My present invention involves improvements in the construction of ampoules of the class designed to be inserted into the barrel or body of a hypodermic syringe and from which a medicament may be expelled for administering to a patient.

More specifically, the ampoule of my invention is of the type in which a medicament, preferably in solid or powdered form, is contained in a medicament chamber, and by movement of a certain member or members of the ampoule is caused to be liquefied preliminary to administering said medicament by the operation of the syringe.

An object of my invention is to simplify the operation of causing the mixing of the water with the medicament in the preparation of the ampoule for the expelling of medicament in liquefied form. It has been proposed heretofore to use ampoules in which the dry medicament is admixed with a liquefying agent, an action brought about by the same plunger which causes ejection of the medicament, and the ejection and mixing have occurred simultaneously. This is a somewhat dangerous practice for ampoule construction, for the first fraction of solution injected is at times practically free of medicament, whereas the last portions will be too concentrated. Furthermore, oftentimes all of the solution may be injected before all of the medicament has become dissolved, and therefore there is no uniformity in the solution administered. Thus, if the solution were used for different patients, different concentrations of the solution might be administered to such patients, and obviously, this is not the desired result. With my present improved ampoule construction the foregoing difficulties are obviated.

Another disadvantage incident to the use of present types of ampoules or cartridges of the class of my invention arises in the fact that there is either a diaphragm between the medicament and the solution, which diaphragm has to be dislodged by movement in the ampoule, or there is a trap-door diaphragm which is required to be opened, or a plug required to be pushed out in order that the solution may be mixed with the medicament. In such types of construction the replaceable diaphragm, movable trap-door diaphragm, or plug, when forced out of normal position, interfere with the travel of the medicament ejecting or expelling piston or plunger, and prevent the complete travel of the latter in such a way as to prevent administration of considerable of the medicated solution.

It is a further object of my invention to avoid the disadvantages of the types of construction last referred to.

With the foregoing objects in view I have devised a construction of syringe ampoule or cartridge which is water-tight, which is greatly simplified in regard to the number and formation of the several parts, and therefore inexpensive to manufacture, which affords a perfect seal between the medicament or solution compartment containing the solution to be mixed with the medicament, and which ampoule is very easily insertable into the syringe for use. Moreover, in my construction I am enabled to effect the liquefying of the medicament without requiring a great amount of movement of the internal parts of the ampoule.

Another object of my invention has been to produce a novel construction of ampoule wherein the dry medicament is not only enabled to be liquefied in the advantageous manner previously referred to, but in which, also, gas may be generated providing the pressure medium for the expulsion of the medicament through the syringe instrumentalities, including the needle, by movement of a special expelling or ejecting plunger forming a part of the ampoule unit. My invention has to do especially with detail improvements in relation to the type of ampoule last referred to, one which is readily adapted to be used in conjunction with a special construction of syringe of my invention disclosed in my pending application for patent, Serial No. 361,781, filed October 18, 1940, now Patent Number 2,390,246.

A full understanding of my invention will be had upon reference to the accompanying drawings, in which modified constructions of my ampoule are shown, and also in which drawings—

Figure 1 is a longitudinal sectional view of my ampoule in the condition in which it is manufactured and supplied to the user for employment in the syringe, by which the medicament in the ampoule is to be administered.

Figure 2 is a view similar to Figure 1, showing the medicament mixing plunger as when it has been moved in order to cause the medicament to be mixed with the liquefying water, and showing the expelling plunger just about in the position in which it displaces the closure between said last mentioned plunger and the liquid chamber containing the liquid for generating the gas. In this view dotted lines show the syringe instrumentalities that may be used for moving the mixing plunger initially to cause the medicament to be placed in solution.
Figure 3 is a view somewhat similar to Figures 1 and 2, but showing the medicament expelling plunger as when it has been forced by the pressure of the gas contained in the ampoule to a position expelling a large portion of the medicament.

Figure 4 is a view similar to Figure 1, but illustrating a somewhat modified form of my invention.

Figure 5 is a transverse sectional view taken about on the line 5—5 of Figure 3.

Figure 6 is a transverse sectional view taken on the line 6—6 of Figure 2.

Describing my invention specifically, and referring to Figure 1 particularly, my ampoule in the state of its completed manufacture is constructed of the following primary parts: the tube 1 of glass, the mixing plunger 2 which may be of plastic or similar material and which is provided with a medicament chamber 3 consisting of a hollow or tubular extension of the body of the plunger 2, a rubber or similar plug 4 for the outer end of the mixing plunger 2 and seated in a recess in said end so as to provide a closure for the adjacent end of the medicament chamber 3. Additionally, my ampoule construction comprises the expelling plunger 6 having the skirt portion 6a extending toward the mixing plunger 2, the diaphragm or the partition 7 having the closure or plug 8 for normally closing a central opening 9 of said diaphragm or partition 7, and an end closure member 10 which is of the same construction, preferably, as the expelling plunger 6 with its skirt 6a, so that these parts are interchangeable in the manufacture of the ampoule.

It is notable that, in addition to the foregoing parts, 1, provide a gasket and guide ring 11 fixedly mounted in the tube or body 1, so that in the normal position of parts as seen in Figure 1, certain ports or openings 12 at the sides of the inner end of the medicament tubular extension 3 are closed by the said gasket or guide rings 11. In the medicament chamber 3 of the member 3 there will be received dry medicament, designated 13, and in the space or chamber provided between the expelling plunger 6 and the fixed partition 7 there will be received a gas generating substance in tablet or powdered form, as designated at 14.

In the construction as above set forth, it is contemplated that the parts 4, 11, 1, 6a, 1, 8, and 10 shall be made preferably of rubber. The parts 11, 7, and 10 are immovably imprinted in the glass to be 6.

When the mixing plunger 2 is moved sufficiently that the parts 12 are disposed to the right of the guide or gasket ring 11 as seen in Figure 1, the liquid designated 15, and contained in the space between the parts 3, 11, and 6, will be free to enter the medicament chamber and liquify the dry medicament 13 in the latter.

When the expelling plunger 6 is moved to the right as seen in Figure 1, from the position shown in said figure, the plug 8 will be displaced from the opening 9 of the diaphragm 7 and instead will be displaced from the plug 8, diaphragm 7, and member 10, will act upon the gas generating substance 14 and convert the latter into gas under pressure in the chamber between the parts 7, 8, and 10. The liquid in the chamber between the parts 7, 8, and 10 is designated at 16.

I will now describe the operation of my invented ampoule under practical conditions of use in a syringe.

The syringe with which my ampoule may be used is one of the construction of the special operating parts of which is illustrated in Figure 2 of the drawings by dotted lines. Such a syringe will include a barrel or body into which the ampoule is introduced, and when introduced, the ampoule is given a slight longitudinal movement to cause a hollow needle 18 of the syringe to penetrate or puncture the closure 4, and at the same time an abutment member 23 in which said needle 18 is located engages the rubber plug or closure 4 and causes the mixing plunger 2 to be forced inwardly into the tube 1 of the ampoule so that the ports or openings 12 of the medicament containing extension 3 of the plunger 2 are carried to the right beyond the gasket and guide ring 11. This permits the distilled water or liquid 15 to enter the medicament chamber 8 and liquify the dry medicament in the latter. As a result of this action, the mixing plunger 2 is disposed in the position shown in Figure 2, and by reason of the movement of said plunger and its member 3, and the fact that initially, incident to such movement, the liquid 15 is incompressible, results in the transmission of the movement of the plunger 2 and part 3 to the expelling plunger 6 for shifting of the latter rightward into the position shown in Figure 2 also. The rightward movement of the expelling plunger 6 causes it, by impact, to displace the plug or closure member 8 from the diaphragm or partition 7. The portion 15 between the parts 7 and 10 is permitted to act upon the dry gas generating substance 14 to generate gas between the parts 7 and 10, which gas places the expelling plunger 6 under pressure ready to expel the now liquefied dry medicament between the plunger 2 and the mixing plunger 6.

It will be seen from the foregoing that the medicament is still trapped in the ampoule along with the gas under pressure, and has thus far not been administered. However, referring to Figure 2, it will be seen that the abutment 23 extends from a valve chamber 18 containing a flexible tubular valve 20 which is normally closed by the plunger 22 of a spring actuated lever 21. In alignment with the opening through the tubular valve 20 is the penetrating needle 11 adapted to be introduced to the flesh or person to whom the medicament is to be administered. Thus, when the lever 21 is depressed so as to open the valve 20, the now liquefied medicament in the space between the expelling plunger 6 and the mixing plunger 2 will be expelled from the ampoule through the puncturing needle 11, the valve 20, and the penetrating administering needle 17.

In this operation, of course, the gas which is generated in the chamber between the parts 10 and 6 acts, by its pressure, upon the expelling plunger 6 and causes the latter to move toward the mixing plunger 2 to some such position as shown in Figure 3, dependent upon how long the lever 21 is depressed to maintain the valve 20 open. In accomplishing its expelling function the plunger 6 is assisted by the skirt 6a because the latter is adapted to enter the space between the medicament chamber extension 3 and the interior wall of the tube 1. Said skirt member 6a is of sufficiently narrow cross section as not to close the communication between the chamber 5 and the space between the parts 6, 2, and 3. The guide or gasket ring 11, the partition 7, and the closure member 10 are always stationary relatively to the tube 1.

Figure 3 shows the condition of the ampoule as when the expelling piston or plunger 6 has moved to expel a portion of the liquefied medicament.
through the administering means of the syringe.

Different constructions of syringes may be adopted as long as the essential features of the syringe permit of the operation of the parts in the manner which I have described in reference to my ampoule of Figures 1 to 3 inclusive, Figures 5 and 6.

I now refer to Figures 7 to 9 of my drawings, whereinafter I shall show a modification of my invention, and in this modification those parts which are the same as used in my previously described construction are designated in the same manner by like reference characters.

In this modification, however, I provide an expelling plunger 32. In this instance the expelling plunger is a rubber ring 32, fastened securely to a tubular chamber 26, containing the dry gas generating chemical. Integral with this tubular chemical containing chamber is a cylindrical extension 24. This is the part which will telescope over chamber 3 to expel medicament liquid after the syringe valve is opened.

This cylindrical extension has a central orifice 26a normally closed by a rubber stopper 25. The expelling plunger 32 is movable rightward in the same manner as previously described, and the rubber plug or member 4 is punctured. This permits the distilled water or liquid 15 to enter the medicament chamber 8 and convert the medicament into solution. Simultaneously with the movement of the plunger 2 to the right, as seen in Figure 4, the liquid 15, by being compressed, is caused to force the plunger 32, along with its entire assembly 24, 25 and 26 to the right. The cylindrical tube 26 forms the closure member 36 and displaces it between the parts 28 and 30 which space contains the liquid for acting on the dry gas generating substance 14 in the member 26, generating sufficient gas under pressure to act upon the plug or closure 25 and the expelling plunger assembly 32, 25, 26, 24 to perform the medicament expelling function when, by operation of valve means such as 20 in Figure 2, the medicament is released to flow from the medicament chamber and portion of the tube in which the liquid medicament may be disposed.

In the modified construction of Figure 4, therefore, it will be understood that the mixing plunger 2 moves to the right, as before, and the expelling plunger assembly 24, 32, 25, 26, 24 first moves to the right, the mixing of the medicament, and then under the pressure of the gas generated, will move to the left upon release of the medicament to flow out of the ampoule.

It will be apparent that in reference to both the modified embodiments of my invention, the various parts may be assembled in a very easy manner, are simple of manufacture, and enable the ampoule to be produced at a relatively low cost, thus obtaining the advantages first outlined herein as attributable to my construction.

In the syringe in which my ampoule is used, one such as is disclosed in my identified copending application, the syringe is made to provide an abutment to engage the outer face of the closures 10 or 20, as the case may be, so this part will be held from outward displacement, when the gas under pressure is generated in the gas chamber of the tube or body 1. Likewise, after the medicament of the ampoule is administered, and before the ampoule is thrown away, the part 10 or 20, is punctured by a hollow needle to permit the gas to exhaust from the ampoule, so no possibility of exploding of the latter, by dropping or mishandling, will arise.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. An ampoule comprising a tubular body, a mixing plunger at one end of the body, movable thereininto, and comprising a puncturable plug, a stationary closure at the other end of the body, said mixing plunger having a hollow portion forming a medicament containing chamber, said chamber having ports for establishing communication between the interior of the chamber and the space within the body normally closed, said ports in the body normally closed ports until the mixing plunger and chamber are moved inwardly of the body, and a medicament ejecting plunger spaced from the mixing plunger and providing a space in the body for a medicament liquefying agent.

2. An ampoule comprising a tubular body, a mixing plunger at one end of the body, movable thereininto, and comprising a puncturable plug, a stationary closure at the other end of the body, said mixing plunger having a hollow portion forming a medicament containing chamber of smaller diameter than the said plunger and movable therewith and extending inwardly therefrom, said chamber having lateral ports for establishing communication between the interior of the chamber and the space within the body normally closed, said ports until the mixing plunger and chamber are moved inwardly of the body, and a medicament ejecting plunger spaced from the mixing plunger and providing a space in the body for a medicament liquefying agent.

3. An ampoule as claimed in claim 1, in which said port closing member is a gasket ring surrounding the medicament chamber.

4. An ampoule as claimed in claim 1, in which the chamber is smaller in diameter than the mixing plunger and spaced from the inner walls of the body, and the ports closing member is a ring surrounding the medicament chamber.

5. An ampoule as claimed in claim 2, in which the medicament chamber and the walls of the body for medicament expelling action.

6. An ampoule as claimed in claim 2, in which the medicament chamber and the walls of the body for medicament expelling action.

7. An ampoule as claimed in claim 2, combined with a partition having an opening therethrough and spaced from the ejecting piston on the side opposite the mixing plunger to form a compartment for a gas generating substance, a gas generating substance in the last mentioned compartment, a closure for the opening of the partition.
displaceable from the opening, liquid between the medicament chamber and ports closing member, and the ejecting plunger, and liquid between the partition and its opening closure, and the stationary closure of the body.

8. An ampoule as claimed in claim 1, combined with a partition having an opening therethrough and spaced from the ejecting piston on the side opposite the mixing plunger to form a compartment for a gas generating substance, a closure for the opening of the partition displaceable from the opening by abutment with the ejecting piston, liquid between the medicament chamber and ports closing member, and the ejecting plunger, and liquid between the partition and the stationary closure of the body, the ejecting plunger having a portion for engaging the closure of the partition, for opening the compartment for the gas generating substance to the last mentioned liquid, and means sealing the last compartment from the liquid between the mixing and ejecting plungers.

9. An ampoule comprising a tubular body, a first mixing plunger at one end of the body movable inwardly in the body and comprising a needle puncturable plug, a stationary closure closing the other end of the body, a second medicament ejecting plunger in the body between and spaced from the first plunger and the closure to provide a liquid space between it and the first plunger and a pressure space between it and the closure, one of the said plungers having a medicament holding chamber having means to establish communication between it and the liquid space between the first plunger and the ejecting plunger, the first plunger being movable inwardly in the body to act on said liquid and to effect movement of the medicament chamber while the said stationary member is stationary, whereby to open up the medicament chamber for receiving the said liquid for providing fresh medicament to be administered from the ampoule.

10. An ampoule comprising a tubular body, a first mixing plunger at one end of the body movable inwardly in the body and comprising a needle puncturable plug, a second medicament ejecting plunger in the body spaced from the first plunger, one of said plungers having a medicament holding chamber having means to establish communication between it and the space between said plungers, a member normally stationary in the body and positioned to close the medicament chamber against the communication mentioned, a liquid between said plungers, the first plunger being movable inwardly in the body to effect movement of the medicament chamber while the said stationary member remains stationary to open communication of the medicament chamber to the liquid space for producing freshly made medicament, and means for effecting ejecting movement of the ejecting piston.

MARVIN L. FOLKMAN.

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