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2,591,706

PLURAL-COMPARTMENT ADMIXING HYPODERMIC SYRINGE AMPOULE FOR
SEGREGATED STORAGE OF INGREDIENTS OF LIQUID MEDICINAL
SOLUTIONS AND THERAPEUTIC PREPARATIONS

Filed Sept. 29, 1950

2 SHEETS—SHEET 1

Fig. 1.

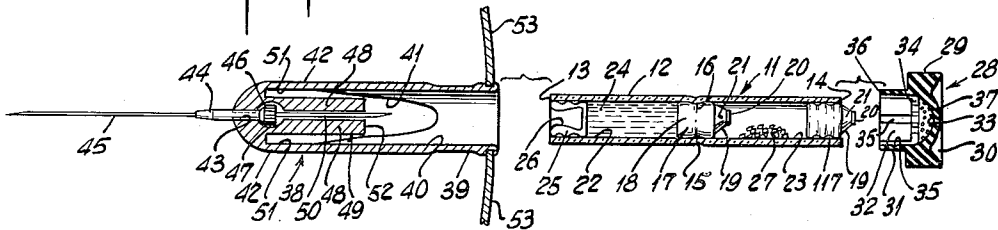


Fig. 2.

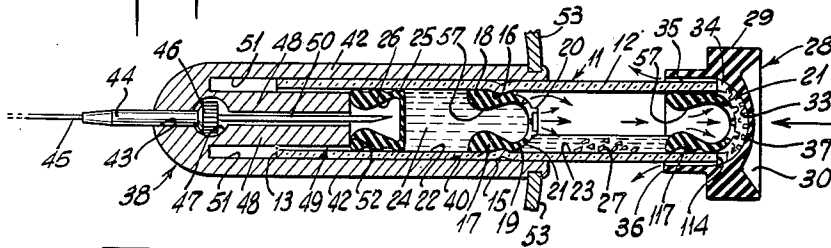


Fig. 3.

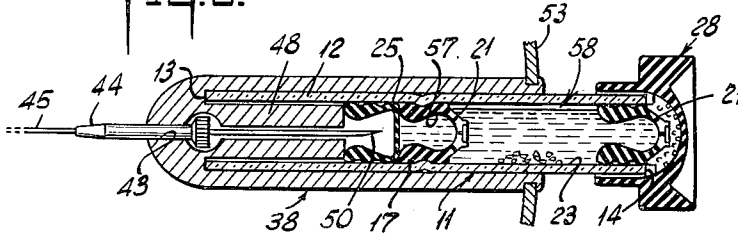


Fig. 5.

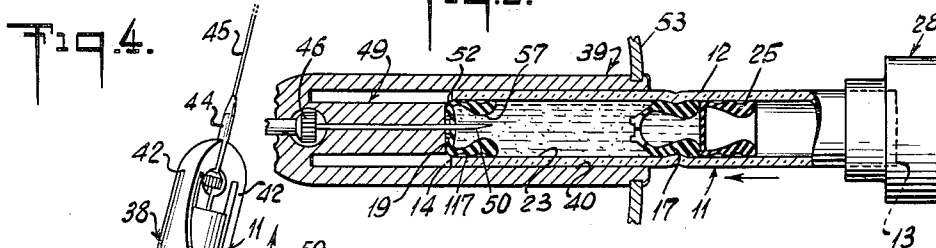
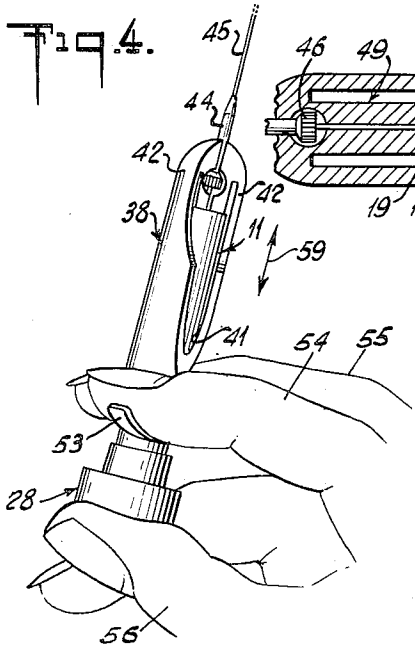
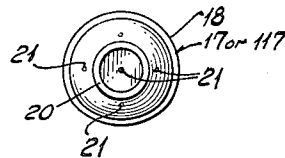


Fig. 6.



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2 SHEETS—SHEET 2

Fig. 7.

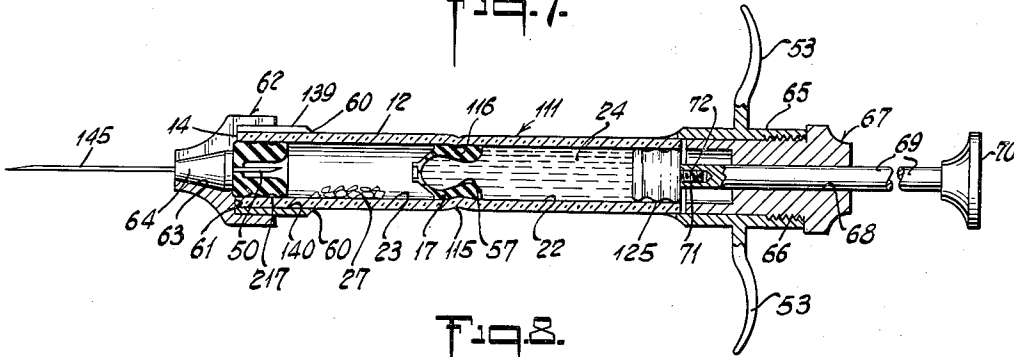


Fig. 8.

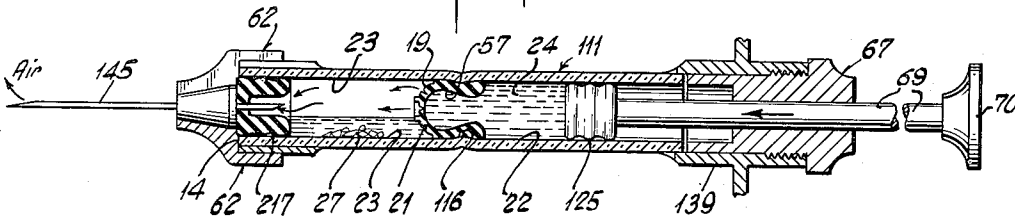


Fig. 9.

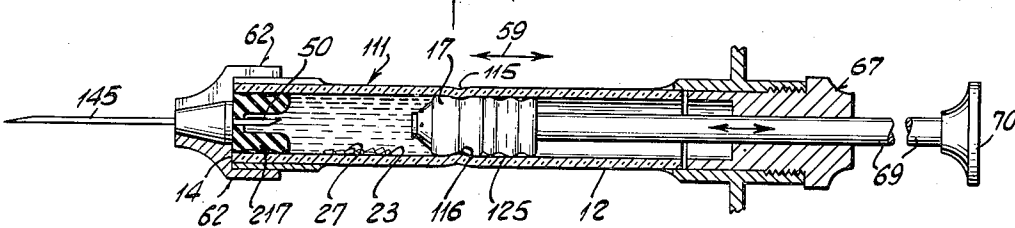
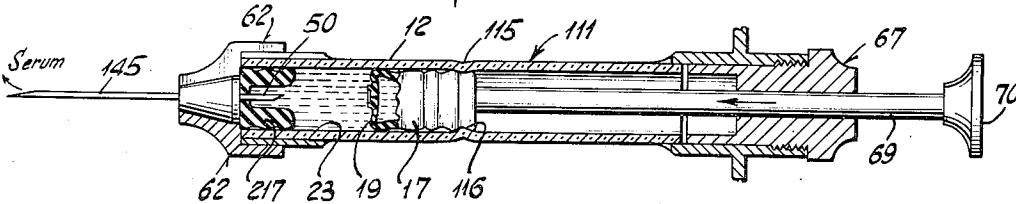


Fig. 10.



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UNITED STATES PATENT OFFICE

2,591,706

PLURAL-COMPARTMENT ADMIXING HYPODERMIC SYRINGE AMPOULE FOR SEGREGATED STORAGE OF INGREDIENTS OF LIQUID MEDICINAL SOLUTIONS AND THERAPEUTIC PREPARATIONS

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Application September 29, 1950, Serial No. 187,502

18 Claims. (Cl. 128—272)

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The present invention relates to hypodermic syringe ampules of the plural-compartment type for segregated storage of ingredients of liquid medicinal solutions and therapeutic preparations which are manipulatable to accomplish admixture of the ingredients and then operable as a syringe barrel and piston means to expel the resulting mixture in the hypodermic administration of the latter.

A general object of the present invention is to provide such hypodermic syringe ampules, the parts of each of which are of simple construction, readily produced on an economical mass basis and easily assembled to form a self-contained ampule unit with chambers thereof separately charged or loaded with the different ingredients of medicinal solutions and therapeutic preparations or solvent and medicament solids in a manner assuring sterility; various embodiments thereof featuring a tubular syringe barrel having a partition intermediate its ends provided with one-way valve means through which passage of liquid solvent from one chamber to the other for admixture of segregated contents may be had by application thereto of a differential in fluid pressure easily and effectively applied by manipulations external of the chambers, with continued isolation of the ingredients so as to avoid undesirable interference with sterile conditions.

A more specific object of the present invention is to provide such a hypodermic syringe ampule in which is featured a valving partition to define one chamber from another for segregation of solvent and medicament solids in the chambers, the valve means of said partition being self-closing, and openable by application of fluid pressure only to the solvent chamber side thereof, the structure being such as to permit the creation of hydraulic pressure in the solvent chamber by simple manual operation exterior of the chambers while effectively maintaining them closed, the valving partition effectively preventing back-flow to permit efficient expulsion in the hypodermic administration of the latter.

Another object of the present invention is the provision of such hypodermic syringe ampules in which the valving partition is formed as a body of elastic material having a portion cupped inward in the solvent or liquid chamber side thereof and provided with at least one or more self-closing perforations extending therethrough openable when the cupped portion is stretched by application therein of hydraulic pressure developed in said liquid chamber and self-closing upon

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relaxation of the elastic material with approximate equalization of pressure on both sides, and of such construction as to assure maintenance of closure of the perforation or perforations when pressure is increased on the other side thereof to prevent back-flow of fluid, thus permitting a desired effective utilization of said partition means as an expulsion piston during hypodermic administration of mixture resulting from admixture of the segregated ingredients.

A further object of the present invention is to provide such a partitioned hypodermic syringe ampule with closure means closing off the end of the chamber in which the solute or medicament is stored and in which the ingredients are to be mixed so constructed that gaseous fluid or air contained in the mixing chamber may be efficiently vented therefrom simultaneously with transfer thereof of liquid solvent.

A still further object of the present invention is to provide structural embodiments of the apparatus which are readily and economically constructed and permit efficient use and operation thereof, as will be more fully apparent from the following descriptions of said embodiments shown by way of example in the accompanying drawings.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts, which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a longitudinal or axial section, with parts broken away, of a loaded dual-chamber embodiment of the hypodermic syringe ampule of the present invention, of a needle-equipped syringe casing structure adapted to receive the ampule as a barrel, and of a pressure-applying or thrust cap to be fitted over one end of said ampule for forcing it down into said casing, the separated parts shown being arranged in the order of their assembly for admixing manipulation;

Fig. 2 is an axial section, with parts broken away, of the parts depicted in Fig. 1, but showing them to a larger scale and with the ampule being "fired" by telescoping it into the syringe

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casing with application of pressure to the mounted cap for the transfer of liquid solvent from the liquid storage chamber to the solute or medicament solids storage chamber for admixture thereof in the latter, but not shown in the preferred position of orientation shown in Fig. 4;

Fig. 3 is a sectional view similar to Fig. 2 showing the relative position of the parts after the ampule has been so "fired" with substantially complete transfer of the liquid solvent to the mixing chamber;

Fig. 4 is a perspective view of the "fired" ampule, syringe casing and thrust cap assembly shown in Fig. 3, showing a portion of the operator's hand holding it in the position of orientation favored for "firing" and obtaining efficient admixture of ingredients with longitudinal shaking;

Fig. 5 is a sectional view similar to Fig. 2, with some parts broken away and others in elevation, showing the thrust cap mounted on the opposite end of the "fired" ampule after the latter has been removed and reversed in the syringe casing end-for-end for hypodermic administration of the mixture contents;

Fig. 6 is an enlarged end view of crowned cupped plug structure, preferably employed both as the partition means and the closing means for the end of the mixing chamber of the embodiment shown in Figs. 1 to 5 incl.;

Fig. 7 is a sectional view of another embodiment of the hypodermic syringe ampule of the present invention showing it mounted as a barrel of another type of syringe casing structure, with the parts being depicted in their relative positions prior to "firing."

Fig. 8 is a sectional view similar to Fig. 7 showing the "firing" of the ampule by depression of the syringe plunger for transfer of liquid solvent from the liquid chamber to the mixing chamber, but not shown in the preferred position of orientation indicated in Fig. 4;

Fig. 9 is a sectional view similar to Fig. 8 showing the relative positions of parts after completion of the "firing" with substantially complete transfer of liquid from the liquid chamber to the mixing chamber; and

Fig. 10 is a sectional view, with parts broken away, similar to Fig. 9, showing manipulation of the syringe structure in the hypodermic administration of the resulting mixture.

Referring to the drawings, in which like numerals identify similar parts throughout, it will be seen that an embodiment of the present invention, shown in Figs. 1 to 5 incl., may be adapted for employment with a metal or disposable plastic cartridge type syringe, such as that illustrated in my Patent No. 2,410,351, of October 29, 1946. As shown in Figs. 1 to 5 incl., hypodermic syringe ampule 11 may comprise a substantially cylindrical tube or barrel 12 of suitable material, preferably transparent to permit inspection and observation of contents and internal actions, such as glass, a suitable plastic, or the like. Tubular barrel 12 preferably is provided between its ends 13 and 14 with a waist constriction 15 to form a circular internal seat 16, the latter preferably being of a diameter substantially less than the internal diameter of the remainder of the barrel.

Transversely-extending partition means are mounted in barrel 12 on seat 16 and, as shown, preferably comprises a crowned cupped plug 17 formed of suitable elastic material, such as synthetic or natural rubber, for example, pure gum.

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Plug 17 preferably comprises a hollow cylindrical base sleeve section 18 which may be of a diameter appreciably greater than the diameter of seat 16 when the plug is in its relaxed condition, before being mounted in barrel 12. Thus, when plug 17 is forced into the seat 16 its base sleeve section 18 will be compressed to the shape shown, there to be frictionally retained and to resist, at least temporarily, dislocation by application of a differential in pressure to opposite sides or ends thereof. Plug 17 includes a domed protruding closure end or crown 19, preferably made integral with the base sleeve section 18, and preferably thinner than the latter, at least in certain circumambient areas thereof to assure greater flexibility. Flexible membrane crown 19 preferably is stiffened about a central area of its tip by a protruding integral rib 20 and is provided in thinner sections thereof with at least one self-closing perforation, preferably in the nature of a slit formed by piercing it with a needle or other slender instrument. Preferably, as shown in Fig. 6, a plurality of such perforations or slits 21-21 are formed in the membrane crown 19 both about and within the stiffening rib 20.

Such crowned cupped plug structure is more fully described in my copending application Serial No. 160,987, filed May 9, 1950 and now Patent Number 2,577,780, granted December 11, 1951, and, as therein indicated, when fluid pressure is applied interiorly thereof, that is, to the inner side of membrane crown 19, the latter will be stretched or bulged to open up the perforations or slits 21-21 to permit passage of fluid. Application of pressure, either hydraulic or mechanical, to the outside of crown 19 will cause it to flex or fold inwardly so as to crowd the stock thereof into a smaller area to squeeze the sides of the perforations or slits closely together efficiently to resist considerable fluid pressure to prevent reverse flow of fluid. Thus, the crowned cupped plug 17 serves as a one-way valved partition means. Partition plug 17 divides tubular barrel 12 into a pair of chambers, chamber 22 at one end preferably being adapted to store liquid ingredient or solvent, and a second chamber 23 at the other end adapted to store another ingredient or medicament solute and to serve as a mixing chamber for admixture of the ingredients. A body 24 of liquid solvent of any suitable nature, such as distilled water, in which medicament solute is to be dissolved to form a liquid medicinal solution or therapeutic preparation to be administered hypodermically, is placed in liquid storage chamber 22 substantially to fill the same when end 13 of the tubular barrel 12 is closed off by means of a suitable piston plug 25.

Piston plug 25 preferably is of the cupped type having a recess 26 in the outer side or end thereof so as to avoid being pierced when pushed against plunger or piston post means from which the end of a needle may project, as in the type of cartridge syringe structure shown in Figs. 1 to 5 incl. and as more fully explained hereinafter. Piston plug 25 preferably is formed of suitable resilient or elastic material, such as synthetic or natural rubber, for example, pure gum; and is made slightly oversize, i. e., it has an external diameter slightly greater than the internal diameter of liquid chamber 22, to engage the inner walls of the barrel in the liquid chamber snugly so as to serve as a secure liquid seal at the end thereof while being slidable therein

so as to expel or discharge the liquid solute therefrom with piston action.

The other ingredient or medicament solute, which is to be dissolved into the liquid solvent, may comprise a mass 27 of discrete particles or a solid body in pill form placed in mixing chamber 23 with the remainder of the space therein being occupied by a sterile gaseous medium, such as air. The end 14 of tubular barrel 12, and thus the end of storage chamber 23, is closed off by a gas-venting plug 117, preferably of a construction similar to partition plug 17. Thus, plug 117 will permit automatic valving from the mixing chamber 23 of the contained gas as liquid solvent is transferred from the liquid storage chamber 22 thereto. Since end-closing plug 117 must assure effective sealing of mixing chamber 23 while the latter serves as a storage chamber for the medicament solute it is also preferably oversize, and its base sleeve section may have either a smooth outside cylindrical surface like 18 or, if desired, a plurality of circumambient grooves, as proposed in Figs. 1 to 5 incl. Since closing plug 117 is similar in structure to partition plug 17, it has a pierced membrane crown 19 in which self-closing venting slits 21-21 are formed.

A pressure-applying or thrust cap 28 is provided for fitting over either end 14 or 13 of tubular barrel 12, and preferably is formed as a molded body of synthetic or natural rubber or the like, having a top portion 29 providing an end surface 30 for engagement by an operator's digit for application of biasing force thereto or push or thrust thereagainst. Cap 28 preferably has formed integral with the top portion 29 a circumambient flange or skirt 31 surrounding an axial socket 32. The end or bottom surface 33 of socket 32 is arched to provide clearance for membrane crown 19 of end closing plug 117 even when bulged by internal application of pressure. Socket 32 is preferably formed of a diameter slightly less than the external diameter of the tubular barrel 12 so as to require stretching of the skirt 31 when either end of the barrel is received or forced into the socket 32, to assure secure frictional mountation of the cap on the barrel while permitting ready removal thereof. Thus, cap 28 may be fitted on the end 14 of the barrel 12 at the time the latter is charged with solvent and solute protectively to remain so mounted during distribution, desirably to preserve sterile conditions of the closing plug 117 since the latter is to be pierced by the hypodermic needle for hypodermic administration of the medicinal mixture. Preferably, there is provided an interrupted, laterally-extending flange 34 near the bottom of socket 32 to form an abutment for either end of the barrel 12 and limit its movement thereinto, so as to assure provision of sufficient clearance space at the bottom of the socket for accommodating the bulged membrane crown 19 of end closing plug 117.

Thrust cap 28 is designed to permit venting of the gas from mixing chamber 23 with transfer of liquid solvent thereinto and, accordingly, is provided with one or more venting ways or passages leading from the vicinity of the venting perforations 21-21 in membrane crown 19 of end closing plug 117 to atmosphere at the side of the cap so as to avoid being closed off when the end of the cap is engaged by an operator's digit. Such ways may be provided by a plurality of longitudinal grooves 35 formed in

the inner side wall of socket 32, and extending from interrupted flange 34 to the free edge 36 of the skirt 31. The notches in interrupted flange 34 are in communication with the grooves 35 so as to vent gas from the arched bottom surface 33 of socket 32 to atmosphere. A plurality of protuberances or nibs 37 on the arched bottom surface 33 limit outward movement of the crown membrane 19 of end closing plug 117 when bulged under internal pressure, so that portions thereof or its rib 20 will not tend to close off passages for escaping gas. It is to be understood that such thrust cap structure may take various forms as proposed in my co-pending application Ser. No. 187,501 filed September 29, 1950, and entitled "Plural-Compartment Admixing Containers or Vials for Segregated Storage of Ingredients of Liquid Mixtures, and Parts Thereof."

The hypodermic syringe casing structure in which the injection needle or cannula is mounted and which is adapted to receive ampule 11 to serve as the barrel thereof, may be substantially of the form shown at 38 in Figs. 1 to 5 incl. As there shown such syringe casing structure 38 may comprise a tubular base section 39 having an axial bore 40 therein slidably to receive either end of barrel 12 and cut away at 41 on opposite sides to provide a pair of spring legs 42, 42 intervened by a slot 43 having opposed arcuate surfaces adapted to be snapped about mounting shank 44 of a double-ended hollow hypodermic needle or cannula 45 so as to engage the latter snugly. Shank 44 of needle 45 may be provided with an enlargement 46, preferably knurled, received within an enlargement 47 of slot 43 so as to limit inward movement of the needle relative to the casing when the former is thrust into the patient's flesh. The ends of the spring legs 42, 42 carry complementary halves 48, 48 of a plunger or piston post 49 separated by a continuation of slot 43 to receive upper end 50 of needle 45. Plunger or piston post 49 extends upwardly substantially coaxially into bore 40 with arcuate portions 51, 51 of the latter between the legs 42, 42 and post halves 48, 48 being adapted to receive either end of barrel 12 as it is telescoped down into the bore. The upper or inner end 52 of post 49 is preferably formed substantially circular, interrupted only by the needle-receiving slot therein, with the tip of the upper end 50 of the needle extending appreciably therebeyond to pierce means closing the end of the barrel so that contained liquid mixture may be discharged through the hollow needle in hypodermic administration thereof when the barrel is pushed down into the casing. The chamber 26 in end closing cupped plug 25 is of a depth sufficient to receive the upper protruding tip of the needle end 50 so as to avoid piercing that closing plug in the initial manipulations of the ampule during which segregated solute and solvent are brought together in the mixing chamber, as is indicated in Fig. 2. Base 39 is provided with suitable opposed finger-engaging wings 53, 53.

In operation of the embodiment shown in Figs. 1 to 5 incl., a loaded ampule construction, such as 11, is selected by the physician or other technician who is to administer an injection to a patient. It may have protective thrust cap 28 mounted on end 14 of tubular barrel 12, as previously explained. The other end 13 of the barrel is placed in bore 40, and the operator preferably engages syringe casing 39 between his index and middle fingers 54 and 55, with the latter

located beyond or behind the wings 53, 53, and places his thumb 56 against the thrust cap 28, as will be understood from Fig. 4. He then "fires" the ampule by applying mechanical pressure to the thrust cap 28 to cause barrel 12 to be telescoped down into bore 40, as is indicated in Fig. 2, with the structure preferably oriented in the position indicated in Fig. 4. As a result, plunger piston post 49 will cause piston plug 25 to slide up into liquid chamber 24 to develop hydraulic pressure within chamber 57 of partition plug 17 causing its membrane crown 19 to stretch and bulge, thereby opening up perforations or slits 21—21. As a result, liquid solvent 24 is expelled from liquid chamber 22 and squirted or sprayed through the slits 21—21 into mixing chamber 23, there to be brought into contact with medicinal solute 27. Simultaneously, as indicated in Fig. 2, the gas or air in mixing chamber 23 is caused to apply fluid pressure on the inner side of membrane crown 19 of end closing plug 117, i. e., within the chamber 57 of the latter, so as also to cause it to stretch and bulge, opening up its perforations or slits 21—21 to permit escape of the gas or air. The vented gas or air passes from slits 21—21 in end closing plug 117 into the clearance space provided by the arched bottom surface 33 of socket 32 through the notches in abutment flange 34 and via the grooves 35 to atmosphere. Protuberances or ribs 37 on the arched bottom surface 33 prevent any portions of membrane crown 19 from closing off the escape passages of one or more of the slits 21—21.

After the end 13 of barrel 12 has been telescoped down into bore 40 to bring the various parts to the relative positions shown in Fig. 3, it will be found that a predetermined major amount of the body 24 of solvent previously stored in liquid chamber 22 will have been transferred to the mixing chamber 23, leaving only a minor quantity entrapped within chamber 57 of partition plug 17 beyond the inner end of piston plug 25. The parts preferably are so proportioned as to provide a small head 58 of gas or air in the mixing chamber 23, as indicated in Fig. 3, so that a desired aspirating action may be had at the time of injection. As indicated in Fig. 4, the operator then assures thorough admixture of the solvent and solute in the mixing chamber 23 by shaking the assembly end-wise or substantially longitudinally of the ampule 11, as proposed by the double-ended arrow 59 shown in Fig. 4. As a result of the end-wise sloshing of the solvent in the mixing chamber 23 and thorough agitation thereof with the solute solids 27 therein, the desired medicinal liquid mixture or solution intended for hypodermic injection into the patient is formed, all without access to the interior of the dual-chamber barrel while maintaining the sterile condition of the contents of the chambers.

Thereafter, the so-fired ampule 11 is withdrawn from bore 40 of syringe casing 39 and thrust cap 28 is transferred to the other end 13 of the barrel, as shown in Fig. 5. The uncovered end 14 of barrel 12 is then inserted in bore 40 of syringe casing 39, and by application of thrust to thrust cap 28, the tip of upper end 50 of the needle which projects beyond the end 52 of post 49 is caused to pierce membrane crown 19 of end closing plug 117 to provide access to the medicinal mixture in mixing chamber 23. With the operator's thumb and fingers again engaging the thrust cap and syringe casing in a manner similar to that proposed in Fig. 4, the medicinal mixture may then be hypodermically

administered to the patient. Such technique usually includes initial aspiration for a show of blood at the end of the needle in the liquid body of medicinal mixture to assure proper insertion for intravenous injections, or to dictate reinjection for subcutaneous and intramuscular injections. This aspiration may be obtained by pushing the barrel 12 inward slightly to fold membrane crown 19 of end closing plug 117 inward to the position shown in Fig. 5, and then releasing the barrel so that that membrane crown will flex out to a relaxed position, shown in Fig. 3, to create suction. The air head 58 in mixing chamber 23 assures proper obtainment of such aspirating action since, otherwise, if all of the liquid transferred through partition plug 17 into mixing chamber 23 substantially filled the space in the latter, inward folding of the membrane crown 19 of end-closing plug 117 would tend to create hydraulic pressure sufficient to fold inwardly the membrane crown 19 of the partition plug 17, with probable attendant distortion or a backing-up of piston plug 25.

The liquid medicinal mixture in mixing chamber 23 is then expelled therefrom through the hollow needle 45 by piston action of end-closing plug 117 in that chamber when pushed forward by plunger or piston post 49 as barrel 12 is telescoped down into bore 40 with application of forward thrust to cap 28. The membrane crown 19 of partition plug 17 will thus be brought to engagement of the throat of chamber 57 in end-closing piston plug 117 while there is still liquid mixture surrounding the opening in the tip of the end 50 of injecting needle 45. Since injections are usually made with the needle pointing downwardly, it will be understood that the small air head 58 provided in mixing chamber 23 for purposes of assuring attainment of desired aspiration will be kept continuously out of reach of the open upper end of the needle bore during the injection operation.

In Figs. 7 to 10 incl. is shown another embodiment of the hypodermic syringe ampule of the present invention designed particularly for use with another well-known type of hypodermic syringe structure, such as the Cook type disclosed in Patent No. 1,661,818, of March 6, 1928. In that embodiment tubular barrel 12 of ampule 111 has a waist constriction 115 which is preferably of less depth than waist constriction 15 of the ampule 11 shown in Figs. 1 to 5 incl. This is for the reason that in the embodiment shown in Figs. 1 to 5 incl., it is intended that partition plug 17 be maintained in a relatively fixed position at seat 16 at all times, while in the embodiment shown in Figs. 7 to 10 incl., the partition plug is to be held at the relatively larger seat 116 only temporarily during transfer of liquid solvent to the mixing chamber, and thereafter to be dislodged by the piston plug closing off the end of the liquid chamber, so that it may be pushed ahead of that piston plug through the mixing chamber during injection expulsion of liquid mixture from the mixing chamber, as will be more fully explained hereinafter.

As will be seen from Figs. 7 to 10 incl., the assembly shown therein may comprise a tubular syringe casing 139 having a bore 140 which receives loaded ampule 111. Tubular casing 139 is preferably cut away on opposite sides at 60 to provide elongated sight slots, and its outer end is mounted in a socket 61 in head 62 with the bottom of the socket providing an abutment against which end 14 of barrel 12 may be rested.

As is usual, head 62 has a seat or socket 63 therein which receives enlargement 64 of a double-ended needle 145, with the upper end 50 of the latter projecting into socket 61. The other end 65 of tubular casing 139 carries finger-engaging wings 53, 53, and is internally threaded at 66 threadably to receive a closure plug 67 having an axial bore 68 reciprocally receiving plunger 69. Plunger 69 carries a thumb-engaging thrust knob 70 on its outer end, and preferably has in its inner end an internally-threaded socket 71 into which may be threadably engaged an externally-threaded stud 72 carried by piston plug 125 of ampule 111 for temporary connection thereof to permit an aspirating action.

Ampule 111 is also provided with a one-way valved partition, preferably by the employment of pierced crowned cupped plug 17 fitted snugly into constriction seat 116, and its mixing chamber 23 containing medicament solids 27 is closed off at the end, preferably by a reversed cupped plug 217. Plug 217 is needle-pierceable and may be formed of elastic material, such as synthetic or natural rubber, for example, pure gum, and may be of a shape substantially similar to the piston plug 25 of the embodiment shown in Figs. 1 to 5 incl., although it is not intended to have any piston action in the mixing chamber. The liquid solvent chamber 22 on the other side of partition plug 17 is closed off at its end by piston plug 125, which may be a substantially solid body of similar elastic material, having embedded therein during the molding thereof the head of externally threaded stud 72, so that it can be temporarily connected to piston 69.

In operation of the embodiment shown in Figs. 7 to 10 incl., the casing plug 67 is removed with plunger 69 from tubular casing 139, and a loaded ampule 111 is slid thereinto with its mixing chamber end leading. The socketed end of plunger 69 is threadably engaged on stud 72 to connect piston plug 125 thereto and casing plug 67 is threaded into end 65 of the casing. The technician then grasps the syringe structure in a manner similar to that proposed in Fig. 4, depressing or thrusting upward the knob 70 to cause piston plug 125 to be slid forward into liquid chamber 22. As a result, hydraulic pressure is developed in chamber 57 of partition plug 17 to bulge its membrane crown 19, as shown in Fig. 8, thereby opening the slits 21—21 to permit liquid solvent 24 to be sprayed into mixing chamber 23. During transfer of liquid 24 from liquid chamber 22 through partition plug 17 into mixing chamber 23, gas or air contained in the latter will be vented through the bore of needle 145 due to the communication thereof with the interior of the mixing chamber when the needle tip 50 is pierced through the closing membrane of plug 217.

After piston plug 125 has been brought to contact with the rear end of partition plug 17, thorough admixture of solvent and solute in mixing chamber 23 is obtained by shaking the assembly substantially axially or lengthwise of the ampule 111, as proposed by the double-ended arrow 59 in Fig. 9. Then upon insertion of the needle 145 into a patient's flesh, aspiration which may give a show of blood may readily be attained by slight pumping or reciprocating action of plunger 69 to create suction on the interior of partition plug 17 which will develop a similar suction in mixing chamber 23.

The liquid medicinal mixture in mixing chamber 23 may then be discharged through the

needle 145 by forcing the plunger 69 further into syringe barrel 12 with force sufficient first to cause piston plug 125 to unseat partition plug 17 from constricted seat 116 and force it into chamber 23. Due to the elasticity of piston plug 125 and the fact that constricted seat 116 is of a diameter preferably only slightly less than the internal diameter of the remaining portions of barrel 12 or chamber 23, the piston plug may then be forced through and beyond seat 116 into the latter chamber behind the partition plug 17 to cause the latter to be slid forward therein with piston action to expel therefrom liquid medicinal mixture, as is indicated in Fig. 10. Such piston action of partition plug 17, of course, is permitted by virtue of the fact that fluid may be valved therethrough in only one direction, namely, from the liquid chamber to the mixing chamber, and upon application of greater pressure to the outside of its membrane crown 19, it will be folded inwardly securely to keep the perforations or slits 21—21 closed.

It is to be understood that in accordance with the present invention, other types of one-way valving partition means or plug structures which will give similar action may be employed in lieu of the partition plug structure shown by way of example in the present drawings, and that variations of other parts of the embodiments of the ampules and associated syringe constructions depicted may be used to perform similar functions and operations, such as other means for temporarily connecting the piston plug to the plunger. For example, an enlargement on the inner end of the plunger may be snapped into a socket in the elastic body of the piston plug with the socket provided with a constricted opening, and other equivalent means, proposed in my co-pending application Serial No. 658,670, filed April 1, 1946, now Patent No. 2,556,331, dated June 12, 1951.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A hypodermic syringe ampule for storage of segregated ingredients of liquid medicinal solutions and therapeutic preparations manipulatable to accomplish admixture of the ingredients and hypodermically to administer the resulting mixture comprising, in combination, a substantially tubular hypodermic syringe barrel, partition means mounted in said barrel between opposite ends thereof to define from each other a liquid storage chamber and a mixing chamber for storage of the other ingredient, one-way valve means in said partition means operable by hydraulic pressure applied from the liquid chamber side of the latter and preventing reverse flow, piston plug means closing off the liquid chamber end of said barrel and being adapted to be slid

forward therein to expel liquid from said liquid chamber into said mixing chamber, and needle-pierceable plug means closing off the mixing chamber end of said barrel and through which the hollow needle of the syringe is to be thrust to permit expulsion of mixture in the hypodermic administration of the latter.

2. The ampule as defined in claim 1 characterized by the provision of said partition and valve means as comprising a body of elastic material having a portion cupped inward on the liquid chamber side thereof and provided with at least one self-closing perforation extending therethrough openable when the cupped portion is stretched by application of hydraulic pressure developed in said liquid chamber.

3. The ampule as defined in claim 2 characterized by the provision of said cupped portion as a pierced membrane crown in which a slit is openable upon bulging of the crown with application of hydraulic pressure inside thereof and self-closing upon relaxation of the elastic material with approximate equalization of pressure on both sides, said crown being foldable inwardly by application of fluid pressure from the outer side thereof securely to close the slit and prevent back flow of fluid.

4. The ampule as defined in claim 1 characterized by the provision of said needle-pierceable end plug means as an air-venting structure having at least one self-closing opening therein openable by application of fluid pressure only from the mixing chamber side thereof.

5. The ampule as defined in claim 4 characterized by the provision of said needle-pierceable plug means as comprising a body of elastic material having a portion cupped inward on the mixing chamber side thereof and provided with at least one self-closing perforation extending therethrough openable when the cupped portion is stretched by application of fluid pressure developed in said mixture chamber.

6. The ampule as defined in claim 5 characterized by the provision of said cupped portion as a pierced membrane crown in which a slit is openable upon bulging of the crown with application of fluid pressure inside thereof and self-closing upon relaxation of the elastic material with approximate equalization of pressure on both sides, said crown being foldable inwardly by application of pressure from the outer side thereof securely to close the slit.

7. The ampule as defined in claim 6 characterized by said needle-pierceable plug as being slidable into said mixing chamber to serve as a piston plug for discharge of liquid contents through a hollow hypodermic needle when thrust therethrough.

8. The ampule as defined in claim 7 characterized by the provision of said partition means and said needle-pierceable plug means as substantial duplicates each comprising a cupped plug of elastic material having a pierced membrane crown with both oriented in the same direction so that the crown of the partition plug projects into said mixing chamber and the crown of the other projects out away from said mixing chamber.

9. A hypodermic syringe ampule for storage of segregated ingredients of liquid medicinal solutions and therapeutic preparations manipulatable to accomplish admixture of the ingredients and hypodermically to administer the resulting mixture comprising, in combination, a substantially tubular hypodermic syringe barrel,

a crowned cupped plug of elastic material having the closed end thereof formed as a pierced membrane crown and mounted in said barrel between opposite ends thereof to define from each other a liquid storage chamber and a mixing chamber for storage of the other ingredient, said partition plug having its crown projecting into said mixing chamber to provide a one-way valve with the perforations therein being openable by hydraulic pressure applied interiorly from said liquid chamber and self-closing upon relief of such pressure, said crown being foldable inwardly by application of pressure to the mixing chamber side thereof to assure maintenance of closure of the perforations for preventing reverse flow of fluid, a cupped piston plug closing off the liquid chamber end of said barrel with a body of liquid confined in said liquid chamber to be expelled through said partition plug into said mixing chamber when said piston plug is slid forward in said liquid chamber, said piston plug being cupped inward on its outer side to avoid being pierced by an end of a hypodermic needle which may project inward from plunger means of hypodermic syringe structure adapted to utilize said ampule, and a similar crowned cupped plug closing off the mixing chamber end of said barrel with the other ingredients confined in said mixing chamber and with the pierced crown of the latter plug extending out away from that end of said barrel to permit venting of gas from within said mixing chamber, the crown of said venting plug being pierceable by such hypodermic needle with that plug being slidable into said mixing chamber to serve as a piston for discharge of liquid mixture through the needle.

10. The ampule as defined in claim 1 characterized by the provision of said partition means in the form of a piston plug frictionally mounted in said barrel temporarily to be held substantially fixed while the end-closing piston plug means is slid forward in said liquid chamber toward it to expel the liquid through it into said mixing chamber while permitting dislodgement from its fixed partitioning location by the end-closing piston plug means with further advance of the latter into said mixing chamber, said partitioning piston plug being adapted to expel liquid mixture from said mixing chamber as it is advanced therein by said end-closing piston plug means.

11. The ampule as defined in claim 10 characterized by the provision of said barrel with a waist constriction to form an internal seat for said partitioning piston plug of at least slightly less diameter than that plug frictionally to hold it securely in position temporarily while permitting that plug to be of a diameter slightly larger than and close to that of said mixing chamber to permit effective liquid-expelling piston action of ease in the latter.

12. The ampule as defined in claim 11 characterized by the provision of said barrel with substantially uniform diameter except at the waist constriction, the diameter at the latter being only slightly less with the end-closing piston plug means being formed of elastic material to permit it to be forced into said mixing chamber behind said partitioning plug to cause the latter to expel liquid therefrom by piston action.

13. The ampule as defined in claim 10 characterized by the provision of said partitioning piston plug as comprising a body of elastic material having a portion cupped inward on the liquid chamber side thereof and provided with at least

one self-closing perforation extending there-through openable when the cupped portion is stretched by application of liquid pressure developed in said liquid chamber.

14. The ampule as defined in claim 13 characterized by the provision of said cupped portion as a pierced membrane crown in which a slit is openable upon bulging of the crown with application of hydraulic pressure inside thereof and self-closing upon relaxation of the elastic material with approximate equalization of pressure on both sides, said crown being foldable inwardly by application of fluid pressure from the outer side thereof securely to close the slit and prevent back flow of fluid.

15. The ampule as defined in claim 14 characterized by the provision of said barrel with a waist constriction to form an internal seat for said partitioning piston plug with the remainder thereof being of substantially uniform diameter and the diameter at said waist constriction being only slightly less and with the end-closing piston plug means being formed of elastic material to permit it to be forced into said mixing chamber behind said partitioning plug to cause the latter to expel liquid therefrom by piston action.

16. The ampule as defined in claim 15 characterized by the provision of said end-closing piston plug means with means temporarily to connect it to reciprocative syringe plunger means to permit that piston plug means to be moved back and forth in said mixing chamber with aspirating action by said plunger means.

17. The ampule as defined in claim 10 characterized by the provision of said end-closing piston plug means with means temporarily to connect it to reciprocative syringe plunger means to permit back and forth aspirating action of the former by the latter.

18. A hypodermic syringe ampule for storage of segregated ingredients of liquid medicinal solutions and therapeutic preparations manipulatable to accomplish admixture of the ingredients and hypodermically to administer the resulting mixture comprising, in combination, a substantially tubular hypodermic syringe barrel of substantially uniform diameter throughout the major portion thereof having an internal seat intermediate its ends provided by a circumambient waist constriction, a crowned cupped plug of elastic material mounted in said internal seat so

as to define from each other a liquid storage chamber and a mixing chamber for storage of the other ingredients and having a pierced membrane crown projecting into said mixing chamber to provide a one-way valve with the perforations therein being openable by hydraulic pressure applied interiorly from said liquid chamber and self-closing upon relief of such pressure, said crown being foldable inwardly by application of pressure to the mixing chamber side thereof to assure maintenance of closure of the perforations for preventing reverse flow of fluid, said internal seat being only slightly smaller than that of the remainder of said barrel frictionally to hold said partition plug in position only temporarily with the latter of a diameter slightly larger than the diameter of said mixing chamber so as to be slidable therein with piston action for discharge of liquid mixture contents, a piston plug of elastic material of a diameter only slightly greater than the internal diameter of said liquid chamber closing off the outer end of the latter with a body of liquid confined therein to be expelled through said pierced partition plug into said mixing chamber when said piston plug is slid forward through said liquid chamber, said partition plug being dislodgeable from said constricted seat by said piston plug with the latter being squeezeable through that seat into said mixing chamber therein to push said partition plug ahead of it to serve as a mixture-expelling piston plug, means temporarily to connect said end-closing piston plug to reciprocative syringe plunger means, and a needle-pierceable plug closing off the outer end of said mixing chamber with the other ingredients confined therein.

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