

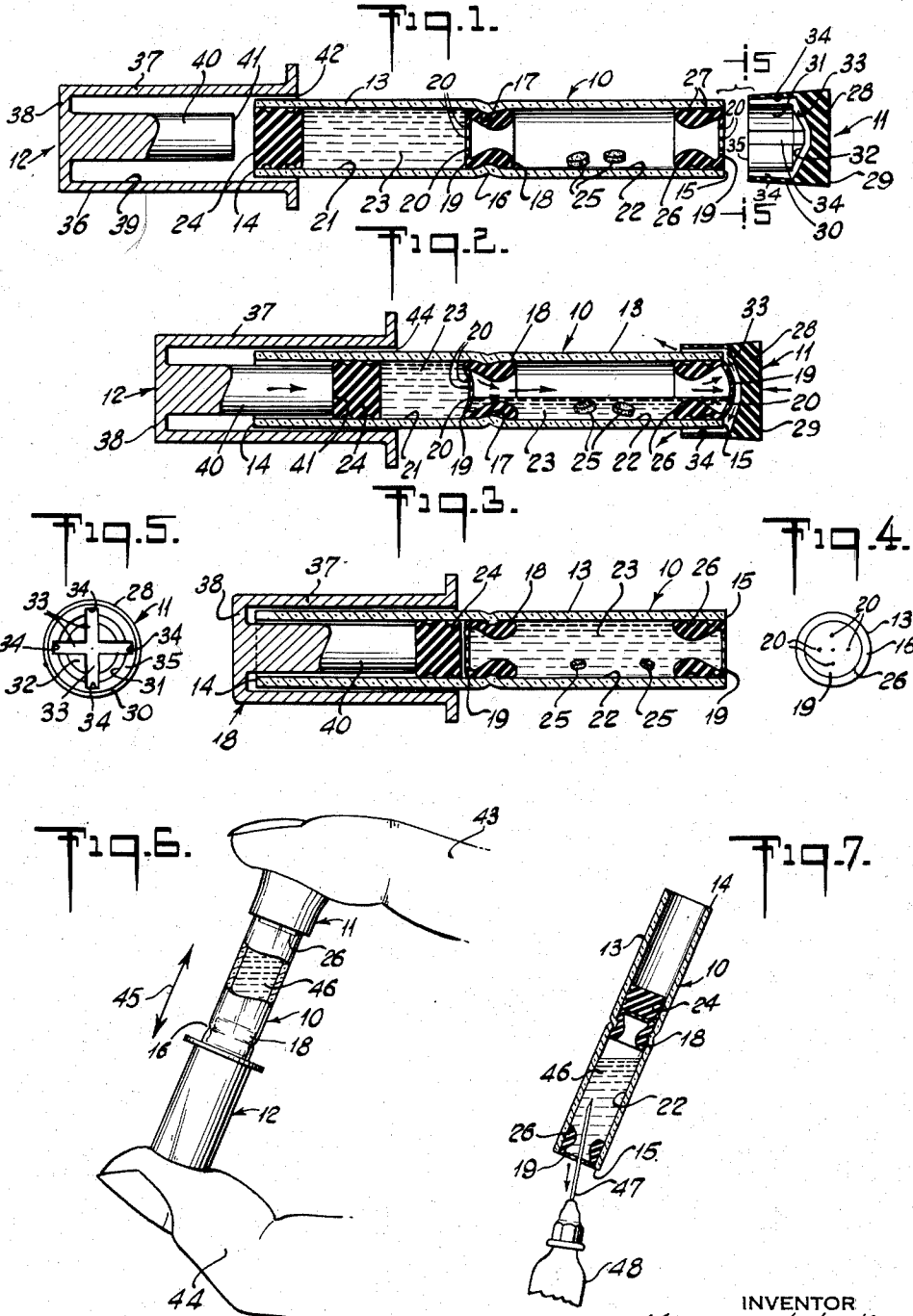
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PLURAL-COMPARTMENT ADMIXING CONTAINER OR VIAL

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## PLURAL-COMPARTMENT ADMIXING CONTAINER OR VIAL

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The present invention relates to containers or vials for segregated storage therein of different ingredients of solutions and liquid mixtures so constructed as to permit at will admixing of the ingredients without necessitating opening of the containers or vials and, more particularly, to such structures desirably adapted to preservative storage of segregated liquids, medicaments and liquid vehicles or solutes and solvents to be admixed for production of medicinal solutions and therapeutic preparations, other liquid mixtures or solutions, and the like.

A general object of the present invention is to provide such a container or vial structure, the parts of which are of simple construction, readily produced economically on a mass basis and easily assembled to form such a plural-compartment container or vial with chambers thereof charged or loaded with the different ingredients in a manner which assures sterility if desirable; the structure featuring a tubular container or vial body having a valve-equipped partition intermediate its ends through which passage of liquid from one chamber to the other for admixture of contents may be had by the application thereto of a differential in fluid pressure easily and effectively applied by manipulations external of the chambers with continued isolation of the materials by the container or vial, so as to avoid any undesirable interference with sterile conditions which may exist.

A more specific object of the present invention is to provide such container or vial structure in which is featured a valving partition to define one chamber from another for segregation of different materials in the chambers, the valve means of said partition being self-closing and openable by application of fluid pressure to one side thereof, readily applied hydraulically when one chamber contains a liquid to be transferred through said partition to the other chamber, the structure being such as to permit creation of the hydraulic pressure by simple manual operation exterior of the chambers while effectively maintaining them closed.

Another object of the present invention is the provision of such container or vial structure in which the valving partition comprises a simple elastic body having at least one self-closing perforation or puncture slit therein openable when said elastic body is distorted by application of fluid pressure to one side thereof.

Further objects of the present invention are to provide in such container or vial structure a pressure-operable, fluid venting end closure for the mixing chamber to vent fluid, such as air,

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therefrom as liquid is transferred thereto from the other chamber; to close the mixing chamber with means, such as said venting closure, which is needle-pierceable to allow ready withdrawal of mixture; and to provide as means for creating the valve-operating hydraulic pressure a piston plug for closing the end of the liquid chamber.

And another object of the present invention is to provide a thrust cap structure removably-mountable on the end of said container or vial from which fluid, specifically air, is to be vented, with venting ways formed therein to permit efficient fluid escape at the sides thereof while its top end is engaged or covered, such as by one's finger, for application of biasing force thereto or to push against it.

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 drawing.

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 drawing, in which:

Fig. 1 is a longitudinal or axial section, to an enlarged scale, of a loaded dual-chamber embodiment of the vial structure of the present invention, showing also in axial section the pressure-applying or thrust cap to be fitted over one end thereof and depicting partly in section and with parts broken away a piston cup to be telescoped over the other end, such cap and piston cup being employed in accomplishing admixture of segregated ingredients;

Fig. 2 is a sectional view similar to Fig. 1, showing the thrust cap mounted on one end of the vial structure and the piston cup being telescoped over the other end to accomplish transfer of liquid from one chamber to another as graphically indicated, but not shown in the preferred position of orientation indicated in Fig. 6;

Fig. 3 is a sectional view similar to Figs. 1 and

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2, but with the thrust cap omitted or removed, and with the piston cup completely telescoped up over the liquid chamber end of the vial structure to the "fired" position thereof or position of substantially complete transfer of liquid from its storage chamber to the second chamber;

Fig. 4 is an elevational view of the right end of the vial structure shown in Fig. 3;

Fig. 5 is an inside end view of the pressure-applying or thrust cap as viewed substantially from line 5—5 in Fig. 1;

Fig. 6 is a side view of the structure shown in Fig. 2, substantially to scale with parts broken away and in section, showing the piston cup pushed up to the substantially complete discharge or "fired" position shown in Fig. 3, parts of an operator's thumb and finger being indicated in the preferred positions of orientation for manipulations to effect, first, intercommunication between the chambers, and then, admixing of the ingredients which had been segregated in the separate chambers, including shaking to assure intimate mixture thereof; and

Fig. 7 is a longitudinal or axial section of the "fired" vial structure shown in Fig. 6 after complete admixture by shaking of the ingredients of the liquid mixture or solution, showing the pressure-applying or thrust cap and the piston cup removed therefrom and a hollow hypodermic needle thrust up through an end closure into the mixing chamber for withdrawal of mixture contents.

Referring to the drawing, in which like numerals identify similar parts throughout, it will be seen that a preferred embodiment of the present invention, there illustrated by way of example, comprises a vial structure 10, a pressure-applying or thrust cap 11 adapted to be fitted over one end, and a piston cup 12 adapted to be fitted over the other end during the manipulations of "firing" and mixing of stored segregated ingredients of a liquid mixture or solution. The vial structure 10 comprises a substantially cylindrical tube 13 of suitable material, preferably transparent to permit inspection and observation of contents and internal actions, such as glass, a suitable plastic, or the like. Tube 13 preferably is provided between its ends 14 and 15 with a waist constriction 16 to form a circular internal seat 17 of a diameter substantially less than the internal diameter of the remainder of the tube.

Transversely-extending partition means are mounted in the tube on the seat 17 and, as shown in the drawing, preferably comprises a cupped plug 18 formed of suitable resilient or elastic material, such as synthetic or natural rubber, for example, pure gum, which, in the relaxed condition before mounting in the tube 13, preferably is substantially cylindrical and of a diameter appreciably greater than the diameter of the internal seat 17, so that when forced into the latter it will be constricted to the shape shown in the drawing to be there frictionally retained and to resist dislocation by application of a differential in pressure to opposite sides thereof. The cupped partitioning plug 18 includes a head portion 19 formed as an integral part of the plug, preferably in the form of a substantially flat elastic membrane through which are provided a plurality of self-closing perforations or puncture slits 20—20. Membrane 19 may be readily provided with perforations or puncture slits 20—20 by piercing it at a plurality of points with a needle. Perforations or puncture slits 20—20 serve as self-valving passages or open-

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ings, remaining securely closed when the pressures on opposite sides of the membrane 19 are substantially equal due to the natural constrictive characteristic of the material, and opening up when greater pressure is applied to one side of the membrane to cause the latter to bulge away from the high pressure side with attendant stretching. Partition plug 18 divides tube 13 into a pair of chambers, chamber 21 at one end preferably being adapted to store liquid ingredient, and a second chamber 22 at the other end adapted to contain another ingredient of the mixture or solution to be formed and serve as a mixing chamber therefor.

A body 23 of liquid ingredient which, by way of example, may be a suitable solvent or distilled water in which a medicament solute is to be dissolved to form a liquid solution, is placed in liquid storage chamber 21 substantially to fill the same when the end 14 of the tube 13 is closed off by means of a piston plug 24. Piston plug 24 may, as is well recognized in this art, be formed of suitable resilient or elastic material, such as synthetic or natural rubber, for example, pure gum, and slightly oversize snugly to engage the inner walls of the tube so as to serve as a secure liquid seal at the end thereof while being slidable in the liquid storage chamber 21 so as to discharge the liquid contents therefrom with piston action. It is to be understood, of course, that piston plug 24 may take any suitable form other than that shown, such as various other types known in the prior art.

In the mixing chamber 22 is placed the other ingredient of the liquid mixture or solution to be formed, and may comprise a solid body or bodies 25 of medicament solute in powder or pill form, with the remainder of the space in that mixing chamber being occupied by sterile gas, such as air. The end 15 of tube 13 is closed off by suitable plug means 26 of any suitable structure which will permit automatic valving from chamber 22 of the contained gas as liquid 23 is transferred from liquid storage chamber 21 thereto. Such closing plug 26 must, of course, be of such structure as to assure effective sealing of chamber 22 while permitting venting of gas therefrom when liquid 23 is being transferred thereto. Accordingly, closing plug 26 preferably is a substantial duplicate of partition plug 18, having either a smooth outside cylindrical surface, or, if desired, a plurality of circumambient grooves 27, 27 formed therein as shown, and, if desired, one or more such grooves may be provided in the external cylindrical surface of the partition plug. The closing plug 26 is provided with a perforated end or top portion, preferably in the form of pierced membrane 19, having one or more perforations or puncture slits 20—20 therein.

Pressure-applying or thrust cap 11, adapted to be fitted or telescopically slid down or inward over end 15 of tube 13, preferably is formed as a molded body of synthetic or natural rubber, or the like, having a top portion or end 28 providing an end surface 29 for engagement by one's finger for application of biasing force thereto or push thereagainst. Cap 11 preferably has formed integral with the top portion 28 a circumambient flange or skirt 30 surrounding an axial socket 31 preferably provided with a crowned end or bottom surface 32. Socket 31 is preferably formed of a diameter slightly less than the external diameter of the end 15 of tube 13 so as to require stretching of the skirt 30 when the tube end is received or forced telescopically into the socket

31, to assure secure frictional mount of the cap 11 on the tube end while permitting ready sliding removal thereof. Thus the cap 11 may be fitted protectively on an end of the vial structure 10 at the time the latter is charged with ingredients material. Cap 11 may remain in such protective position during distribution of the vial structure and until the user is ready to fire the structure and remove the mixture contents therefrom. Consequently, cap 11 may thus serve to preserve sterile conditions of the closing plug 26, which is important to the use of the vial structure of the present invention for distribution of therapeutic and medicinal ingredients, particularly since when the mixture contents is designed for hypodermic injection it is intended that the syringe needle be thrust through the end of that plug closing off the mixing chamber 22 for withdrawal therefrom of a dosage.

The thrust cap 11 is designed to permit venting of the gas from chamber 22 with transfer of liquid 23 thereinto and, accordingly, is provided with one or more venting ways or passages leading from the vicinity of the venting perforations 20 in the closing plug 26 to atmosphere at the side of the cap so as to avoid being closed off when the end of the cap is engaged by one's finger. Such ways may be provided by a plurality of grooves 33 formed in the bottom or end surface 32 of socket 31 and extending substantially radially from the center thereof to the skirt or flange 30. Grooves 33 communicate with the atmosphere preferably via longitudinally-extending grooves 34-34 formed in the inner side wall of socket 31 to terminate at the free outer edge 35 of the skirt, as shown. Thus, it will be seen that the inner side wall of socket 31 is provided with contact lands intervened by venting ways for escape of fluid or gas, and it is to be understood that such contact lands may be provided within the scope of the present invention in a plurality of forms other than that shown by way of example in the drawings.

The piston cup 12 may comprise a socket member 36, having a cylindrical side wall 37 and an end or bottom wall 38 to form a socket 39 in which is coaxially mounted a piston post 40, preferably formed integral with the bottom wall as shown, and may be molded of any suitable material, such as a synthetic resin or plastic. The end 41 of piston post 40 is preferably located down in circular socket 39 an appreciable distance from the mouth 42 of socket member 36, so that the initial portion of the socket will serve as a guide for the end 14 of vial tube 13 before any piston action is applied to piston plug 24.

In operation of the embodiment shown in the drawing, a loaded vial construction, such as 10, is selected from a supply, such as by a physician or other technician in the case of administering an injection to a patient. The loaded vial construction 10 as distributed, may have thrust cap 11 mounted on the end 15 of the vial tube 13 for protective purposes, as previously explained. The end 14 of the vial tube 13 is placed in the mouth of socket 39, as indicated in Fig. 1, and the combination may then be grasped by the technician between his index finger 43 and thumb 44, in the manner and approximate orientation indicated in Fig. 6. He then applies mechanical pressure to the piston cup 12 as he biases the thrust cap 11 so as to telescope the piston cup up onto the liquid chamber end of the tube 13, as indicated in Fig. 2, but preferably with the vial 10 oriented as indicated in Fig. 6 so that as

liquid is displaced into mixing chamber 22 it will not escape with air through the venting closure 26. As a result, piston plug 24 is forced or slid forward by piston post 40 into liquid chamber 21 to develop fluid pressure against partition membrane 19 to apply thereto a differential in pressure greater on the liquid chamber side than on the other side. As a result, membrane 19 will be bulged with attendant stretching out away from the liquid chamber side and in toward the mixing chamber side with attendant opening of the perforations or puncture slits 20 to permit liquid 23 to squirt therethrough into the second chamber in which the solids 25 are housed. Simultaneously, as indicated in Fig. 2, the gas or air in the mixing chamber 22 is caused to apply fluid pressure on the inner side of membrane 19 of closing plug 26 causing it to bulge outwardly thereby opening its perforations or puncture slits 20. Due to this bulging of membrane 19 of closing plug 26, the bottom or end wall 32 of socket 31 in thrust cap 11 is preferably crowned or coned as previously indicated, so as to accommodate such bulging. As liquid 23 thus is transferred in this manner from liquid chamber 21 into the mixing chamber 22, the gas or air in the latter will be displaced and vented out through the valved closing plug 26 to the atmosphere via the ways provided by the intercommunicating passages 33 and 34.

After the piston cup 12 has been substantially completely telescoped up about the liquid chamber end of vial 13, to bring the piston plug 24 to the vicinity of partition plug 18 with transfer of substantially all of the liquid 23 from liquid chamber 21 into the mixing chamber 22 as indicated in Fig. 3, thorough admixture of the solvent and solute is attained by shaking the apparatus endwise or longitudinally, as proposed by the double-ended arrow 45 shown in Fig. 6. As a result of the endwise sloshing of the liquid in the mixing chamber 22 and thorough agitation thereof with the solids therein, the desired mixture or solution 46 is formed, all without access to the interior of the tube 13 with preservation of the sterile conditions of the contents of the chambers.

Thereafter thrust cap 11 and piston cup 12 may be removed by the operator by positioning the vial structure 10 in a canted position as indicated in Fig. 7, with the closing plug 26 facing down. The operator may then thrust a hollow needle 47 of a conventional hypodermic syringe 48 up through the relatively thin membrane 19 of closing plug 26 into the mixing chamber 22 to withdraw therefrom as a syringe charge part or all of the body of solution 46. By virtue of the self-closing characteristic of the venting perforations or puncture slits 20 in the membrane 19 of closing plug 26, the inversion of the vial structure 10 to the position shown in Fig. 7 for withdrawal of dosages is permitted without danger of spillage of any of the solution 46.

It is to be understood that although the partition plug 18 shown by way of example in the drawings is of a type which may be considered to be a two-way valving structure, other suitable valving partition means may be employed wherein it is possible to pass therethrough fluid in only one direction. Flat membrane 19 of partition plug 18, of course, would pass fluid through in the reverse direction if its membrane 19 was bulged in the opposite direction, as can be understood from the action of the membrane 19 of closing plug 26. However, that possibility is of no

moment to the structure shown by way of example in the drawing since reverse flow is not intended and at no time in use of the device is pressure on the mixing chamber side of the partition membrane 19 ever appreciably increased above any pressure developed on the liquid chamber side thereof. For example, a one-way valving plug structure of the type shown in Fig. 9 of my copending application Ser. No. 160,987, filed May 9, 1950, now Patent 2,577,780, granted December 11, 1951, may be used in lieu of partition plug 18, with, of course, the crowned end thereof oriented to extend toward or into mixing chamber 22.

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 drawing 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 vial for storage of a liquid and another material segregated in separate chambers having a valved intercommunicating passage to permit admixture comprising, in combination, a substantially tubular body, transversely-extending partition means mounted within said body between opposite ends thereof to define from each other a liquid storage chamber and a mixing chamber for storing the other material, self-closing valve means in said partition means operable by a differential in fluid pressure on opposite sides thereof developed by elevated fluid pressure applied from the liquid chamber side of the latter, said valve means being automatically closed by substantial balance of pressures on both sides thereof, means closing off the mixing chamber end of said tubular body while permitting access to mixture contents for withdrawal thereof, and piston plug means closing off the liquid storage chamber end of said tubular body and being adapted to be slid forward in that chamber toward said partition means to expel liquid through the latter into said mixing chamber.

2. The vial structure as defined in claim 1 characterized by the provision of said partition and valve means as comprising an elastic membrane having at least one self-closing perforation therein openable when said membrane is bulged away from said liquid chamber by application to opposite sides thereof of a differential in fluid pressure.

3. The vial structure as defined in claim 1 characterized by the provision of said closing means for the end of said mixing chamber as a needle-pierceable closure having self-closing, pressure-operable valve means to permit venting of fluid under pressure from said mixing chamber.

4. The vial structure as defined in claim 3 characterized by the provision of said needle-pierceable closure as comprising a transversely-extending body of elastic material having at least

one self-closing perforation therein openable by a differential in pressure on opposite sides thereof attendant upon application of elevated fluid pressure to the inner side thereof.

5. The vial structure as defined in claim 4 characterized by the provision of said partition and valve means as comprising a body of elastic material having at least one self-closing perforation therein openable when said elastic body is distorted by said differential in pressure attendant upon application of the elevated fluid pressure to one side thereof.

6. The vial structure as defined in claim 5 characterized by the provision of said partition and closure bodies each as an elastic membrane formed as the head portion of a cupped plug of elastic material snugly fitted within said tubular body.

7. The vial structure as defined in claim 3 characterized by the provision of a thrust cap removably mounted over the mixing chamber end of said tubular body to provide a biasing member, said cap being formed with at least one fluid-venting way opening to the atmosphere at the side thereof.

8. The vial structure as defined in claim 7 characterized by the provision of said thrust cap in the form of a cup-shaped member having an externally-engageable top and a skirt surrounding a socket therein, the interior walls of said socket being provided with venting ways leading from the under side of said top to the edge of said skirt.

9. A thrust cap for removable sliding mount on the end of a tubular container structure comprising a head of elastic material having a transversely-extending outer face for manual engagement to apply biasing force inwardly and axially thereof, and circumambiently arranged integral means extending from the inner side of said head substantially normal thereto to provide therewith a receiving socket for telescopic sliding reception of an end of such container, the inner surfaces of the bottom of the socket being provided with venting ways leading from the vicinity of the center thereof laterally at least to said circumambiently-arranged means and communicating with the atmosphere externally of said means.

10. The thrust cap as defined in claim 9 characterized by the provision of said circumambiently-arranged means as a skirt having a free outer edge with continuance of the venting ways in the inner face of said skirt to the free outer edge of the latter.

11. The thrust cap as defined in claim 10 characterized by the formation of the venting ways by providing the inner surfaces of the socket with contact lands.

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