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(54) HYPODERMIC INJECTION DEVICE

(71) We, N.V. PHILIPS' GLOEILAMPENFABRIEKEN, of Emmasingel 29, Eindhoven, Holland, a limited liability company organized and established under the laws of the Kingdom of the Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to hypodermic injection devices of the kind comprising a spring-loaded operating mechanism, a cartridge-holder fixed in operative relationship thereto and a cartridge incorporating an ampoule and an associated cannula, said operating mechanism comprising a sleeve open at one end thereof, a plunger within the sleeve, spring means loading said plunger and tending to move it out of the open end of the sleeve, restraining means cooperative with said plunger to prevent such plunger movement and safety means serving to maintain said restraining means operative until the device is required to be used, said cartridge-holder comprising a hollow shell forming an elongate co-axial extension of the open end of said sleeve, said shell, at the end thereof remote from said sleeve, being closed by a puncturable seal, and said ampoule being in the form of a hollow cylinder, with a piston in one end thereof and containing a dose of a pharmaceutically or veterinarily acceptable liquid, the cannula being located at the end of the cylinder remote from the piston, and the cartridge fitting within the holder with the free end of the cannula adjacent said puncturable seal.

In known injection devices of the above kind, attempts have been made to maintain sterility of the free end of the cannula, while still within said holder, by maintaining a close fit between the ampoule and the holder, but this has resulted in slowing down the eventual operational movement of the cartridge relative to the holder. Also, as a result of the close fit, a mass of air under compression was built up in advance of the moving ampoule as it advanced in the holder, thereby further hindering rapid ejection of the cannula and tending to cause premature expulsion of the liquid from the ampoule.

It is an object of the present invention to obviate these disadvantages. Thus, according to the invention, in a hypodermic injection device of the kind referred to in the first paragraph of this specification, the end of the cartridge remote from the cannula is held frictionally in peripheral sealing engagement with said hollow shell, thereby sealing off said cannula within said shell, the arrangement being such that, when the device is used, said spring means becomes effective to impel the cartridge so that the free end of the cannula passes through said puncturable seal and said sealing engagement becomes no longer effective, thereby allowing free passage of gaseous fluid from the region ahead of said cylinder to the region behind it, and to expel said liquid through said cannula.

Other objects of this invention will become apparent after a consideration of the following specification in conjunction with the accompanying drawings in which:

Fig. 1 is a cross sectional view of one embodiment of the injection device, with the spring-loaded operating mechanism in a cocked position, the cannula being hermetically sheathed within the cartridge holder;

Fig. 2 is a cross sectional view of the same injection device with the mechanism released and the contents of the cartridge expelled therefrom;

Fig. 3 is a cross section of the line 3—3 of Fig. 1;

Fig. 4 is a view similar to Fig. 1 illustrating a modified embodiment of the invention;

Fig. 5 is a view similar to Fig. 2 showing the modified embodiment of Fig. 4;

Fig. 6 is a cross sectional view taken on line 6—6 of Fig. 4;

Fig. 7 is a cross sectional view of the preferred form of the injection device with the mechanism in a cocked position;

Fig. 8 is a sectional view of the device of Fig. 7, illustrating the intermediate position

of operation wherein the mechanism has propelled the plunger and the engaged cartridge forward and forced the cannula out through the stoppered end;

Fig. 9 is a sectional view of the device of Fig. 7, illustrating the complete travel of the plunger resulting in full discharge of the medicament from the ampoule;

Fig. 10 is a cross sectional view taken along line 10—10 of Fig. 7 showing the manner in which the plunger engages the end periphery of the ampoule;

Fig. 11 is a cross sectional view taken along line 11—11 of Fig. 10 further illustrating the manner in which the plunger engages the end of the ampoule;

Fig. 12 is a cross sectional view taken along line 12—12 of Fig. 7 showing the relative disposition of parts of the mechanism;

Fig. 13 is a cross sectional view taken along line 13—13 of Fig. 7 illustrating the inner profile of the safety cap.

Fig. 14 is a cross sectional view of yet another form of injection device according to the invention, with the mechanism in a cocked position;

Fig. 15 is a sectional view of the device of Fig. 14 illustrating the complete travel of the plunger resulting in full discharge of the medicament from the ampoule;

Fig. 16 is a cross sectional view taken along line 16—16 of Fig. 14, and

Fig. 17 is a cross sectional view taken along line 17—17 of Fig. 14.

Now referring to the drawings with greater particularity, in Figs. 1 and 2 there is shown a spring-loaded operating mechanism indicated generally at 10, a cartridge holder 12 and a cartridge 14, the cartridge comprising an ampoule 16 and a cannula 18.

The mechanism 10 comprises a structure of the general type shown in patent specification 773,216 and includes an inner tube or inner sleeve 20 having a threaded end portion 24 and being provided with an integral knurled knob 22 for facilitating rotation of the inner sleeve when assembling this sleeve to the threaded portion 52 of cartridge holder 12. The inner sleeve 20 is closed at its unthreaded end 26 except for a central opening 28 for the passage therethrough of the furcated end of plunger 30, the right hand end of which in cooperation with the outer face of the end 26 of the sleeve 20 provides a restraint against the forcing of the plunger 30 out of the inner sleeve by the action of a spring 32 under compression between a shoulder 34 on the plunger 30 and the inner face of the inner sleeve end 26. As explained more fully in patent specification 773,216, the plunger at its right hand end, as viewed in Figs. 1 and 2, is furcated and the springy metal of the plunger normally is positioned so that conical portions 36 have flat base portions resting against the outer face of end 26. When the furcations are compressed together, the conical portions 36 are of a diameter less than the diameter of the opening 28 and the spring is then free to expand and rapidly move the plunger to the left. An outer sleeve 38 is telescopically movable on the inner sleeve 20 and is provided with a thickened end 40 having an inner central cam face 42 to engage the conical portions 36 and squeeze them together when the outer sleeve is moved to the left. To prevent inadvertent release of the plunger 30, a safety device 44 is provided, comprising a knurled manually engageable cap 46 having an integral pin 48 insertable between the furcations to prevent collapsing movement of the conical portions 36.

The cartridge holder 12 shown in Figs. 1 and 2 comprises a hollow cylindrical shell 50 of resilient material, such as a synthetic plastics material, having a threaded end 52 for engagement with the threaded portion 24 of the gun sleeve 20. The shell tapers from the threaded end 52 toward the other end both internally and externally for ease of removal thereof in moulding of the shell and is reinforced by outside longitudinal ribs 54. At the smaller diametered end of the shell there is provided a conical nose 56 with a central opening 58, this opening in the unoperated condition of the injection device being closed off by an air and micro-organism impervious stopper, such as a puncturable rubber seal 60. Closely adjacent the threaded end of the shell 50, there is provided a bead 62 running completely about the inner wall of the shell. The bead is for the purpose of frictionally engaging and retaining an end portion of ampoule 16 and to form a peripheral seal therewith, thus preventing the entrance of micro-organisms into the space occupied by the cannula 18.

The cartridge 14 is as disclosed in U.S. patent 3,391,695, and comprises an ampoule 16 and a cannula 18 attached to the ampoule by a hollow cap 68 firmly embracing a sleeve 66 fixed to the cannula 18 and spun over the flange 70 at the neck portion of the ampoule. Within the ampoule a resilient diaphragm 72 is held to the flange 70 by the cap 68, said diaphragm being adapted to be burst by application of fluid pressure to a thinned wall 74 thereof. Within the ampoule at the right hand end thereof is a piston 76 forming space between it and the diaphragm for the medicament 78. When the medicament is forced to the left by operation of piston 76, the fluid pressure will invert the V-shaped wall 74 and stretch it so that it eventually bursts either by reason of tension in the membrane or by reason of the stretched membrane engaging a sharp projection in the sleeve 66 or the sharp end of the cannula 18 extending into the sleeve 66. The ampoule is slightly tapered in diameter from the piston end to the cannula end with the external

diameter of the ampoule at the piston end portion thereof being slightly greater than the internal diameter of the bead 62 so that when the cartridge is forced into the holder, there is a peripheral hermetic seal between the bead 62 and the exterior wall of the ampoule 16. The holder or ampoule or bead must be sufficiently elastic to permit the insertion of the ampoule into the holder without rupturing of parts. Since the front end of the holder is sealed off by the stopper 60, when the cartridge 14 is inserted into the holder 12 while working in a sterile atmosphere, a non-contaminating atmosphere is created and maintained in and about the cannula 18.

The greatest external diameter of the ampoule 16 at the piston end is less than the internal diameter of the holder 12 in front of the bead 62 and throughout the entire length of displacement of the ampoule in the holder so that once the ampoule has been freed from the bead 62 there is freedom of motion of the cartridge in the holder. Moreover, there is sufficient clearance between the external diameter of the ampoule 16 and the internal diameter of the holder 12 to permit free movement of gas from in front of the ampoule to the read thereof on displacement of the cartridge.

In the use of the injector device, first the mechanism 10 is cocked by forcing the plunger 30 into the inner sleeve 20 until the conical portions 36 pass through the opening 28 and spread out to engage the outer surface of the end 26 of the sleeve 20. For safety reasons, the pin 48 is inserted between the furcations of the plunger. While in a sterile atmosphere, the cartridge 14 is loaded into the holder 12 with the ampoule 16 in air sealing engagement with the bead 62 and the cannula 18 in nonpierced-through relationship with the stopper 60. The utilizer of the injection device threadedly couples the holder 12 to the mechanism 10 and the device is now ready for use. To use the device, the safety pin 48 is removed and the stoppered end of the holder 12 is pressed firmly against the desired area of injection. Upon telescopic action of sleeve 38 on sleeve 20, conical portions 36 pass through opening 28 and the plunger 30 is released. Under the action of spring 32, the plunger shifts the cartridge so that the end of the cannula 18 pierces the stopper 60 and enters the flesh of the patient. Movement of the cartridge continues until arrested by the nose of the holder. Continued movement of the plunger and movement of the piston 76 in the ampoule causes an expulsion of the medicament through the cannula into the patient.

In Figs. 4 to 6 there is disclosed a modified embodiment of the invention. In this embodiment, the bead 62 in the holder is replaced in part by a plurality of internal ribs and in part by a flanged portion on the ampoule 90. The ribs indicated as 82 are equally spaced around the inner peripheral wall of the holder and run parallel to the longitudinal axis thereof. The number of ribs may be conveniently selected as three. The ribs terminate short of the threaded end 84 of the holder and taper in decreasing height and width as they extend toward the stoppered nose end.

The cartridge utilized with this form of holder is like the cartridge previously described except that the end of the ampoule, here indicated as 90, is modified by placing a flared portion 92 at the piston end thereof, the flared portion being resilient and becoming progressively thinner toward the mouth or right hand end of the ampoule. The external diameter of the ampoule is less than the diameter afforded by the clearance between the ribs 82 to allow free movement by the ampoule with respect to the holder, but the flared portion of the ampoule in the unoperated position of parts resiliently engages the inner wall of the holder to the right of the ribs to form a peripheral hermetic seal therewith.

When the injector device of Figs. 4 to 6 is put into operation, the plunger 30 moves the cartridge to the left, as previously explained. In this operation the flanged portion 92 engages the ribs 82 and becomes distorted providing avenues for flow of gaseous fluid thereabout to the rear of the ampoule, the fluid flowing along the ribs and through passageways opened by flange distortion.

The preferred form of this invention is illustrated in Figs. 7—13 of the drawings. In this embodiment the device comprises an outer cylindrical sleeve 100 having an inturned shoulder 110 at one end and an annular groove 113 in the inner wall adjacent the other open end. A cartridge assembly 106 is assembled within the outer sleeve 100. The cartridge assembly 106 includes a cartridge holder sleeve 104 fitted within the sleeve 100 and having a forward end portion 153 of smaller diameter, adjoining a shoulder 154 which fits against seat 112 provided by outer sleeve shoulder 110. The extreme forward end portion 156 of the holder sleeve 104 is tapered to form a small circular opening which is closed by a cannula-pierceable stopper 158 that hermetically seals this end of the cartridge holder 104.

The cartridge assembly 106 includes an ampoule 136 with liquid medicament 146 therewithin and a piston 148 at one end with a cannula 150 at the other end. Within the neck of the ampoule 136 between the inner end of the cannula 150 and the medicament there may be interposed a fluid pressure rupturable diaphragm 152 generally like that described in the embodiment of Fig. 1. More specifically, the ampoule and cannula combination may be essentially like that in U.S. Patent 3,391,695.

Referring particularly to Fig. 7, the cartridge assembly 106 is assembled in the outer sleeve 100 with the cannula 150 spaced from the stoppered end of the holder 104. The piston end of the ampoule 136 is retained in place within the holder sleeve 104 by resilient contact between the exterior surface of the ampoule 136 and an annular bead 160 on the inner wall of the holder sleeve 104 adjacent its open end. This bead 160, as in Fig. 1, hermetically seals the ampoule at its piston end and frictionally retains it in position within the holder sleeve 104. The diameter of the exterior of the ampoule 136 is less than the internal diameter of the holder sleeve 104 throughout the major length of said holder sleeve so that once the ampoule is moved forward and is free of the annular head 160 and the cannula 150 has pierced the stopper 158, the ampoule will move freely in the holder sleeve. The gas in front of the ampoule will readily flow past the ampoule in the annular space between the ampoule and the inner wall of the holdersleeve 104 as the ampoule travels forward. By this method of sealing, the cannula 150 may be maintained in a sterile environment until use is made of the device. It should be noted that the forward interior of the holder sleeve 104 is contoured to form a seat 161 for the forward end of the ampoule, when it is advanced thereinto. The overall length of the ampoule 136 and cannula 150 is such that it is all contained within the holder sleeve 104 as illustrated in Fig. 7.

The outer sleeve 100 is of such length that it accommodates the cartridge assembly 106 in one end and receives the gun assembly 200 in the other to complete the device. The assembly 200 comprises an inner sleeve 101 having an out turned flange 103 which fits up against the end of the cartridge holder sleeve 104 when the assembly is inserted in the outer sleeve 100. The other end of the inner sleeve 101 is centrally apertured to form a hole 120. The rear outer face 122 of the inner sleeve 101 is planar and perpendicular to the longitudinal axis of the sleeve for a purpose to be brought out later.

A plunger 162 fits within the out turned flange end of the inner sleeve 101. This plunger has a cylindrical body portion 163 and a circular head portion 164 of a diameter larger than the body portion 163 and generally slightly less than that of the piston 148 in the ampoule 136. The head 164 has an opening which is sized to align and correspond to the through hole 166 (Fig. 12) in the plunger body 163. The plunger head 164 is provided with a plurality of circumferentially spaced, radially extending tabs 168. As best illustrated in Figs. 10 and 11, these tabs 168 form a diameter greater than that of the plunger head 164 so that the tabs will engage the end of the ampoule 136. It should be noted that each tab tapers inwardly from its outer edge to provide a neck portion 170 of thinner proportions. Longitudinal slots 172 are formed in the plunger head 164 immediately behind the tabs 168. These slots are sized so that they will accomodate the tabs 168 when they are later broken off or bent rearwardly at their neck portion 170 in the operation of the device. These slots extend throughout the length of the head behind the tabs.

Referring to Figs. 7 and 11, a locking detent 176 is fitted through the hole 166 in the plunger 162 and has a central body portion 178 with outwardly extending lugs 180 on one end fitting on annular shoulder 182 of the plunger head 164. The other end of the locking detent 176 is provided with four equally spaced longitudinally extending springy detent arms 184 terminating in frusto-conical detent heads 186. This locking detent 176 maintains the plunger 162 and inner sleeve 101 in assembled position with a coil spring 138 compressed therebetween as follows. The coil spring 138 is positioned over the plunger body 163 and abuts the plunger head 164 at one end and the inner face of the end wall of the inner sleeve 101 at the other. Upon compressing of the coil spring 138 sufficiently the detent heads 186 will be deflected inwardly by engaging the periphery of the end wall opening 120 and pass therethrough whereupon the bases of the detent heads 186 will come to rest on the planar face 122 of the inner sleeve 101 to retain the plunger and inner sleeve in assembled condition with the coil spring 138 compressed therebetween. If desired, the rear planar surface 122 of the inner sleeve 101 may be overlaid with a metal washer 127, in which case it is advantageous to provide a guide and holding flange 128 to surround the opening 120. The flange 128 is provided with a lip portion to retain the washer in place.

As best illustrated in Fig. 12, the inner sleeve 101 has a plurality of longitudinally extending raised ribs 129 running from the flange 103 approximately one-half the length of the said sleeve. An outer sleeve 192 fits over inner sleeve 101 and is sized to frictionally engage ribs 129. The outer sleeve 192 has a closed end 194 with a central aperture 196 from which extends a cam surface 198 sized and shaped to cooperate with frusto-conical detent heads 186 to deflect said heads radially inwardly. The outer sleeve 192 is provided with a circumferential locking rib 199 which fits in a groove 113 in the outer sleeve 100 to retain the assembly 200 in position in said outer sleeve. It should be noted that the length of the outer sleeve 192 is slightly less than that of the inner sleeve 101 so as to make certain that there will be space between the inner wall of the outer sleeve 192 and the flange 103 of the inner sleeve 101 so that the two

sleeves may move relative to each other to deflect the detent heads 186 inwardly in operating the device.

In order to make certain that the tapering detent heads 186 are not accidentally deflected inwardly, a safety pin assembly is provided. This safety pin assembly comprises a cap 142 having a cylindrical sleeve 143 sized to fit over the end portion of the outer sleeve 192. A safety pin 144 extends inwardly from the center of the cap 142 into the opening formed by the inner portions of the detent heads 186 to thereby prevent inward movement of said detent heads. The cap 142 is provided internally with a plurality of spacer abutments 145 to assure proper positioning of the cap on the outer sleeve 192.

In the use of the embodiment disclosed in Figs. 7 to 13, the complete device is furnished to the user thereof as illustrated in Fig. 7.

For use, initially the safety pin 144 is removed and then the forward end of the device is applied to the patient at the locus desired. Subsequently, when the outer sleeve 192 is thrust toward the locus, a telscoping action takes place between the outer and inner sleeves. An advantage of the arrangement of Figs. 7 to 13 is that the outer sleeve 100 is long and the injection device may be grasped very conveniently along substantially its entire length to operate it.

Telescoping action of the gun sleeves causes the frusto-conical cam surface 198 to squeeze the detent heads 186 together, whereby they become smaller in diameter than the opening 120, and the spring 138 becomes effective to advance the plunger 162. In the initial movement, the plunger tabs 168 engage the end of the ampoule 136 and force it forwardly off the bead 160 and upon further travel forces the cannula 150 through stopper 158 into the position illustrated in Fig. 8. At this point, the ampoule 136 and cannula 150 are fully seated whereby further travel of the plunger 162 causes tabs 168 to be sheared off at the neck portion 170 and fall back into slots 172 so that the plunger may continue to move forward by engaging the ampoule piston 148 to force the medicament out of the cannula 150 and ultimately arrive at the position illustrated in Fig. 9 with the piston 148 pressed against the closed end of the ampoule.

The many advantages of the embodiment of Figs 7—13 are immediately apparent, for example, the device lends itself to component sub-assembly construction. The device may be said to comprise three basic components, namely, the outer sleeve 100, the cartridge assembly 106 and the operating mechanism assembly 200. The cartridge assembly 106 is slipped into the outer sleeve 100 down against shoulder seat 112 after which the mechanism assembly 200 is inserted in the outer sleeve 100 by having the locking rib 199 engage annular groove 113 in the outer sleeve 100. The device is thus assembled and ready for use.

Yet another embodiment of this invention is shown in Figs. 14 to 17. In this embodiment the device comprises an outer sleeve 400, an inner plunger-containing sleeve 402, and a cartridge holder 404 with a cartridge 406 therein.

The outer sleeve is of springy material, e.g. a moulded material, the forward end portion of which is slotted as indicated at 408, Fig. 17, there being, for example, two such diametrical slots. The forward end of sleeve 400 is further provided with an outwardly extending flange 410 and is thickened at that end to provide an internal seat 412 for the cartridge holder 404 as will be described. When the cartridge holder 404 is positioned within the outer sleeve 400, a ring such as an aluminum ring 414, is spun around the flange 410 to retain the holder and outer sleeve in assembled relationship. In that condition, the outer sleeve 400 is bowed slightly outwardly away from the cartridge holder 404, as indicated most markedly at 415, so as to permit easy telescopic movements of the parts. The rear right-hand end of the outer sleeve 400 is centrally apertured as indicated at 416 and provided with a bevelled surface interiorly of the sleeve to form a cam surface 418. The inner sleeve 402 is also centrally apertured at its rear end as indicated at 420, the rear outer face 422 of the sleeve being perpendicular to the longitudinal axis of the sleeve to provide a seat for the bases of the frusto-conical portions 424 of the plunger 426, in the manner shown in greater detail in patent specification 773,216. If desired, the rear surface of the inner sleeve may be overlaid with a metal washer 427, in which case it is desirable to provide a guide and holding flange 428 to surround the opening 420, the flange having a turned-over portion 430 to hold the washer in place. The interior wall of the inner sleeve 402 is provided with a number of equally circumferentially spaced longitudinal ribs 432 to guide a wide seat portion 434 of the plunger in its movement and direct it into the ampoule 436 of the cartridge. Under compression, between the seat 434 of the plunger 426 and the inner surface of the rear end of the inner sleeve 402, is a coil spring 438. The rear end of the plunger 426 is furcated and springy. The furcations of the plunger can be compressed together against its springy force by telescopic movement of the outer sleeve 400 relative to the inner sleeve 402, the cam or bevelled surface 418 then engaging the conical surfaces 424 and squeezing the furcations toward each other sufficiently to enable the frusto-conical portions to move forwardly through the opening 420, thus releasing the plunger

406 to the action of the spring 438. To prevent accidental release of the frusto-conical portions 424 off the seat provided therefor, a safety pin is provided in the form of a cap 442 to be applied to the rear of the outer sleeve 400 and a pin portion 444 to enter the axial bore of the furcations, to inhibit their being squeezed together.

The inner sleeve 402 and plunger 426, when the spring is compressed, extend only partially of the length of the outer sleeve, so as to permit of insertion of the cartridge holder 404 into the outer sleeve, with the rear end of the holder 404 abutting the forward end of the inner sleeve 402. In view of the length of the cartridge 406, the inner sleeve 402 extends a little less than half way of the length of the outer sleeve 400. With a different length cartridge the length of inner sleeve 402 would be different.

The cartridge itself comprises the ampoule 436 having therewithin a liquid or liquid medication 446 with a piston 448 at one end and a cannula 450 at the other end. Within the neck of the ampoule 436, between the rear end of the cannula and the medicament there may be interposed a fluid-pressure-rupturable diaphragm 452, as is well known in the art. The internal diameter of the ampoule 436 is larger than the diameter of the seat 434 of the plunger 426 to allow free movement of the plunger in the ampoule when the plunger is released to the action of the spring 438. The cartridge may be of the type shown in U.S. patent 3,391,695.

The cartridge holder 404 is substantially of the same external diameter at its rear portion as the inner sleeve 402. The forward end of the holder 404 is of reduced diameter to provide a shoulder 454 to coperate with seat 412 in effecting a coupling of the holder and outer sleeve. The extreme forward end of the holder is tapered as indicated at 456 and a cannula-puncturable stopper 458 of rubber hermetically seals the apertured end of the holder. The rear end of the holder is sealed by resilient contact between the exterior surface of the ampoule and an annular bead 460 formed close to the rear end of the holder 404. The resiliency is obtained by making the holder 404, or bead 460, or ampoule 436 of resilient material. The diameter of the exterior of the ampoule is less than the internal diameter of the holder 404 throughout the major length of the holder so that once the cartridge is thrust forward to free it from the bead 460, and the cannula has pierced the stopper, the cartridge is free to move in the holder, the gas in front of the cartridge passing freely past the walls of the ampoule to the rear thereof. By sealing off the interior of the holder 404, the contents thereof may be placed in and maintained in a sterile atmosphere. The interior of the holder at its forward end is contoured to form a seat 462 for the forward end of the ampoule when it is advanced in the holder. The overall length of the cartridge is such that all of it is contained within the holder.

In the use of the embodiment disclosed in Figs. 14 to 17, the parts are furnished to the user thereof cocked as illustrated in Fig. 14.

In use, initially the safety pin 444 is removed and then the forward end of the holder 404 is applied to the patient at the locus desired. Subsequently, when the outer sleeve 400 is thrust toward the patient, a telescoping action takes place between the outer and inner sleeves. An advantage of the arrangement of Figs. 14 to 17 is that the outer sleeve is long and the injection device may be grasped very conveniently along substantially its entire length to operate it.

Telescoping action of the sleeves 400 and 402 causes the cam surface 418 to squeeze the furcations together, whereby they become smaller in diameter than the opening 420, and the spring 438 becomes effective to advance the plunger 426. The initial movement of the plunger, and as directed by the ribs 432, causes the plunger to thrust against the piston 448 within the ampoule. However, since the friction between the bead 460 and the ampoule coupled with the resistance to penetration of the stopper by the cannula is less than the force required to move the piston in the ampoule, the initial advance of the plunger results in a translation of the cartridge with respect to the holder whereby the cannula is unsheathed and the ampoule is brought into engagement with the seat 462. Subsequent advance of the plunger, under the force of the spring 438 causes the piston to advance in the ampoule, effecting passage of fluid by the diaphragm 452 and through the cannula 450. The action of parts is so rapid that advance of the cartridge and expulsion of medication appears to take place substantially simultaneously.

WHAT WE CLAIM IS:—

1. A hypodermic injection device comprising a spring-loaded operating mechanism, a cartridge-holder fixed in operative relationship thereto and a cartridge incorporating an ampoule and an associated cannula, said operating mechanism comprising a sleeve open at one end thereof, a plunger within the sleeve, spring means loading said plunger and tending to move it out of the open end of the sleeve, restraining means cooperative with said plunger to prevent such plunger movement and safety means serving to maintain said restraining means operative until the device is required to be used, said cartridge-holder comprising a hollowed shell forming an elongate co-axial extension of the open end of said sleeve, said shell, at the end thereof remote from said sleeve, being closed by a puncturable

seal, and said ampoule being in the form of a hollow cylinder, with a piston in one end thereof and containing a dose of a pharmaceutically or veterinarily acceptable liquid, the cannula being located at the end of the cylinder remote from the piston, the cartridge fitting within the holder with the free end of the cannula adjacent said puncturable seal, and the end of the cartridge remote from the cannula being held frictionally in peripheral sealing engagement with said hollow shell, thereby sealing off said cannula within said shell, the arrangement being such that, when the device is used, said spring means becomes effective to impel the cartridge so that the free end of the cannula passes through said puncturable seal and said sealing engagement becomes no longer effective, thereby allowing free passage of gaseous fluid from the region ahead of said cylinder to the region behind it, and to expel said liquid through said cannula.

2. A device as claimed in claim 1, wherein the ampoule incorporates a diaphragm serving to prevent escape of liquid from the ampoule through the cannula until the device is used.

3. A device as claimed in claim 1 or claim 2, wherein the sealing engagement between the cartridge and the shell is effected by an annular bead on the inner wall of the shell.

4. A device as claimed in claim 1, 2 or 3, wherein the plunger is provided with a head portion sized to fit within the ampoule cylinder and having a plurality of radially extending tabs adapted to engage the ampoule cylinder at its piston end, said tabs being frangible or at least displaceable, at a stage in the operation of the device when the ampoule cylinder has reached its limit of travel towards said puncturable seal, to permit movement of the plunger, relative to the ampoule cylinder, to expel said liquid through said cannula.

5. Hypodermic injection devices substantially as herein described with reference to the appropriate Figures of the accompanying drawings.

C. A. CLARK,
Chartered Patent Agent,
Century House,
Shaftesbury Avenue,
London, W.C.2.
Agent for the Applicants.

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