United States Patent [19]

Hurschman et al.

[11] **3,797,490**

[45] **Mar. 19, 1974**

[54] **HYPODERMIC AMPOULE WITH SKIN TENSIONING CLIP**

[75] Inventors: **Alfred A. Hurschman; Thomas P. Schiller,** both of Streetsboro, Ohio

[73] Assignee: **Ampoules, Inc.,** Macedonia, Ohio

[22] Filed: **Aug. 24, 1972**

[21] Appl. No.: **283,581**

Related U.S. Application Data

[62] Division of Ser. No. 114,493, Feb. 11, 1971, Pat. No. 3,735,761.

[52] **U.S. Cl.** ..... **128/218 M,** 128/218 DA

[51] **Int. Cl.** **A61m 5/28**

[58] **Field of Search** .... 128/215, 216, 218 R, 218 P, 128/218 NV, 218 D, 218 DA, 218 F, 220, 272; 206/63.2 R, 56 R; 215/47, 52

[56] **References Cited**

UNITED STATES PATENTS

3,094,988	6/1963	Dunmire	128/216
2,398,544	4/1946	Lockhart	128/173 H
2,888,924	6/1959	Dunmire	128/218 D
2,894,509	7/1959	Bednarz	128/218 NV
3,236,237	2/1966	Dunmire	128/216
3,712,301	1/1973	Sarnoff	128/218 D

FOREIGN PATENTS OR APPLICATIONS

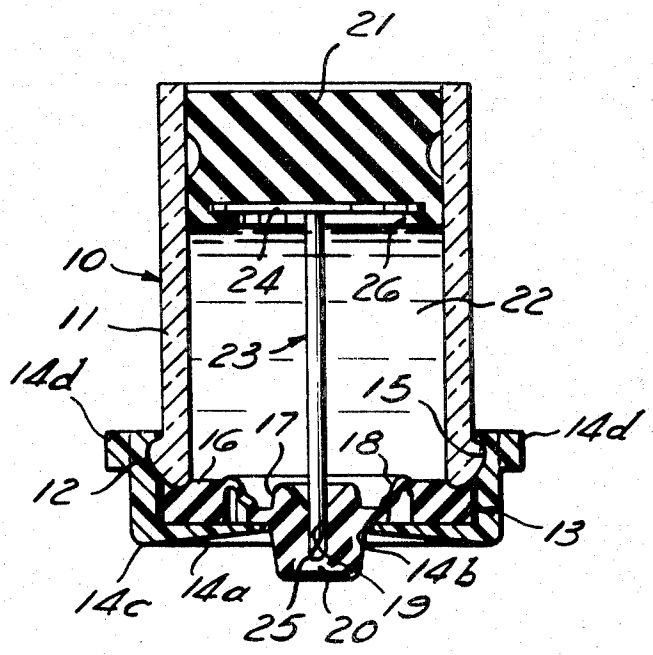
1,143,900	10/1957	France	128/216

Primary Examiner—Richard A. Gaudet
Assistant Examiner—J. C. McGowan
Attorney, Agent, or Firm—McNenny, Farrington, Pearne & Gordon

[57] **ABSTRACT**

Hypodermic ampoules of the contained-needle type, and combinations of such ampoules with so-called "applicators" for actuating the ampoules to make injections are disclosed. Each of several ampoule forms has at least one cylindrical, medicament-containing chamber and a plunger closing one end thereof. A hollow needle is fixed to the plunger and is initially contained within such a chamber. The other end of the ampoule is sealed by a diaphragm which is pressed against a beaded end portion of a cylinder and is sealed thereto by a cup-shaped clip which snaps over the beaded end portion to thereby compress the diaphragm against the end portion. The clip has a peripheral rim about a recessed bottom end which stretches the patient's skin to facilitate the injection. According to one aspect of the invention, such an ampoule is designed to perform a subcutaneous injection. According to a further aspect of the invention, such an ampoule is designed to perform an intramuscular injection. According to a still further aspect of the invention, the ampoule includes multiple chambers for premixing a medicament with at least one other medicament and injecting the mixture, either subcutaneously or intramuscularly. Applicators designed to receive and hold the several forms of ampoules and to actuate them as required by their particular forms and functions provide several applicator-ampoule combinations of novel structure and functions.

14 Claims, 22 Drawing Figures



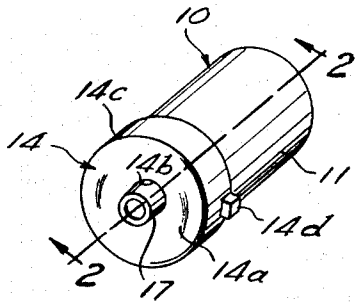


Fig. 1

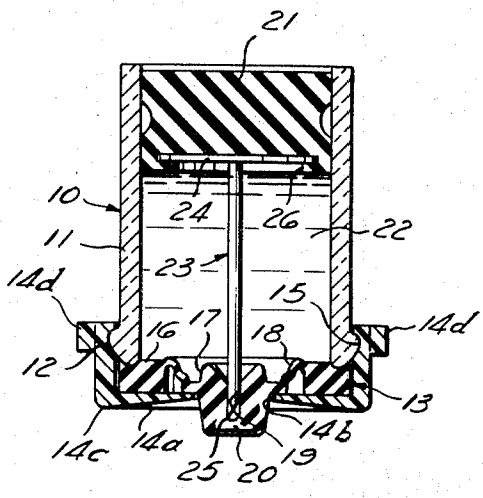


Fig. 2

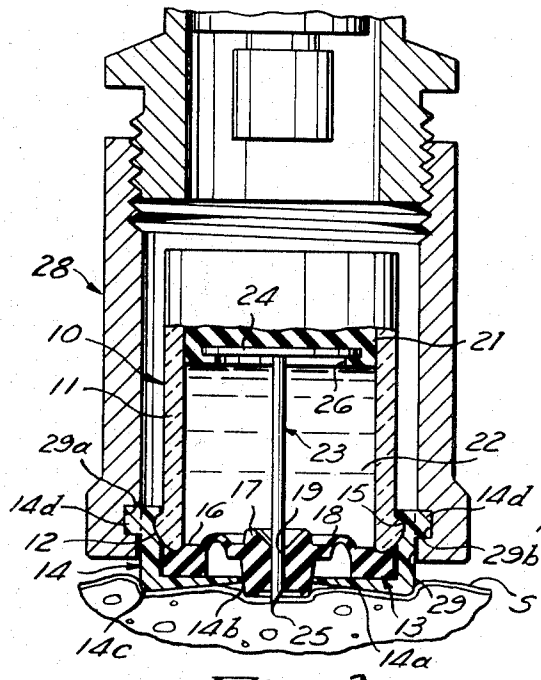


Fig. 3

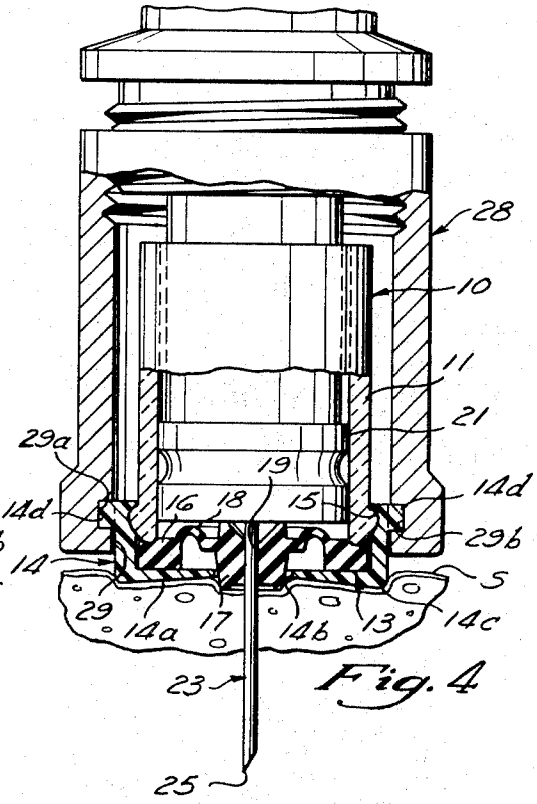


Fig. 4

Fig. 5

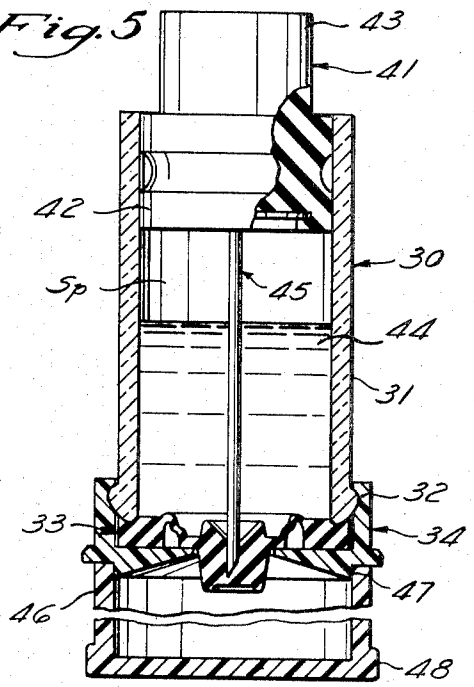
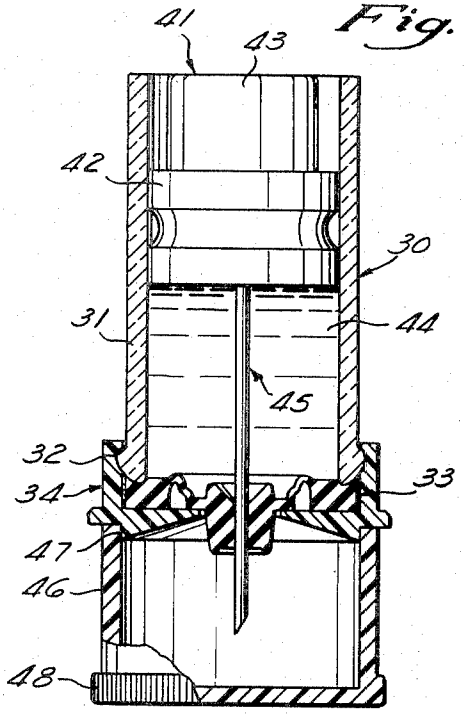


Fig. 6



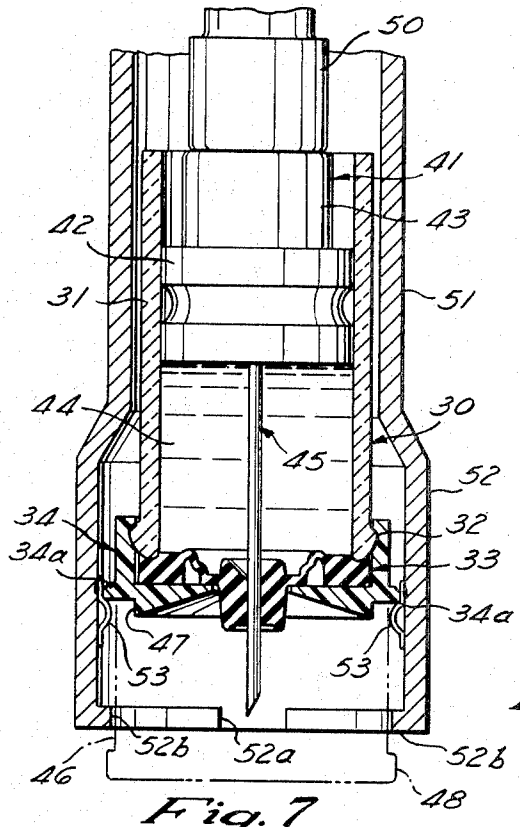


Fig. 7

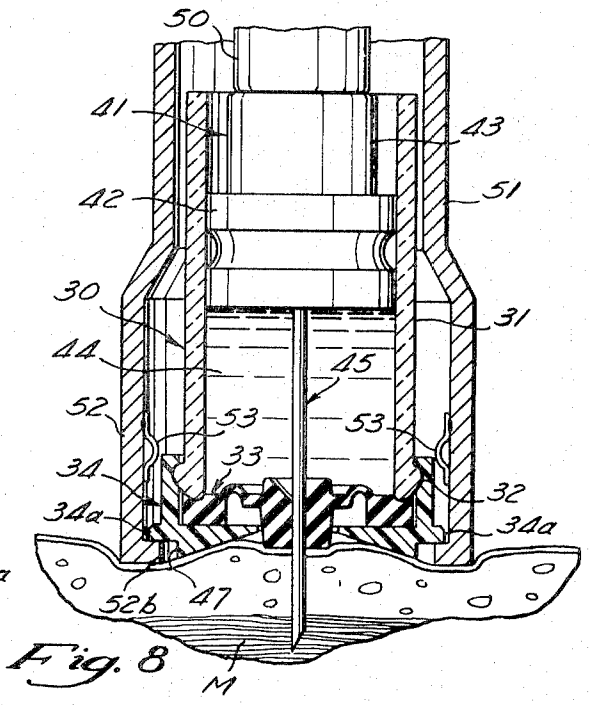


Fig. 8

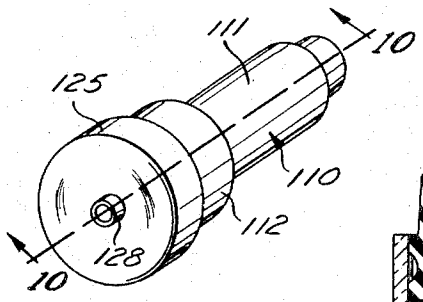


Fig. 9

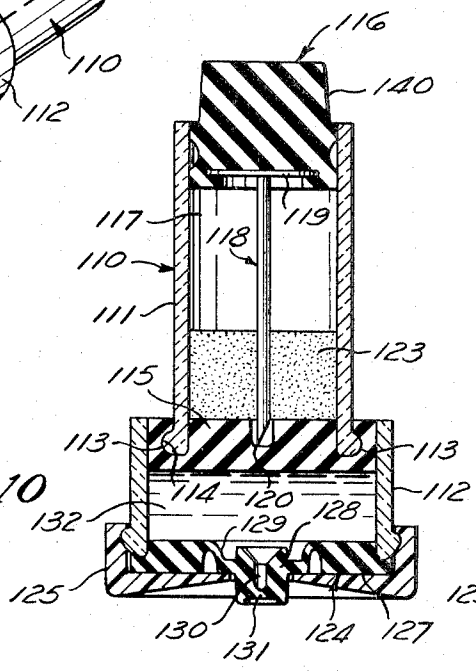
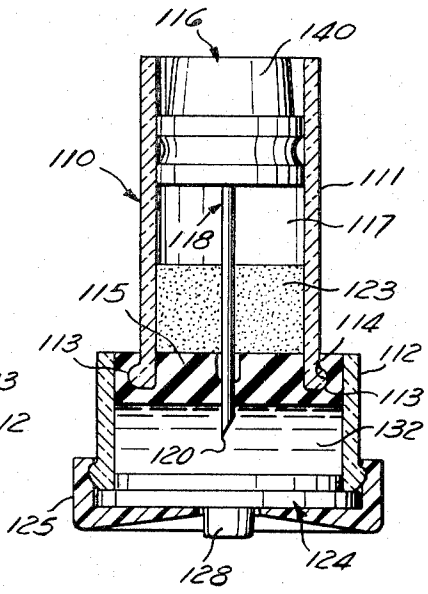


Fig. 10

Fig. 11



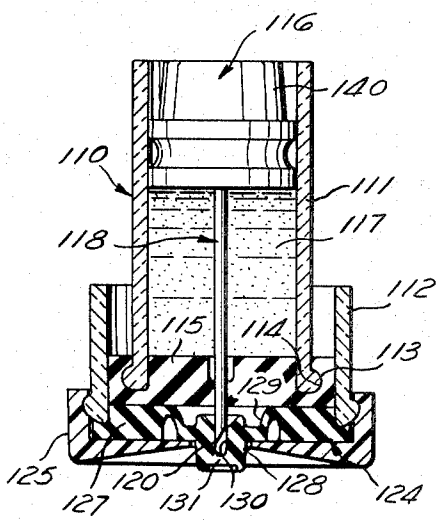


Fig. 12

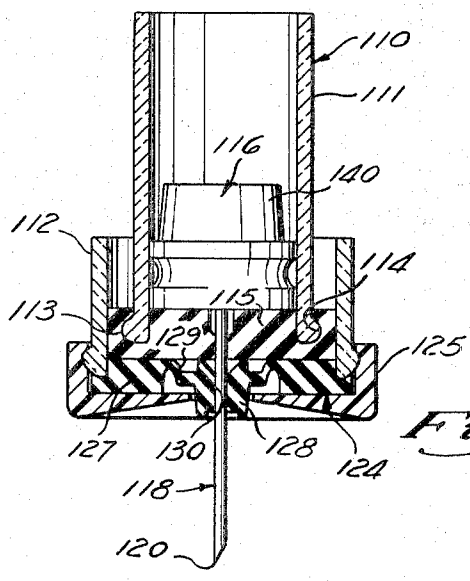


Fig. 13

Fig. 14

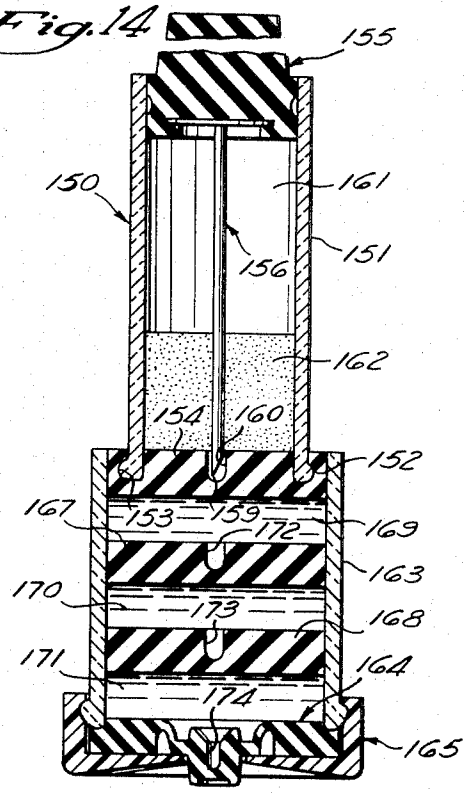
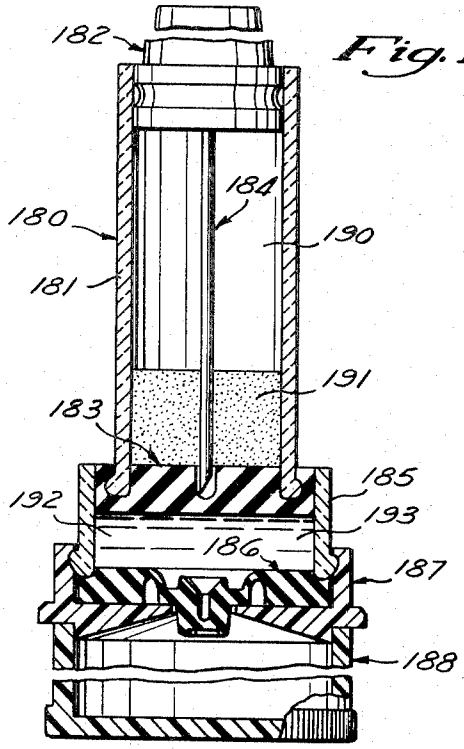


Fig. 15



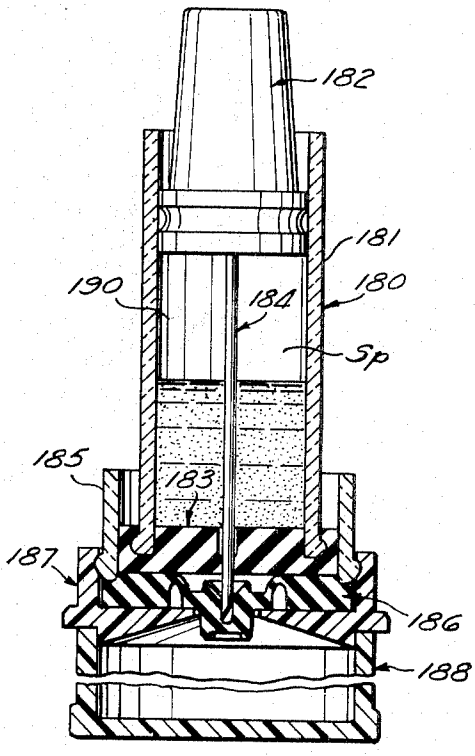


Fig. 16

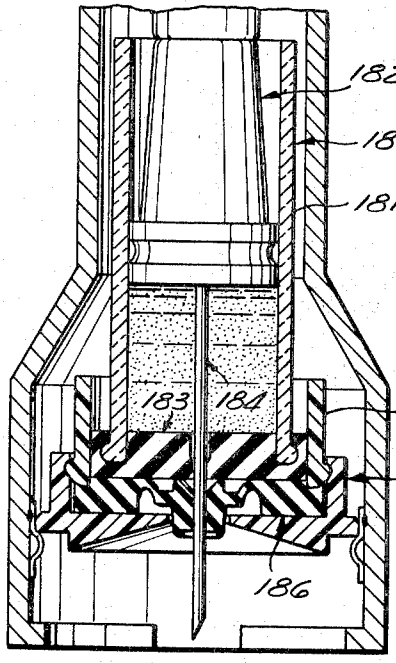


Fig. 17

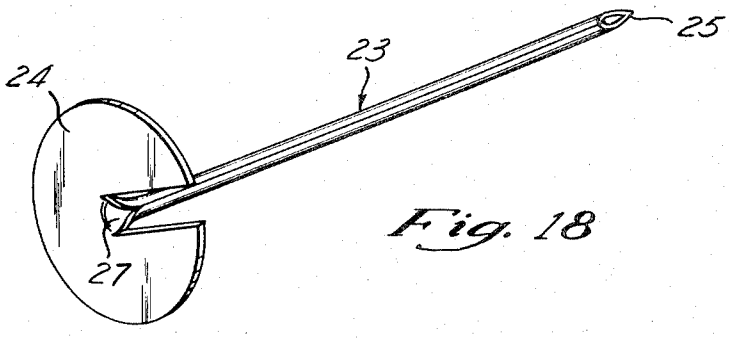
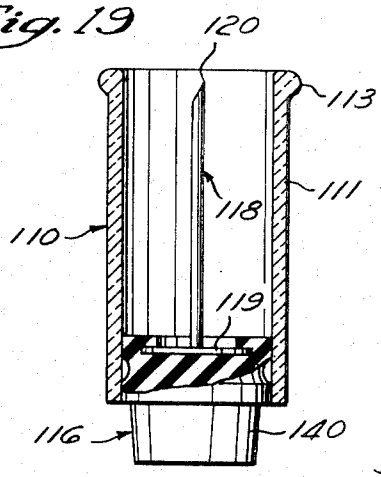


Fig. 18

Fig. 19



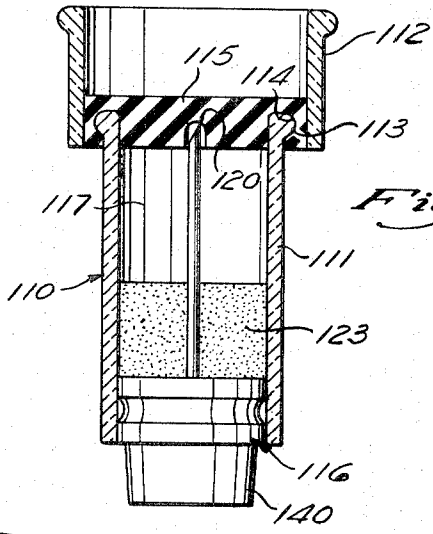


Fig. 20

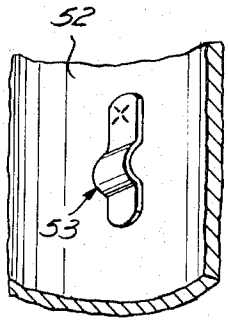


Fig. 21

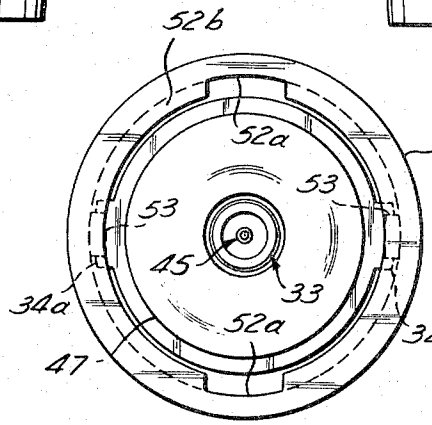


Fig. 22

HYPODERMIC AMPOULE WITH SKIN TENSIONING CLIP

This application is a division of application Ser. No. 114,493, filed Feb. 11, 1971, now U.S. Pat. No. 3,735,761 dated May 29, 1973.

BACKGROUND OF THE INVENTION

This invention relates to disposable hypodermic ampoules that provide a chamber containing both a medicament to be injected and the hypodermic needle through which the injection is made, the injection being performed by collapsing or otherwise actuating the device to project the pointed end of the needle through a puncturable wall of the ampoule and then into the patient while reducing the volume of the medicament-containing chamber to express the medicament through the needle and into the patient. Such ampoules are referred to herein by the generic designation, "contained-needle type."

Ampoules of this general character are represented, for example, by two series of United States patents granted, respectively, to Russell P. Dunmire and to Stanley J. Sarnoff or Stanley J. Sarnoff et al. The principal ones of those patents to Dunmire are U.S. Pat. Nos. 2,769,443, 3,094,987, 3,094,988, and 3,236,237, and the principal ones of those patents to Sarnoff (or Sarnoff et al.) are U.S. Pat. Nos. 2,704,072, 2,832,339, 3,320,955, and 3,396,726. The devices of those patents of Dunmire and Sarnoff (or Sarnoff et al.) involve a particularly advantageous mode of operation in that the medicament is injected into the patient from the pointed end of the needle as it travels longitudinally to its maximum depth of penetration, thus distributing the medicament for faster absorption and minimizing discomfort and trauma sometimes occasioned by injecting all of the medicament in one location after the needle has been inserted to the maximum depth. They also greatly reduce the chances for contamination of the medicament or the needle; they require little or no skill on the part of the user, and even make self-injection safe and practical; and they have numerous other inherent advantages which the art has long recognized. However, none of the devices of that general type has yet been perfected sufficiently for widespread use.

For inspection purposes after filling, it is important that ampoules of the contained-needle types disclosed in the Dunmire and Sarnoff (or Sarnoff et al.) patents have transparent walls. In order to make the collapsible walls of the ampoules of the Dunmire patents transparent, it has been necessary to mold them from synthetic resin materials which, because of their possible reactivity with certain medicaments during prolonged periods of storage after filling and before use, have limited the use of such ampoules. Although the components of such devices could be molded of suitably inert natural rubber, that material does not have the transparency required for inspection after filling and, therefore, cannot be used for many applications.

Although the ampoule shell walls that are in contact with a contained medicament during storage of the devices of the Sarnoff (or Sarnoff et al.) patents could be made of transparent, inert, glass tubing and sufficiently inert, molded rubber, end closures for the tubing, so as to avoid the aforementioned inspection problem, the forms of devices shown in those patents have involved various structural, assembly, operational, and/or cost problems that have limited their usefulness and, hence, their commercial acceptance. For example, the puncturable end wall of the devices of those patents of Sarnoff (or Sarnoff et al.) are incapable of sealing against the skin of a patient as required to avoid loss of medicament by seepage between the ampoule end wall and surface of the skin, particularly in the case of such devices designed and used for making relatively shallow subcutaneous injections. When designed as shown in those patents and used as intended for making intramuscular injections, the flow of medicament out of the pointed end of the needle begins as soon as the needle point emerges from the ampoule for penetrating the skin, and such flow continues until the needle has penetrated to its maximum depth in the muscle layer. The result is neither a normal subcutaneous injection nor a normal intramuscular injection but, rather, is a combination of the two that has been acceptable only for very limited injection purposes. The devices of those Dunmire patents, on the other hand, were ideal for making subcutaneous injections, but, for the same reason as the devices of the patents of Sarnoff (or Sarnoff et al.), were incapable of giving a normal intramuscular injection.

Devices have been proposed which are designed for making subcutaneous injections. One such device is shown in U.S. Pat. No. 3,396,726 to Sarnoff and includes a cylinder which defines a medicament-containing ampoule. A piston driven needle is contained in the ampoule and one end of the ampoule is closed by a pierceable diaphragm. The cylinder is only partially filled by the medicament so that the needle may be driven through the diaphragm and into the muscle prior to ejection of the medicament from the needle. However the disclosed method of performing the intramuscular injection according to the Sarnoff patent necessitates the injection of air into the patient. When an injection is performed by skilled personnel, there is little danger if air is injected into the patient. Desirably, however, an injection device should be designed so that an injection may be performed by unskilled personnel such as the patient himself. Unskilled personnel may inject air into a blood vessel and it is therefore important to provide an ampoule and an injection procedure which eliminates this possibility.

As further examples of problems not heretofore solved, some of the devices of those patents of Sarnoff (or Sarnoff et al.) and of other prior art, in order to ensure a proper seal between a tubular, glass sidewall of an ampoule and a puncturable diaphragm closing one end thereof, have included diaphragm retaining members that are integral parts of an applicator for actuating the ampoule (e.g., U.S. Pat. No. 2,832,339 to Sarnoff et al.), or have included diaphragm retaining members that hold the medicament-containing ampoule in operative position within an applicator (e.g., U.S. Pat. No. 2,866,458 to Hein, Jr.). Such structures necessitate assembly and filling of an ampoule during the assembly of the ampoule within an applicator. However, it is frequently desirable to assemble and fill an ampoule of the contained-needle type and then ship that ampoule to the user so that the user may install it in an applicator.

A more acceptable solution to the problem of sealing a diaphragm to a medicament-containing cylinder may be found in U.S. Pat. No. 2,704,073 to Jensen. In the

Jensen patent, the diaphragm is sealed against one end of a cylinder by a cup-shaped slip which snaps over a beaded end portion of the cylinder to press the diaphragm against the end of the cylinder. This permits an ampoule to be assembled prior to shipment and later installed in an ampoule applicator. However, it provides a relatively large, substantially flat, skin-contacting surface that is incapable of sealing against loss of medicament by seepage between that end wall and the skin.

Moreover, neither the aforementioned Jensen patent nor any of the previously mentioned patents of Sarnoff et al. and Hein, Jr. provides a puncturable diaphragm that will permit an ampoule that is substantially full of liquid to be actuated to reduce the liquid chamber volume and force the needle through the diaphragm without occasionally (at least) creating a hydraulic lock that either bursts the ampoule or prevents initial movement of a plunger for causing the needle to puncture the diaphragm and thereby release the liquid for injection. Dunmire U.S. Pat. Nos. 3,094,988 and 3,236,237, which disclose solutions of the latter problem in the case of molded plastic ampoules, fail to provide solutions for the other problems described above.

The applicator disclosed in U.S. Pat. No. 3,236,237 to Dunmire involves a special endwall construction that cooperates with the special diaphragm of Dunmire U.S. Pat. No. 3,094,988 to perform the desirable functions set forth therein. However, in many instances it is desirable or necessary to perform an injection without employing an applicator. Furthermore, it may be desirable to perform an injection with an applicator different than the particular kind set forth in that patent, so that the advantages afforded by the teachings of the patent must be lost or achieved in some other manner.

A number of drug compounds, including some antibiotics, some vaccines, and several other injectable products, require that an active ingredient (usually in a powder form) be mixed with an injection vehicle (usually water) shortly before administration. One widely accepted procedure for mixing powder and liquid medicament components is to provide them in separate vials, each having its own rubber stopper closing its outlet opening. The liquid is withdrawn from its vial by a needle and syringe and is then injected into the vial containing the powder. The thus mixed liquid and powder in the latter vial, after shaking it where required, are withdrawn as a dispersion by the same needle and syringe, and the injection is effected therewith in a conventional manner.

Attempts have been made to provide a multicompartment vial wherein liquid and solid components to be mixed prior to injection are separately contained in a manner that permits mixing them within the common vial. For example, U.S. Pat. No. 2,495,942 to W. A. Nosek provides an outer container having an inner container mounted therein. The outer container contains a liquid medicament and the inner container contains a solid medicament. The inner container is releasably sealed to a stopper which closes both containers. By depressing the stopper, the inner container is released so that its solid contents may mix with the liquid. The mixture is then withdrawn by piercing the stopper with the needle of a hypodermic syringe. Such an arrangement, however, is not readily applicable to the contained-needle type of hypodermic ampoules to which the present invention relates, apart from other objections thereto.

Another proposal for providing a multichamber container is set forth in U.S. Pat. No. 3,342,180 to Sandhage et al., dated Sept. 19, 1967. In that patent, the patentees provide a vial which is separated into two chambers by a plunger. Powder is provided in a lower chamber and liquid is provided in the upper chamber. The plunger is provided with a one-way check valve so that, upon retraction of the plunger, the liquid is forced through the valve and into the compartment containing the powder. The vial is provided with an external needle at its lower end so that the mixed medicament may be injected into the patient. Again, apart from other objections thereto, such an arrangement is not readily applicable to the contained-needle type of hypodermic ampoules to which the present invention relates.

As a result of the foregoing problems, and numerous others, prior hypodermic ampoules of the contained-needle type, to which the present invention relates, have all been subject to severe limitations on their practical utility, and their uses have been restricted accordingly. The present invention is directed to the provision of a basic ampoule design of the contained-needle type that is adaptable for making both subcutaneous and intramuscular injections, either of a contained premixed medicament or of two or more separated medicament components that are mixed in the ampoule itself. A major objective is to achieve all of this

1. with a maximum utilization of basic parts of both the ampoules and applicators therefor,
2. with a minimum variation in the techniques of assembling, filling, and using the ampoules, and
3. while overcoming or avoiding the many problems that have heretofore prevented general use of the desirable, contained-needle type of injection device.

SUMMARY OF THE INVENTION

In its simplest form, this invention provides a disposable ampoule of the contained-needle type having a rigid, cylindrical sidewall, an actuating, needle-carrying plunger in one end thereof, and an improved skin-engaging, puncturable, endwall assembly at its opposite end that is suitable for use, also, in the other forms of the invention disclosed herein and for use with a variety of applicators or without employing any applicator. The improved, puncturable, endwall assembly includes the main features of the puncturable diaphragm of Dunmire U.S. Pat. No. 3,094,988 and a novel clip for fastening the diaphragm to the cylindrical sidewall.

The clip according to this invention is cup-shaped and has a cylindrical sidewall provided with an annular groove which snaps over a radially extending, circumferential bead adjacent the end of the cylinder. The bottom of the clip has a central opening therein for receiving a central, needle-guiding, gland portion of the puncturable diaphragm. The external bottom surface of the clip is concave and tapers inwardly from an outer rim portion to the central opening so that, upon engagement of the clip with the skin to effect an injection, the skin is stretched to resist indentation by the gland and produce a more reliable seal between the gland and the skin, while urging the gland axially in-

wardly toward the point of the needle to facilitate actuation of the ampoule. This latter feature permits the ampoule to be employed with or without an applicator. If an applicator is to be employed, however, it need not be specially designed to itself perform the skin-stretching function as disclosed in Dunmire U.S. Pat. No. 3,236,237.

This invention also provides an intramuscular, disposable, hypodermic ampoule which includes a longer cylindrical sidewall closed at one end by the puncturable diaphragm assembly and closed at its other end by a slidable plunger carrying a needle with a longer cannula. In this case, the cylinder is only partially filled with medicament. Prior to an injection, the plunger is partially depressed by pushing it toward the diaphragm so that the needle projects through and beyond the diaphragm and so that air within the ampoule is expelled prior to initiating the injection. The projecting end of the needle is then pushed through the skin and fascia layers and into the muscle of the patient, and the plunger is completely depressed to inject the medicament as the needle travels further into the muscle. A removable protective shield for the partially advanced needle is preferably provided as an attachment to the puncturable clip and diaphragm assembly and is removed just prior to making the actual injection. Otherwise, this form of the invention differs from the first described form primarily in the lengths of the cylindrical sidewall and needle cannula.

This invention also provides a multichamber, hypodermic device which includes first and second coaxially disposed cylinders. The cylinders respectively provide first and second, medicament-containing chambers, the adjacent ends of which are separated by a first, puncturable, piston-like diaphragm. This first diaphragm extends across and around the end of the first cylinder to close and seal the same and is slidably mounted in the adjacent end of the second cylinder to close and separately seal the same. These two seals are exposed to and separated by the ambient atmosphere so as to aovid liquid seepage from one chamber into the other. The other end of the first cylinder slidably carries a plunger. A hypodermic needle is mounted on the plunger with its pointed end extending axially toward a pierceable, central portion of the first diaphragm. The other end of the second cylinder is closed and sealed by the above described, puncturable, clip and diaphragm assembly having its pierceable portion also axially aligned with the pointed end of the needle.

The first chamber is partially filled with a first medicament, usually in powder form, and the excess space therein is preferably partially evacuated. The second chamber is filled with a second, liquid medicament or vehicle for the first medicament. These medicament components are mixed by partially depressing the plunger so that the pointed end of the needle cannula pierces the first diaphragm. The partial vacuum in the excess space in the first chamber facilitates the flow of liquid from the second chamber through the needle and into the first chamber as the first diaphragm moves toward and into engagement with the second diaphragm, thus mixing the two medicaments. When the second chamber is exhausted and its volume reduced essentially to zero in this manner, an injection may be effected by pressing the puncturable clip and diaphragm assembly against the skin of a patient and further depressing the plunger to the end of its stroke.

This invention also provides similar multichamber devices like the one last described but with the similar provision in the second cylinder of one or more additional, coaxially disposed chambers containing additional, liquid medicament components to be sequentially mixed in a like manner with the first two components prior to making the actual injection.

A basic applicator design is provided for receiving and actuating each of the several ampoule forms to perform the particular injections for which each is designed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a single chamber ampoule according to this invention.

FIG. 2 is an enlarged, cross-sectional view, the plane of the section being indicated by the line 2—2 in FIG. 1.

FIGS. 3 and 4 are cross-sectional views similar to FIG. 2, but showing the ampoule in an applicator and showing component parts of the ampoule and applicator in positions attained during an injection.

FIG. 5 is a cross-sectional view of an ampoule which is adapted to perform an intramuscular injection according to a further aspect of this invention.

FIG. 6 is a cross-sectional view similar to FIG. 5, but showing components parts of the ampoule in positions attained prior to an injection.

FIG. 7 is a cross-sectional view similar to FIG. 6, but showing the ampoule mounted in an applicator and ready for an injection.

FIG. 8 is a cross-sectional view similar to FIG. 7, but showing the ampoule in a position performing an injection.

FIG. 9 is a perspective view of a multichamber hypodermic ampoule according to a further aspect of this invention.

FIG. 10 is a cross-sectional view of the ampoule of FIG. 9, the plane of the section being indicated by the line 10—10 in FIG. 9.

FIGS. 11, 12, and 13 are cross-sectional views similar to FIG. 10, but showing component parts of the ampoule in positions attained after initiating a mixing operation, completion of the mixing operation, and completion of an injection operation, respectively.

FIG. 14 is a cross-sectional view of a multichamber hypodermic ampoule according to a further aspect of this invention.

FIG. 15 is a cross-sectional view of a multichamber hypodermic ampoule according to a still further aspect of this invention.

FIGS. 16 and 17 are cross-sectional views illustrating the component parts of the ampoule of FIG. 15 in positions attained at the completion of a mixing operation and after further actuation to ready it for making an injection, respectively.

FIG. 18 is a perspective view of a needle which may be employed in combination with devices according to this invention.

FIGS. 19 and 20 illustrate progressive filling and assembly operations to produce the ampoule illustrated in FIGS. 9 through 13.

FIG. 21 is a fragmentary perspective view of an ampoule retaining clip provided in the applicators illustrated in FIGS. 7, 8, and 17.

FIG. 22 is a bottom end view of an ampoule mounted in the applicator illustrated in FIGS. 7, 8, and 17.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and particularly to FIGS. 1 through 4, a single chamber ampoule 10 is illustrated. The ampoule 10 is adapted to perform a subcutaneous injection and includes a cylinder 11. The cylinder 11 is preferably made from glass tubing an has a radially extending annular bead 12 at one end. That end of the cylinder 11 is closed by a diaphragm 13 which is pressed against it by a plastic clip 14. The clip 14 is cup-shaped and has an inner annular groove 15 in its cylindrical sidewall which snaps over the bead 12. The clip 14 also includes a bottom wall 14*a* having a central aperture 14*b* therethrough. the bottom wall 14*a* has a concave outside surface which includes an outer rim 14*c* and which tapers upwardly toward the aperture 14*b*.

The diaphragm 13 is preferably molded from rubber and is shaped to function in accordance with the teachings of U.S. Pat. No. 3,094,988 to Dunmire. It includes an outer, annular portion 16, a thick, elongated, centrally located, needle guiding and liquid sealing gland 17, and a relatively thin, flexible, corrugated, intermediate portion 18 connecting the gland and the outer portion to permit relative axial movement therebetween. The gland extends through the aperture 14*b* in the clip 14. An axial needle passage 19 may extend into the upper end of the gland from the inside and terminates short of the opposite, lower end of the gland to form a thin, easily puncturable wall 20 closing the bottom of the passage. Alternatively, this needle passage may be omitted when molding the diaphragm and, in effect, be formed by partial piercing of the gland by the needle during assembly of the ampoule.

The other end of the cylinder 11 is closed by a plunger 21 which is also preferably molded from rubber and formed to have a sliding interference fit with the inner sidewall of the cylinder 11. The plunger 21, diaphragm 13, and cylinder 11, together, define a chamber 22 which is substantially filled with a liquid medicament.

Entirely enclosed within the chamber 22 is a hypodermic needle 23 (FIG. 18) which is preferably of the type disclosed in U.S. Pat. No. 3,173,200 to Dunmire et al. The illustrated circular base 24 at the butt end of the needle 23 is mounted on the plunger 21 so that the needle is in substantial axial alignment with the cylinder 11 and has a pointed end 25 projecting downwardly and received within the axial needle passage 19 of the diaphragm gland 17 in position to be forced through the thin wall 20 of the gland. Mounting of the needle base 24 on the plunger 21 is effected by snapping the peripheral edge of the needle base under an annular lip 26 that is an integral part of the plunger. Flow into the butt end of the needle from the chamber 22 occurs through an opening 27 in the cannula wall adjacent the base 24 of the needle.

An injection is effected by first pressing the diaphragm gland 17 firmly against the patient's skin S, thus indenting the skin until the rim 14*c* of the bottom of the clip 14 also firmly engages the patient's skin. As may be seen in FIGS. 3 and 4, when the clip 14 and the gland 17, together, firmly engage the skin S, the skin is stretched and domes upwardly to thereby seal it more tightly against the gland while forcing the gland axially inwardly toward the pointed end 25 of the needle 23. Force is then applied to the upper end of the plunger 21 (either manually or by means of an ampoule applicator) to move it downwardly toward the diaphragm 13 so that the needle 23 penetrates the gland wall 20 (see FIG. 3) and enters the patient's skin. As the plunger is depressed in this manner, the liquid medicament in the chamber 22 is forced through the opening 27 in the upper end of the needle, through the needle cannula, and into the subcutaneous tissue of the patient. By reason of the simultaneous upward pressure of the skin S on the gland 17 and the outward flexibility of the corrugated diaphragm portion 18, the needle is easily driven through the gland wall 20 before hydraulic pressure within the ampoule can block movement of the plunger. Also, the seal between the gland 17 and the skin S virtually prevents any seepage of medicament therebetween as the point of the needle moves into the skin layer and thereafter. Because both of these advantages are obtainable with the present invention with or without the use of an applicator, since both result from the new construction of the ampoule, itself.

If force is applied to the upper end of the plunger 21 by means of an applicator, the applicator may be of the type shown and described in the copending application of Hurschman, Ser. No. 114,423, filed Feb. 11, 1971, now U.S. Pat. No. 3,729,003, issued Aug. 24, 1973. A lower end portion 28 of that applicator is illustrated in FIGS. 3 and 4. The ampoule 10 is mounted within the portion 28 by a bayonet-type connection between the ampoule 10 and the portion 28. As is more fully set forth in the application of Hurschman, this connection is effected by providing axially extending, diametrically opposed slots (not shown herein) through an inwardly extending flange portion 29 of the applicator and by providing cooperating, radially extending lugs 14*d* on the clip 14. The lugs 14*d* are received within the slots and enter channels 29*a* and 29*b* which extend in a clockwise direction and taper radially inwardly toward the inner cylindrical sidewall of the portion 28. The ampoule may be removably retained in the applicator by inserting the lugs 14d into the slots and turning the clip 14 in a clockwise direction until the lugs 14*d* frictionally engage the inwardly tapering sidewalls of the channels 29*a* and 29*b*. The means to apply force to the plunger 21 includes a spring biased force applying head 28*a* which is held in a retracted position illustrated in FIG. 3 by detent means (not shown). When the detent means is released, the force applying head drives the plunger 21 to the position illustrated in FIG. 4.

Referring now to FIGS. 5 through 8, a single chamber ampoule 30 is illustrated. The ampoule 30 is adapted to perform an intramuscular injection and includes a cylinder 31 which is preferably made from glass tubing. One end of the cylinder 31 is provided with a radially extending annular bead 32, and that end of the cylinder is closed by a rubber diaphragm 33 that may be identical with the diaphragm 13 of FIGS. 2–4. The diaphragm 33 is pressed and held against the bead 32 by a clip 34 similar to the clip 14 of FIGS. 2–4. The other end of the cylinder 31 is closed by a rubber plunger 41 having an enlarged portion 42 which forms a sliding interference fit with the inner sidewall of the cylinder 31. The plunger 41 is provided with an axially

extending reduced upper portion 43 which initially extends beyond the cylinder 31.

The plunger 41, diaphragm 33, and cylinder 31, together, define a chamber 44 which is partially filled with a liquid medicament. A space Sp (FIG. 5) is provided between the level of the medicament and the initial position of the plunger, and the axial extend of the portion 43 of the plunger 41 corresponds to the axial extent of the space Sp.

Contained within the chamber 44 is a needle 45 which may be identical with the needle 23 illustrated in FIGS. 2–4 and 18 except for having a longer cannula and is disposed and mounted in the chamber similarly to the arrangement of FIGS. 2–4. A needle guard 46 is removably fixed to the clip 34 and extends axially therefrom. The needle guard 46 is preferably of transparent plastic, is cup-shaped, and has an open mouth which forms an interference fit with an annular, axially projecting shoulder portion 47 of the clip 34. For purposes which will hereinafter become apparent, the guard 46 so provided with a knurled bottom rib 48 and has an axial extent which is greater than the space Sp.

To ensure an intramuscular type injection, the needle 45 must pass through the skin, underlying surface layers of fat, and the fascia layer and enter the muscle prior to medicament flow through the needle. Therefore, the chamber 44 is designed so that its volume is greater than the volume of medicament contained therein. Prior to effecting an injection, the plunger 41 is depressed until the upper end of the portion 43 is level with the top of the cylinder 31, at which point the lower end of the plunger contacts the surface of the liquid in the chamber 44. During this depression operation, the needle 45 pierces the diaphragm 33 and the air or gas in the space Sp is substantially all expelled through the needle. This operation is most conveniently performed by placing the needle guard 46 on a flat surface and pressing the plunger portion 43 downwardly until the ampoule 30 achieves the condition illustrated in FIG. 6. If desired, the plunger may be depressed in this manner until the appearance of a drop of medicament at the point of the needle (visible through the transparent sidewall of the needle guard 46) indicates the elimination of substantially all air or gas from the chamber 44. This operation projects the needle 45 a predetermined distance beyond the diaphragm 33, which distance substantially corresponds to the normal maximum depth of the muscle beneath the skin of the patient, and air or gas in the chamber 44 is substantially fully expelled in the process.

After achieving the condition illustrated in FIG. 6, an intramuscular injection may be effected by manually removing the needle guard 46, inserting the needle through the skin, fatty layer, and fascia layer and into the muscle, and then completely depressing the plunger 41. A preferred method of effecting an injection, however, is to employ an applicator. As fragmentarily shown herein, such an applicator includes a spring-biased plunger 50 (FIGS. 7 and 8) mounted within a casing 51. An applicator adapted to perform an intramuscular injection includes an elongated, metal, bell-shaped mouth portion 52 which is provided with diametrically opposed inner spring clips 53 or the like (see FIG. 21) which are spot welded to the inner sidewall of the portion 52. The clips 53 retain the ampoule diaphragm clip 34 in the position illustrated in FIG. 7, so that the partially advanced needle 45 is initially recessed in the applicator. With the needle guard attached, the ampoule 30 is mounted within the applicator by inserting a pair of diametrically opposed lugs 34*a* provided on the clip 34 into a cooperating pair of slots 52*a* (FIG. 22 which extend axially through a radially inwardly extending flange 52*b*. This operation is performed by grasping the knurled bottom rib 48 on the needle guard 46. The ampoule is pushed upwardly into the casing 51 until the lugs 34*a* are above the level of the spring clips and is then rotated 90° until the lugs 34*a* rest on the clips 53 (see FIG. 7). It is desirable to remove the guard 46 after the ampoule 30 is mounted in the applicator to prevent contamination of the needle. The needle guard is removed by pulling one portion of the rib 48 downwardly while pushing a diametrically opposed portion of the rib upwardly since an axial force applied to the rib may disengage the lugs from their retaining spring clips. After the needle guard is removed, the mouth 52 of the applicator is placed against the skin of the patient and the plunger is fired. The applicator spring clips 53 are designed so that they release the ampoule diaphragm clip 34 prior to movement of the plunger 41 relative to the ampoule cylinder 31. To this end, the springs are designed so that the force required to drive the lugs 34*a* from their retained position is less than the force required to move the plunger 42 relative to the cylinder 31. In this manner, the needle 45 is driven into the muscle M (FIG. 8) prior to injection of the medicament. After the needle 45 enters the muscle, the plunger 41 again moves toward the diaphragm 33 to perform the injection by expressing the medicament through the needle 45 as it is driven further into the muscle M. The injection is complete when the plunger engages the diaphragm.

Referring now to FIGS. 9 through 13 of the drawings, a multichamber ampoule 110 is illustrated. The ampoule 110 is adapted to perform a subcutaneous injection and includes a first cylinder 111 and a second cylinder 112 of larger diameter, both being preferably made from glass tubing. One end of the first cylinder 111 has a radially extending annular bead 113 which is received within an annular groove 114 provided in a first diaphragm 115. The first diaphragm 115 is preferably made from rubber and is received with an interference fit within one end of the second cylinder 112. This radially compresses this diaphragm and causes it to more tightly embrace the cylinder bead 113.

The other end of the first cylinder 111 is closed by a rubber plunger 116 which, together with the first cylinder 111 and the first diaphragm 115, defines a first chamber 117. The plunger 116 is preferably made of rubber and has an interference fit in the first cylinder.

Entirely enclosed within the first chamber 117 is a hypodermic needle 118 which may be identical with the needle 23 illustrated in FIGS. 2–4 and 18 except for having a longer cannula. The illustrated circular base 119 at the butt end of the needle 118 is mounted on the plunger 116 similarly to the arrangement of FIGS. 2–4 so that the needle is in substantial axial alignment with the cylinder 111 and has a pointed end 120 projecting downwardly and into the diaphragm 115 in position to be forced through the unpierced remainder thereof.

As will be hereinafter explained in greater detail, the chamber 117 is at least partially filled with a powdered medicament 123 and is partially evacuated. A sliding

interference fit between the diaphragm **115** and the inner sidewall of the cylinder **112** aids in sealing the bead **113** within the annular groove **114.** Friction between the plunger **116** and wall of the cylinder **111** and resistance of the diaphragm **115** to penetration by the needle **118,** of course, prevent the plunger **116** from prematurely moving toward the diaphragm **115.**

The other end of the second cylinder **112** is closed by a second diaphragm **124** and a clip **125** constructed and operating like the previously described similar diaphragm and clip of FIGS. **2–4,** the diaphragm comprising portions **127, 128,** and **129** corresponding to portions **16, 17,** and **18** of the diaphragm of FIGS. **2–4** and having a similar needle receiving passage **130** ending in a puncturable wall **131** closing the bottom of the passage.

The first diaphragm **115,** second diaphragm **124,** and cylinder **112,** together, define a second chamber **132.** The second chamber **132** is filled with a liquid medicament in a manner which will hereinafter be explained.

The liquid medicament in the second chamber is mixed with the solid powder medicament in the first chamber prior to injection in a manner which will now be explained. The plunger **116** is pushed axially toward the first diaphragm **115** until the needle **118** pierces this diaphragm and provides communication through the needle between the second chamber **132** and the first chamber **117,** as shown in FIG. **11.** Once communication is established between these chambers, the liquid is drawn upwardly into the first chamber by downward movement of the cylinder **111** and first diaphragm **115,** together, into engagement with the second diaphragm **124,** as shown in FIG. **12.** At this stage, the pointed end of the needle **118,** which previously pierced the first diaphragm **115,** has entered the gland **128** of the diaphragm **124.**

To ensure that the pointed end of the needle will not be initially extended too far beyond the first diaphragm **115** after it pierces that diaphragm, the plunger **116** is provided with a centrally raised portion **140** which extends beyond the end of the cylinder **111** when the ampoule is initially assembled. The raised portion **140,** therefore, extends beyond the end of the cylinder **111** for a distance which substantially corresponds to the thickness of the portion of the diaphragm **115** to be pierced plus the desired extension of the needle beyond the diaphragm **115** during the mixing operation. To perform the penetration operation, therefore, the raised portion **140** is depressed until its upper or outer end is flush with the top mouth of the cylinder **111,** as illustrated in FIGS. **11** and **12.**

When the ampoule **110** is in the condition illustrated in FIG. **12** and the ampoule has been inverted several times or vigorously shaken as reliable mixing of the medicament components may require (generally not necessary), the ampoule is in a condition suitable for making a subcutaneous injection. To perform the injection, the diaphragm **124** is placed adjacent the patient's skin and the plunger is fully depressed until it assumes the position illustrated in FIG. **13.** During the plunger depressing step, the needle penetrates the wall **131,** and fluid is exhausted from the first chamber through the needle opening adjacent the plunger **116** and through the opening in the end of the needle as the needle penetrates the skin and subcutaneous fat of the patient.

Referring now to FIG. **14,** an ampoule **150** is illustrated. The ampoule **150** is suited for performing an injection requiring the premixing of two or more liquid medicaments with each other or with each other and with a solid medicament. The ampoule **150** includes a first cylinder **151** which is preferably made from glass and which has a beaded rim portion **152** at its lower end. The rim portion **152** is received within an annular groove **153** which is provided in a first diaphragm **154.** The diaphragm **154** closes one end of the cylinder **151,** and the other end of the cylinder **151** is closed by a plunger **155.** A needle **156** similar to the needles **23** and **118** (except for cannula length) is mounted on the plunger **155** similarly to the arrangement of FIGS. **2–4.** A pointed end **159** of the needle **156** is received within a passage **160** in the first diaphragm **154.** The plunger **155,** cylinger **151,** and the diaphragm **154,** together, define a first chamber **161.** As will be hereinafter explained in greater detail, the chamber **161** is partially evacuated during the assembly operation and is at least partially filled with a liquid or powdered medicament **162.**

The first diaphragm **154** is slidably received within a second cylinder **163.** The second cylinder **163** has its upper end closed by the first diaphragm **154** and has its lower end closed by a second diaphragm **164** and a clip **165** constructed and operating like the previously described similar diaphragm and clip of FIGS. **2–4.**

Intermediate diaphragms **167** and **168** are provided in the cylinder **163.** The intermediate diaphragms **167** and **168,** the diaphragms **154** and **164,** and the cylinder **163,** together, define second, third, and fourth chambers **169, 170,** and **171,** respectively. The chambers **169, 170,** and **171** are filled with different liquid medicaments.

The medicaments contained in the chambers **169–171** are mixed together, and the mixture is in turn mixed with the powder **162** in the following manner. The plunger **155** is pushed downwardly until the needle **156** pierces the first diaphragm **154** to provide fluid communication between the chamber **169** and the chamber **161.** The fluid in the chamber **169** is drawn through the hollow needle **156** and into the chamber **161.** After the liquid in the chamber **169** is exhausted in this manner, the diaphragm **154** contacts the diaphragm **167** and the pointed end **159** of the needle enters a passage **172** in the diaphragm **167.** Further pressure on the plunger **155** causes the needle **156** to pierce the diaphragm **167** to thereby draw liquid from the the chamber **170** into the chamber **161** and move the diaphragm **167** against the diaphragm **168.** The pointed end **159** of the needle **156** then enters a passage **173** in the diaphragm **168** and further pressure on the plunger **155** drives the needle **156** through the diaphragm **168** to thereby draw liquid from the chamber **171.** After the liquid in the chamber **171** is exhausted, the diaphragm **168** contacts the diaphragm **164** and the pointed end of the needle is received within a passage **174** provided in the diaphragm **164.**

After the several liquids are mixed with each other and with the material **162** in the chamber **161,** the ampoule **150** is in a condition to perform an injection. This injection is performed by placing the diaphragm **164** against the skin of the patient and by depressing the plunger **155** until the plunger **155** contacts the diaphragm **154.** It should be appreciated that any number of liquids may be mixed in this manner with or without

a powdered medicament, after which the ampoule, with or without an applicator of the kind partially shown in FIGS. 3 and 4, may be used to make a subcutaneous injection in the general manner previously described.

Referring now to FIGS. 15, 16, and 17, an ampoule 180 is illustrated, The ampoule 180 may be employed to mix liquid and powdered medicaments prior to an injection, and may be employed to effect an intramuscular rather than subcutaneous injection. The ampoule 180 is generally similar to the ampoule 110 in that it includes a first cylinder 181 which is closed at one end by a rubber plunger 182 and is closed at the other end by a first diaphragm 183. A needle 184 is fixed to the plunger 182 in the same manner previously described, and the diaphragm 183 is slidably received in a second cylinder 185. The second cylinder 185 is closed at its lower end by a second diaphragm 186 and a clip 187 constructed and operating like the previously described similar diaphragm and clip of FIGS. 2–4. A needle guard 188 similar to the needle guard 46 of FIGS. 5 and 6 is removably fixed to the clip 187 and extends axially therefrom as previously described with reference to the latter figures of the drawings.

The first cylinder 181, diaphragm 183, and plunger 182, together, form a first chamber 190 which is evacuated and partially filled with a powdered medicament 191. The second cylinder 185 and diaphragms 183 and 186, together, form a second chamber 192 which is filled with a liquid medicament 193.

The medicaments 191 and 193 are mixed in a manner similar to the mixing procedure set forth with regard to the ampoule 10 of FIGS. 9–13. The plunger 182 is pushed axially until the needle 184 pierces the diaphragm 183 and provides liquid communication between the chambers 190 and 192. When such communication is established, the diaphragm 183 moves into engagement with the diaphragm 186, and the parts of the ampoule 180 assume the positions illustrated in FIG. 16.

To ensure an intramuscular type injection, the needle 184 must pass through the skin and the surface layers of fat and enter the muscle prior to medicament flow through the needle. Therefore, the chamber 190 is designed so that its volume is greater than the total volume of medicament to be contained therein. Thus, as is illustrated in FIG. 16, there is a space Sp between the liquid level and the plunger 182 when the diaphragms 183 and 186 are drawn together. Prior to effecting an injection, the plunger 182 is further depressed until the plunger 182 contacts the surface of the liquid in the chamber 190. This operation projects the needle 184 a predetermined distance beyond the diaphragm 186, which distance substantially corresponds to the normal maximum depth of the muscle beneath the skin of the patient, and air or gas in the chamber 190 is substantially fully expelled in the process as previously described with reference to FIGS. 5–8.

An injection may then be performed by removing the needle guard 188 and manually applying the ampoule 180 against the skin of the patient so that the needle 184 penetrates the skin and enters the muscle. After this operation, the plunger 182 is completely depressed to inject the medicament into the muscle. Desirably, however, the injection is performed by an applicator which may generally correspond to the applicator.

Referring now to FIGS. 19 and 20, the ampoule 110 is assembled and filled by first attaching the needle 118 to the plunger 116 as previously described with reference to FIGS. 2–4 and then inserting the plunger in one end of the cylinder 111, as shown in FIG. 19. With the open mouth of the cylinder 111 in an upright position, the cylinder 111 is at least partially filled with the powdered medicament 123 and is subjected to a vacuum during or at the conclusion of the introduction of powdered medicament. While subjected to the vacuum, the first diaphragm 115 is applied to the mouth of the cylinder. Thereafter, the second cylinder 112 is applied to the diaphragm 115, as illustrated in FIG. 20. The second cylinder 112 is then filled with a liquid medicament, and the remaining components are assembled to provide the ampoule shown in FIGS. 9 to 13.

The invention is not restricted to the slavish imitation of each and every detail set forth above. Obviously, hypodermic devices may be provided which change, eliminate or add certain specific details without departing from the scope of the invention.

What is claimed is:

1. In a unitary hypodermic device of the contained-needle type comprising a closed medicament-containing cylindrical glass ampoule having a pierceable wall at one end thereof, a hypodermic needle having a pointed discharge end disposed in the ampoule for movement to pierce and project through said pierceable wall, and means for moving said needle through said pierceable wall while expressing medicament from the ampoule therethrough; the improvement in which said ampoule has an outer circumferentially extending bead adjacent the pierceable wall end thereof, and said pierceable wall includes a relatively rigid annular outer portion frictionally retained by said bead and having an external surface configured to provide an annular, skin-engaging rim surrounding a concavely recessed surface portion that defines a central opening thereon and a cylindrical sidewall having an internal circumferential groove for receiving said bead and locking said outer portion to said ampoule, said cylindrical sidewall also including an end portion beyond said internal groove that snugly engages said cylinder about its circumference inwardly of the bead thereon, and said bead having opposite side portions that slope differently relative to the axis of said cylinder to facilitate forcing said end portion of said outer portion over said bead when applying said outer portion to the cylinder and to render removal thereof by reverse movement more difficult; and a separate relatively flexible pierceable inner diaphragm portion for closing the end of said ampoule and held in position by said outer portion, said diaphragm portion having a central gland projecting outwardly through said central opening in said outer portion and embracing the pointed discharge end of said needle, said annular rim and projecting gland being axially related to be pressed, together, against the skin of the patient to tense the skin within the rim for increasing the resistance of the skin to pressure from the gland and more effectively sealing the gland against the skin while urging the gland inwardly against the pointed end of the needle to facilitate piercing of the gland and the skin upon actuation of said needle-moving means.

2. A hypodermic ampoule according to claim 1 in which said cylindrical sidewall of said outer portion is sufficiently resistant to elastic deformation to substan-

tially prevent its removal without breaking said ampoule.

3. A multichamber ampoule for mixing and discharging medicaments, comprising a first cylinder, a first diaphragm sealed to and closing one end of said first cylinder, a plunger slidably disposed in the other end of said first cylinder to provide a first chamber between said plunger and first diaphragm, a hollow needle disposed in said first chamber for movement with said plunger toward said first diaphragm and having an open end adjacent said plunger and an opposite pointed discharge end adjacent said first diaphragm, and a powder medicament in said first chamber; a second cylinder axially aligned with said first cylinder and having one end closed by insertion of said first diaphragm therein with a peripheral portion of the first diaphragm in axial sliding engagement with the inner surface thereof, a second diaphragm closing the other end of said second cylinder, said first and second diaphragms and second cylinder, together, defining a second chamber, and a fluid medicament in said second chamber; whereby said fluid and solid medicaments may be mixed preparatory to discharge thereof by first moving said plunger and needle sufficiently toward said first diaphragm to project the pointed end of the needle through said first diaphragm to establish communication between the two chambers and by then moving said first cylinder, first diaphragm, plunger, and needle as a unit toward said second diaphragm to progressively reduce the volume of said second chamber substantially to zero and thereby express said liquid medicament through the needle into the first chamber while bringing said first and second diaphragms substantially into engagement and disposing the pointed end of said needle in position to project the needle through said second diaphragm upon further movement of said plunger toward said first and second diaphragms the improvement in which said second diaphragm comprises a pierceable wall having a relatively rigid, annular, outer portion having an external surface configured to provide an annular, skin-engaging rim surround a concavely recessed surface portion that defines a central opening therein and a relatively flexible, pierceable, inner diaphragm portion having a central gland projecting outwardly through said central opening and embracing the pointed discharge end of said needle.

4. A multichamber hypodermic ampoule according to claim 3, wherein the outer diameter of said first cylinder is less than the inner diameter of said second cylinder.

5. A multichamber hypodermic ampoule according to claim 3, wherein the volume of said first chamber is substantially equal to the volume of said second chamber.

6. A multichamber hypodermic ampoule according to claim 3, wherein the volume of said first chamber sufficiently exceeds the volume of said second chamber so that the volume of the two medicaments in said first chamber after mixing the medicaments therein is substantially less than the remaining volume of said first chamber, whereby, prior to expelling the mixed contents of the first chamber, said plunger may be further advanced toward said first and second diaphragms to extend a portion of the length of said needle through and beyond said second diaphragm in an exposed condition for projection into a patient to the depth of muscle tissue to be injected, and said plunger may then be moved further toward said first and second diaphragms to progressively expel the mixed contents of said first chamber through said needle and into said muscle tissue while further advancing said needle into said muscle tissue.

7. A multichamber hypodermic ampoule according to claim 3, in which at least one additional diaphragm is disposed in said second chamber between said first and second diaphragms so as to divide said second chamber into a plurality of smaller chambers, and a corresponding plurality of different liquid medicaments respectively substantially fill said smaller chambers, whereby each of said liquid medicaments, one after another, may be caused to flow through said needle into said first chamber by progressive movement of said first diaphragm, first cylinder, plunger, and needle, as a unit, to bring all of said diaphragms substantially into engagement with one another.

8. A hypodermic ampoule comprising a cylinder; a plunger closing one end of the cylinder with a sliding seal; a pierceable diaphragm closing the other end of the cylinder to provide a medicament chamber therein; a hypodermic needle disposed in said chamber and extending axially thereof for movement with said plunger toward said diaphragm, said needle having an opening from the chamber into the needle at one end thereof adjacent said plunger and an opposite, pointed, discharge end; and a clip secured to said other end of said cylinder and having a bottom portion pressing said diaphragm into sealed engagement with that end of the cylinder; said diaphragm having an outwardly extending central gland portion embracing the pointed end of the needle, and said bottom portion of said clip having an external surface configured to provide an annular, skin-engaging rim surrounding a concavely recessed surface portion defining a central opening therein through which said diaphragm gland projects so that said clip rim and projecting gland may be pressed, together, against the skin of a patient to tension the skin within the clip rim, whereby the skin firmly engages the gland to urge it inwardly and facilitate penetration of the gland and skin by the needle upon inward movement of said plunger to inject medicament through the needle and into the patient, a liquid medicament partially filling said chamber so as to leave an initial space between said plunger and the medicament when the ampoule is vertically disposed with the plunger end thereof uppermost, whereby the plunger may be moved inwardly to project the needle through and beyond said diaphragm gland prior to expressing liquid medicament through the needle, and wherein said plunger has a portion extending axially beyond the plunger end of said cylinder for a distance substantially corresponding to the length of said space axially of the cylinder.

9. A hypodermic ampoule according to claim 8, including a cup-shaped needle guard removably secured to said clip and having a bottom portion spaced from said gland an axial distance substantially corresponding to the axial length of said initial space between said plunger and medicament.

10. A hypodermic ampoule according to claim 8, wherein said plunger and diaphragm are rubber and said cylinder is rigid and substantially transparent.

11. A hypodermic ampoule according to claim 8 in which said cylinder has an outer, circumferentially extending bead adjacent the diaphragm end thereof, and said clip is cup-shaped with a cylindrical sidewall em-

bracing said bead and the adjacent end portion of the cylinder for securing the clip and said diaphragm to the cylinder.

12. A hypodermic ampoule according to claim **8** in which said cylinder is formed of glass and has an outer, circumferentially extending bead adjacent the diaphragm end thereof, said clip being cup-shaped with a generally cylindrical sidewall embracing said bead and the adjacent end portion of the cylinder, and said cylindrical sidewall of the clip having an internal, circumferential groove receiving said bead of said cylinder and locking the clip against removal.

13. In a hypodermic injection assembly:

a. a contained-needle type of hypodermic ampoule comprising a cylinder, a puncturable diaphragm closing and sealing one end of said cylinder, a slidable plunger in the opposite end of said cylinder and spaced from said diaphragm to provide a chamber therebetween, a liquid medicament in said chamber, and a hypodermic needle disposed in said chamber for movement by said plunger to a preinjection position in which a discharge end portion of the needle has pierced and extends beyond said diaphragm in an exposed condition and thereafter to transmit medicament from said chamber into a patient receiving an injection while moving further through said diaphragm, the volume of medicament in said chamber being substantially less than the initial volume of said chamber to permit movement of the plunger to project the needle to said preinjection position before expressing medicament from the chamber through the needle, said diaphragm comprising a pierceable wall having a relatively rigid, annular, outer portion having an external surface configured to provide an annular, skin-engaging rim surrounding a concavely recessed surface portion that defines a central opening therein and a relatively flexible, pierceable, inner diaphragm portion having a central gland projecting outwardly through said central opening and embracing the discharge end of said needle; and said ampoule including radially projecting abutments spaced about its periphery;

b. an applicator for actuating said ampoule to perform an injection after the needle has been projected to its preinjection position, said applicator comprising a housing having an open end for insertion of said ampoule into the housing with the needle directed axially outwardly relative to said opening until the pointed end of the needle in its preinjection position is within the housing, detent means for coacting with said abutments on said ampoule for yieldably restraining said ampoule against reverse movement toward said opening, and ampoule moving means operative first to move said ampoule past said detent means and toward said housing opening for projecting the needle from the housing substantially for its exposed length in its preinjection position and then for moving said ampoule plunger and needle toward said ampoule diaphragm with a continuing force sufficient to express the medicament from said chamber through said needle and into a patient;

whereby operation of said ampoule moving means of the applicator while the open end of the applicator is held against the skin of a patient first moves said ampoule and needle to cause the needle to penetrate into the patient for substantially the exposed length of the needle in said preinjection position and then moves said ampoule plunger toward said ampoule diaphragm for further advancing the needle into the patient while expressing medicament from said ampoule chamber through said needle and into the patient, said housing including stop means for subsequent positive restraining engagement with said abutments on said ampoule, said detent means and said stop means being discontinuous circumferentially of said applicator housing to permit passage of said ampoule abutments thereby during insertion of the ampoule, and engagement of said abutments thereby after relative rotation of the inserted ampoule about a common axis of said housing and ampoule.

14. A hypodermic injection assembly according to claim **13** including a cup-shaped needle guard removably secured to the diaphragm end of said ampoule, said guard having a bottom wall spaced from said diaphragm by a distance exceeding the length of said end portion of the needle in its preinjection position.

* * * * *