficient quantity of fluid to be drawn back thereinto to replace that which was expelled therefrom in the initial plunger stroke. This reverse flow of the liquid within the ampule causes a corresponding amount of fluid to be drawn from the patient's body through needle 16 back into the ampule barrel 22, and if the needle has entered a blood vessel, this fluid will include a sufficient quantity of blood to color the fluid within the ampule and thereby disclose the fact that a vessel has been punctured.

Collar 25, in addition to its two functions indicated above (providing the shoulder 27 which limits forward movement of auxiliary piston 28, and providing adequate outward pressure against cylinder 22 to give the proper braking grip upon cylinder 22 in the initial stage of operation) has the further function of providing maximum sealing engagement of the forward end of stopper-piston 19 within cylinder 22, so as to reduce to a minimum any seepage of liquid past the stopper. Sealing groove 24' is located within the axial confines of collar 25, whereby there are two sealing edges (the edge at the forward end of lateral body member 20 and the edge defined at the rear side of groove 24') both subjected to the outward pressure of collar member 25 so as to provide maximum sealing effect.

Fig. 3 illustrates a modified form of the invention in which, instead of auxiliary piston 28, there is provided on the inner end face of plunger head 34a, a reduced diameter cylindrical nose portion 28a projecting axially for engagement with the end member of stopper 19a, which in this case is in the form of a relatively thin diaphragm 29a extending entirely across the end of the stopper. The diameter of nose member 28a is substantially the same as the diameter of auxiliary piston 28, i. e., smaller than the diameter of the inner wall of thin lateral wall portion 26 of stopper 19a, by substantially the thickness of diaphragm 29a. The axial length of nose member 28a is sufficient so that the limit of the initial stroke of plunger 15 may be determined by the engagement of diaphragm 29a against shoulder 27. Preferably, the length is such that the shoulder 35, defined between reduced nose member 28a and head 34a, will engage the doubled portion of lateral wall member 26 at the same time the diaphragm 29 engages shoulder 27, so that the further stroke of the plunger may transmit movement through the entire stopper for delivering the medicament into the patient's body.

After the testing operation, outlined above, has been completed, the plunger is again pressed inwardly, the auxiliary piston 28 being advanced into engagement with collar 25, and further pressure is then applied. Such pressure, transmitted to collar 25 from auxiliary piston 28, will overcome the frictional grip of lateral body member 20 upon the wall of ampule barrel 22, causing the piston 19 to be bodily advanced in barrel 22 to expel the contents of the ampule.

I claim:

1. In a hypodermic syringe, in combination

with an ampule barrel and a plunger, a generally cup shaped stopper-piston including an annular body member received in and engaging the inner wall of said barrel, and a yieldable end member positioned to be engaged by said plunger and to be moved inwardly with reference to said annular body member so as to function as an auxiliary piston for applying first pressure and then suction to the contents of said cylinder as the plunger is first pressed inwardly and then released, said annular body member having an open end and including, at said open end, a radially inwardly extending collar and including a relatively thinner annular intermediate portion extending axially from said collar to said end member and defining a cavity therewithin, said annular body member engaging said cylinder wall with a grip sufficient to hold it stationary while said end member is moved by said plunger, said stopper including means yieldingly opposing inward movement of said end member and moving said end member back to its starting position when pressure on said plunger is released, to develop suction in said cavity for effecting reverse flow in said barrel, said end member being engageable with said collar to limit the initial stroke of said plunger, and to transmit axial movement to said annular body member in a subsequent stage of operation of said syringe in which said stopper-piston is moved bodily within said barrel to expel the contents thereof.

2. A syringe as defined in claim 1, wherein said end member comprises an axially thick central button portion constituting an auxiliary piston and a relatively thin, annular diaphragm joining said auxiliary piston to one axial extremity of said relatively thin annular wall portion, with said auxiliary piston projecting axially beyond said annular body portion, externally thereof, said auxiliary piston having a diameter sufficiently smaller than the diameter of the inner wall of said relatively thin annular wall portion so as to accommodate the thickness of said annular diaphragm portion between the periphery of said auxiliary piston and said inner wall as the diaphragm is drawn into the space within said relatively thin annular wall portion by the projection of said auxiliary piston thereinto under plunger pressure.

3. A syringe as defined in claim 2, wherein said relatively thin annular wall portion is of sufficient thinness to be doubled within itself and accommodated between the periphery of said auxiliary piston and its undoubled adjacent wall portion as said auxiliary piston is projected into said space.

4. A syringe as defined in claim 1, wherein said end member comprises a relatively thin diaphragm member throughout the cross sectional area of said stopper, and wherein said plunger has a portion for engaging said end member, said engaging portion being of a diameter sufficiently smaller than the inner wall of said relatively thin annular body member so as to accommodate the thickness of said diaphragm member as the latter is pushed into the space within said inner wall under the pressure of said engaging portion of the plunger.

5. A stopper for a hypodermic syringe, said stopper being cup shaped and of a material having the general characteristics of soft rubber, said stopper comprising an annular body portion, open at its inner end, and having at its outer end an end member closing said outer end, said annular body portion including a relatively thick

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collar portion adjacent said open end and a relatively thin annular wall portion connecting said collar portion to said end member, said collar portion being joined to said relatively thin annular portion by a shoulder inwardly offset from the inner wall of said relatively thin annular portion, said end member, said shoulder and said inner wall cooperatively defining a cavity of sufficient volume to provide for an indraft of fluid into the syringe from a patient's body sufficient to visually establish communication with a blood vessel when suction to the extent of said volume is applied to the contents of the syringe, said end member including an annular peripheral portion in the form of a relatively thin diaphragm joined to the closed end of said relatively thin wall portion and an integral central button portion constituting an auxiliary piston, of sufficient axial thickness to be form retaining under pressure from the syringe plunger, said auxiliary piston projecting from said diaphragm externally

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of the stopper, and having a peripheral diameter sufficiently smaller than that of said inner wall to accommodate, between the periphery of said auxiliary piston and said inner wall, the thickness of said diaphragm portion, drawn into said cavity by the projection of said auxiliary piston thereinto under plunger pressure, said end member being engageable with said shoulder to limit the inward projection of said auxiliary piston relative to said annular body portion.

6. A stopper as defined in claim 5, having an annular groove in the peripheral face of said annular body portion, within the axial confines of said collar portion.

7. A stopper as defined in claim 6, having a second annular groove in the peripheral face of said relatively thin annular wall portion.

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No references cited.