United States Patent

Gilford

[15] **3,645,252**

[45] **Feb. 29, 1972**

[54] APPARATUS FOR SAMPLING BLOOD OR THE LIKE FLUID

[72] Inventor: **Saul R. Gilford,** Oberlin, Ohio

[73] Assignee: **Gilford Instrument Laboratories Inc.,** Oberlin, Ohio

[22] Filed: **Dec. 5, 1968**

[21] Appl. No.: **781,386**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 741,024, June 28, 1968, abandoned.

[52] **U.S. Cl.** .....**128/2 F,** 128/DIG. 5

[51] **Int. Cl.** **A61b 5/14**

[58] **Field of Search**.....128/2, 272, 276, 214, 215, 128/218 NV, 218 D, 218 DA, 220, 221, DIG. 5, DIG. 24; 23/253, 258.5, 259, 292; 73/421, 425.4, 425.6

[56] **References Cited**

UNITED STATES PATENTS

3,430,628	3/1969	Wiggins	73/425.6 X
3,494,351	2/1970	Horn	128/2 R
1,526,595	2/1925	Gillman	128/276
3,537,453	11/1970	Drummond et al.	73/425.6 X
3,405,706	10/1968	Cinqualbre	128/2 R
3,200,813	8/1965	Christakis	128/2 R
2,698,778	1/1955	Guild	23/292

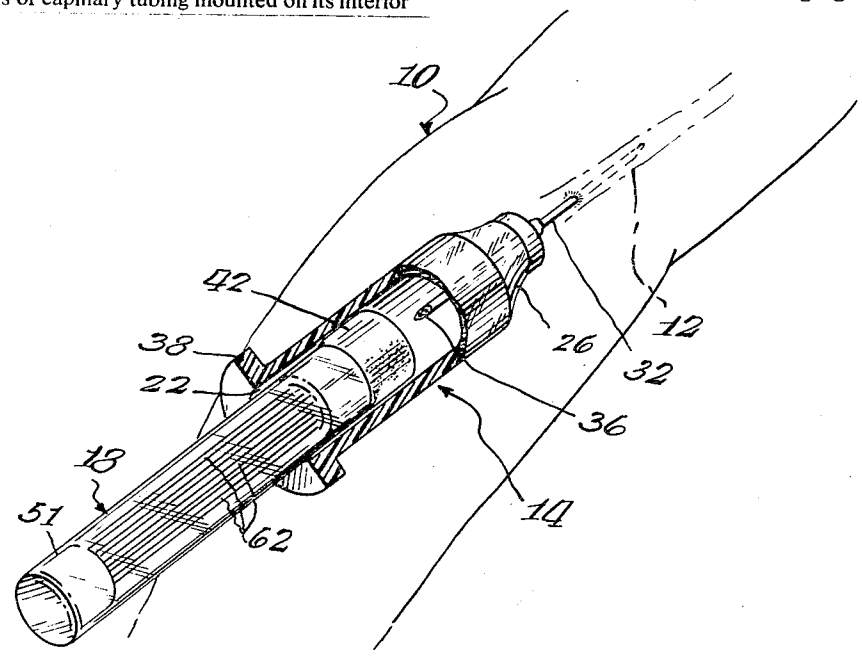
Primary Examiner—Richard A. Gaudet
Assistant Examiner—J. C. McGowan
Attorney—Silverman & Cass

[57] **ABSTRACT**

An elongate vessel having a blind end and an open end as a plurality of lengths of capillary tubing mounted on its interior in a removable assembly, the lengths being parallel to one another and axially arranged relative to the vessel. One end of each length of tubing is closed off and the other end is open. All of the lengths of tubing are mounted in a header that is disposed adjacent the open end of the vessel, the open ends of the lengths of tubing being in communication with the chamber formed in the vessel between the header and the open end, the open end being provided with a closure that includes a diaphragm capable of being pierced by a cannula without leakage. On assembly and closing of the vessel, at least the end chamber is evacuated thereby also evacuating the interior of each of the lengths of capillary tubing. The interior chamber may also be evacuated to prolong storage life, in which case there is a bleed passageway between the two chambers which preferably is capable of being blocked when the apparatus is ready for use. At that time or subsequently the interior chamber may be connected to atmosphere to enable facile withdrawal of the header with the filled lengths of tubing. A valve arrangement provides for the connecting of the chambers, their being disconnected one from the other and the connecting of the interior chamber with the atmosphere.

In use, the closure end is inserted into the socket of a cylindrical receptacle that has a double-ended needle cannula in its end wall, the exterior end being pierced into the blood vessel of a patient. When the collecting vessel is pushed home into the receptacle, the interior end of the cannula pierces the diaphragm, the vacuum in the end chamber and capillary tubing lengths draws blood into said end chamber and lengths, after which the entire apparatus is removed from the patient's blood vessel. A plurality of capillary tube lengths can thus be filled at bedside quickly and conveniently and thus be ready for centrifugation and further processing. The header preferably is secured to the closure of the collecting vessel so that after the lengths of tubing are filled with the sample fluid, the separation of the closure from the remainder of the closed collecting vessel carries all of the lengths of tubing with it, thus rendering them easily handled thereafter. Where the interior chamber has been connected to atmosphere, the closure is easily removed with a minimum of effort.

32 Claims, 11 Drawing Figures



PATENTED FEB 29 1972 3,645,252

SHEET 1 OF 3

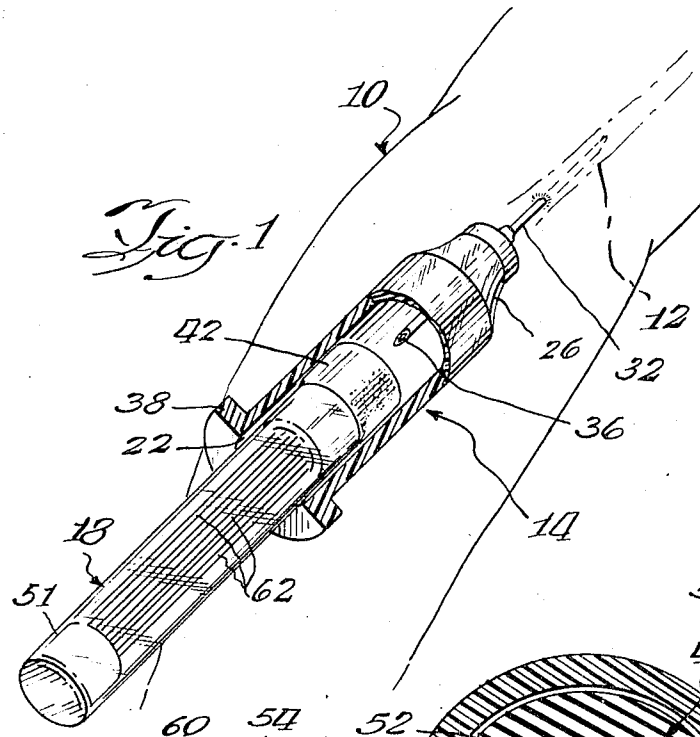


Fig. 1

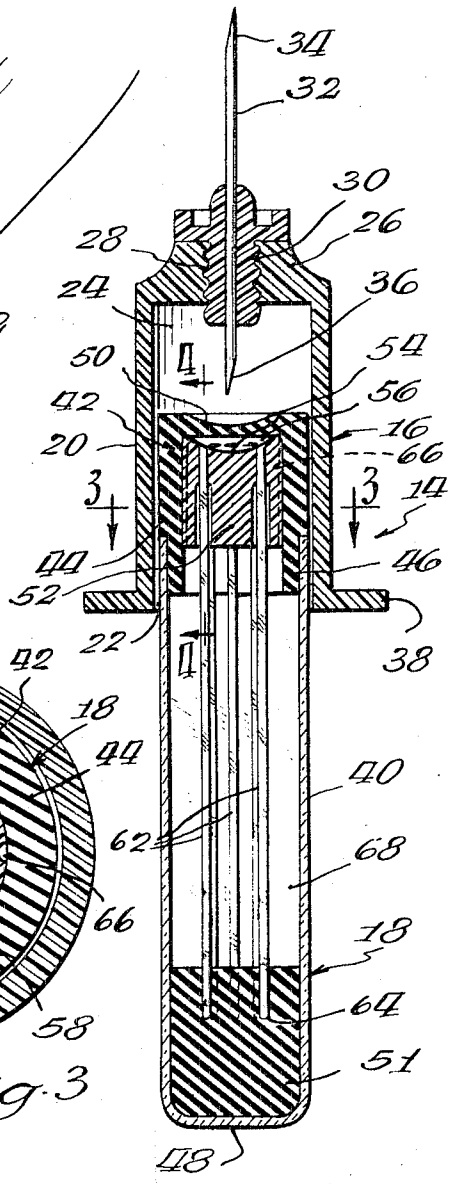


Fig. 2

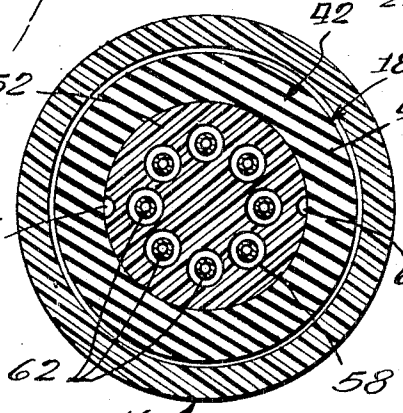


Fig. 3

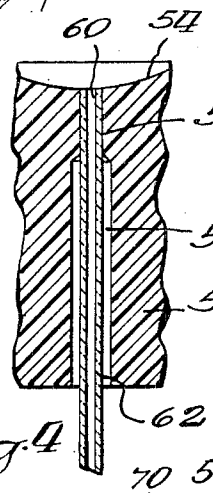


Fig. 4

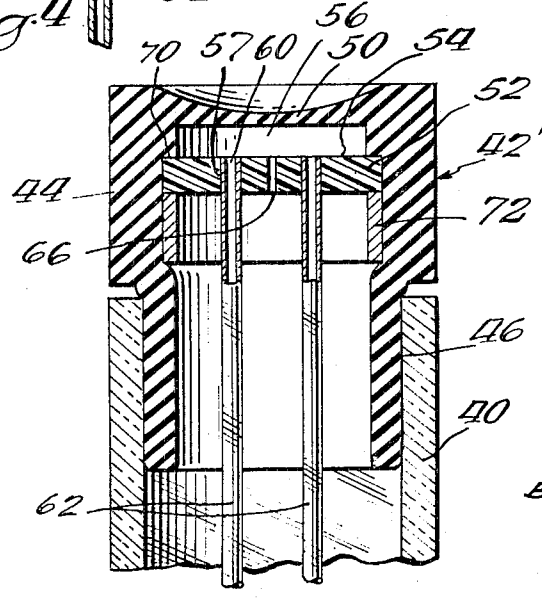


Fig. 5

INVENTOR
Saul R. Gilford
BY Silverman + Cass
ATTORNEYS

Fig. 6

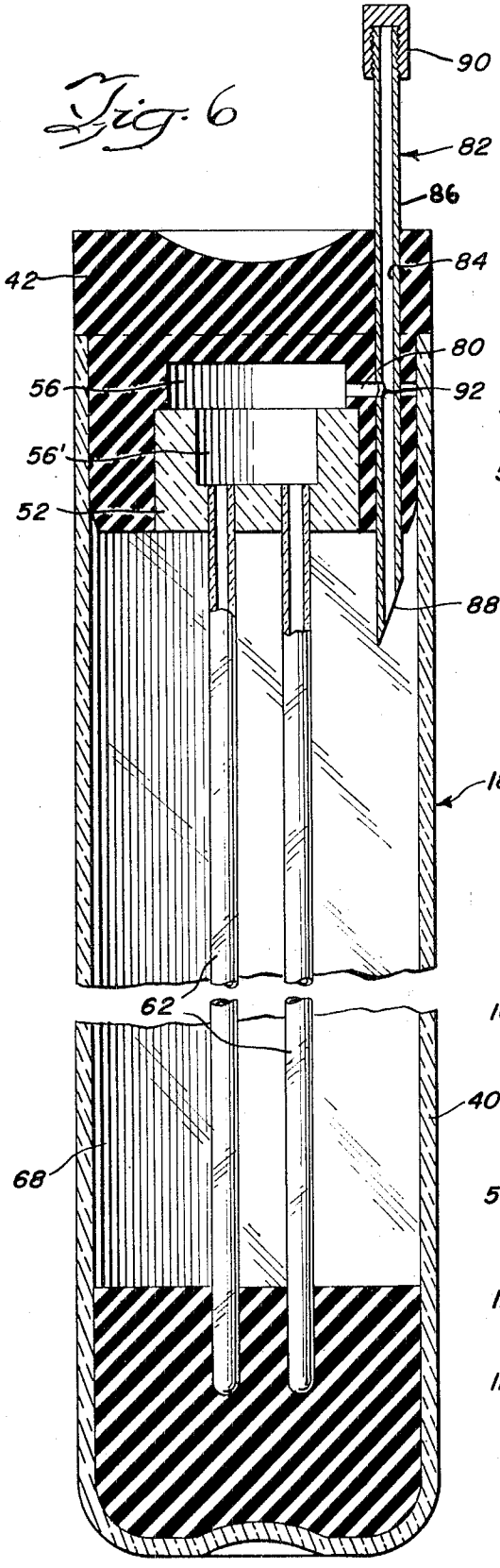


Fig. 7

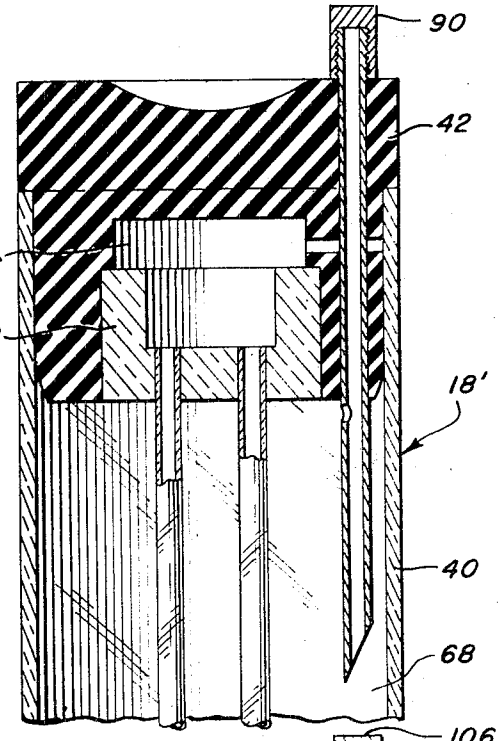
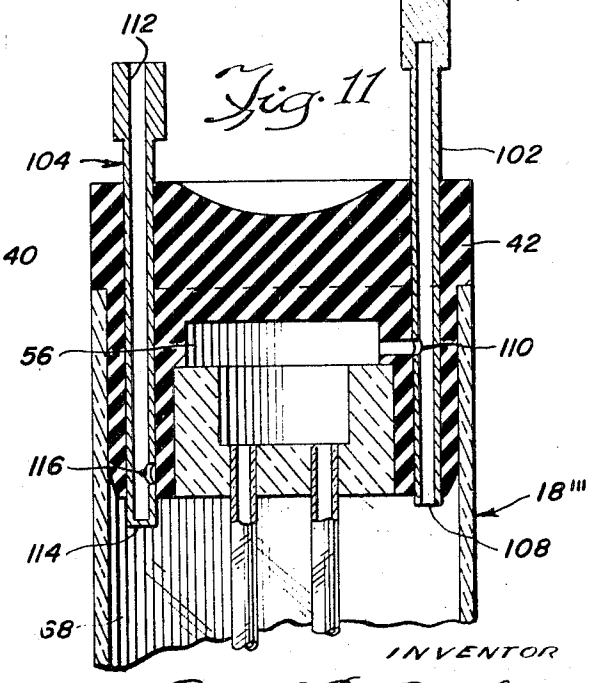


Fig. 11



INVENTOR
Saul R. Gilford
BY Silverman & Cass ATTORNEYS

Fig. 8

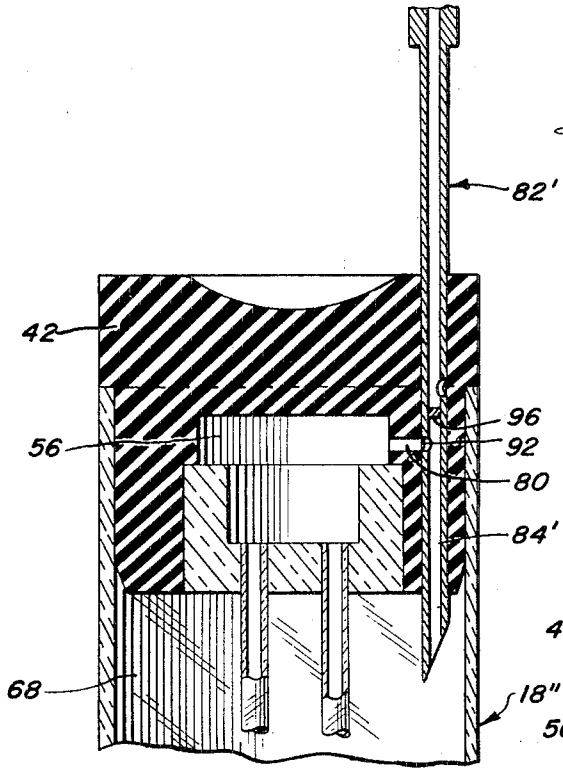


Fig. 10

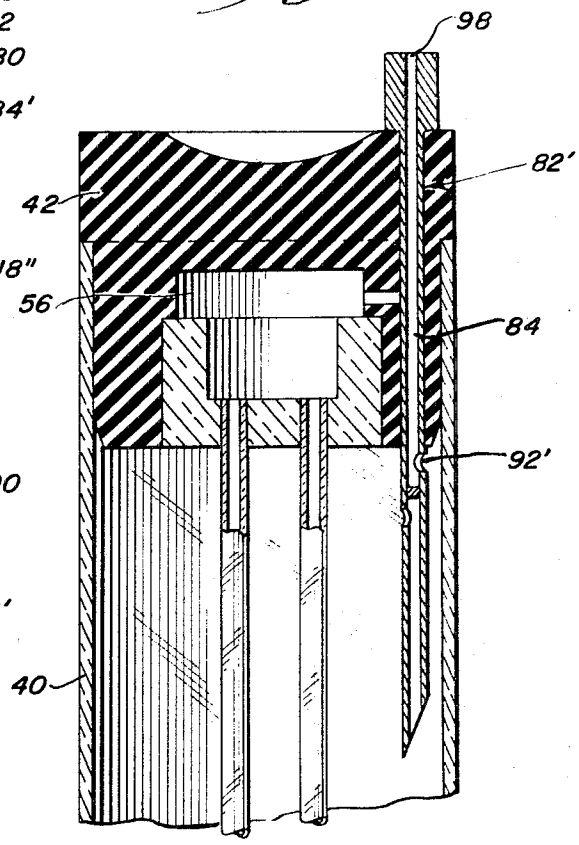
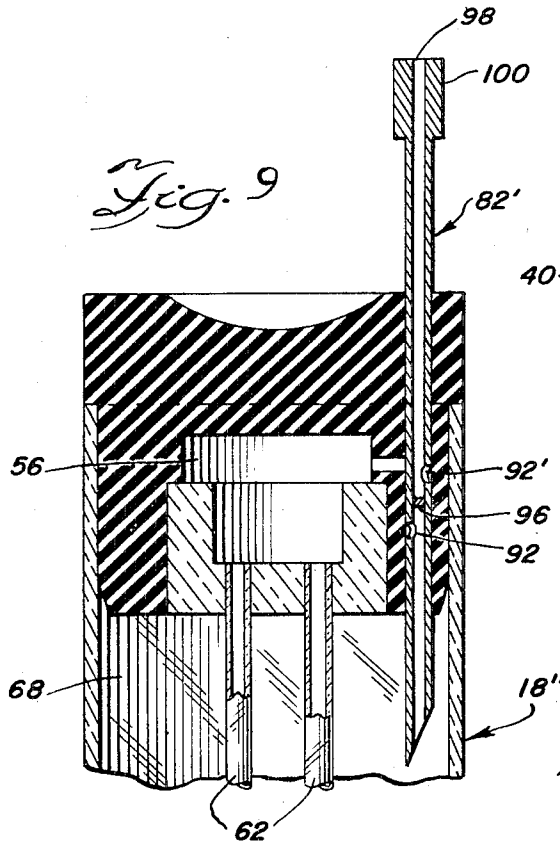


Fig. 9



INVENTOR
Saul R. Gilford
BY Silverman & Cass
ATTORNEYS

APPARATUS FOR SAMPLING BLOOD OR THE LIKE FLUID

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of application, Ser. No. 741,024, filed June 28, 1968, now abandoned, having the same title as this application.

FIELD OF THE INVENTION

The field of the invention is apparatus for sampling any fluids such as blood and the like. Blood sampling is required in hospitals and clinics for diagnosis and detection of pathological conditions of patients and as well in routine testing of blood and the like.

Blood is normally drawn from patients at bedside through the use of different types of syringes including, in recent years, a vacuum-operated syringe of the type disclosed in U.S. Pat. No. 3,460,641. A vena puncture is made by a technician, the blood drawn into a vial or tube, and thereafter transferred to other vessels for testing in the laboratory. The samples must be drawn by the technician from a great many patients during a single period, these transported to the laboratory, measured and processed, one of the more important preliminary processes being configuration. Problems arise is marking of containers, measuring out precise amounts, preventing contamination, and in handling a large number of samples from a large number of patients. Much time is consumed in these mechanical procedures, and the opportunity for error in handling samples obviously is a direct function of the number of operations which must be performed.

In a copending application, Ser. No. 472,294, filed July 15, 1965, and now U.S. Pat. No. 3,314,137, structure and technique are described which depend upon the processing of blood samples by means of lengths of capillary tubing. For example, a sample of whole blood drawn into a length of capillary tubing occupies a volume which is proportional to the length of the tubing assuming accurate and uniform capillary bore. One may close off the end of the length of capillary tubing, centrifuge the length to cause the cells to pack down into a mass, and then cut the portion having the plasma into precise lengths representing known volumes. These lengths can thereafter be immersed into various fluids for dilution and further testing. From the originally centrifuged length of tubing one may first determine the hematocrit index.

The technique described in said copending application utilizes filling procedures which merely require the placement of the end of the length of capillary tubing in a quantity of the fluid being tested, permitting the capillary action of the tubing itself to cause the fluid to be drawn into the bore. Often, for long lengths, this may require that the length of tubing be held horizontally. For centrifuging it is necessary to close the end of the length of tubing and this is done by some cement such as a resinous material. Handling a large number of tubes in this manner may result in loss of some of the entrained liquid and in breakage because of the fragility of the capillary tubing. Flame sealing ends cannot be easily done with entrained fluid in the tubing.

The invention herein obviates the need for handling the lengths of capillary tubing individually as required to fill them, and also eliminates the need for plugging the ends while the fluid is entrained.

As will be seen from the detailed description, there are many advantages which are achieved by the invention in addition to those specifically mentioned above. These can be more fully appreciated when it is pointed out that by means of the invention a plurality of lengths of capillary tubing is flame sealed at the ends thereof prior to use, the lengths are mounted in a closed vessel which is evacuated, they are filled at bedside directly from the patient's vein and carried together to the laboratory for further processing without any intervening transfer, handling, measurement or likelihood of dropping or breakage.

SUMMARY OF THE INVENTION

A plurality of sealed-end lengths of capillary tubing is mounted as an assembly within a closed end collecting vessel having a closure over the open end which includes a pierceable diaphragm, there being an end chamber formed adjacent the diaphragm in the collecting vessel between a header mounting the lengths of tubing and said diaphragm. There is an interior chamber between the header and the closed end of the collecting vessel, the lengths of capillary tubing being mounted with their open ends communicating with the end chamber while a substantial portion of the remainder of the lengths including their closed ends are located in the interior chamber and held in position because of their being mounted in the header.

A bleed passageway may be provided between the two chambers so that both chambers will be evacuated when the apparatus is assembled. This will enhance the storage life of the vacuum. In such case, it is preferred that the passageway be closed off just before use of the apparatus so that there will be no tendency for the fluid being drawn to enter past the header. The bleed passageway may be formed by a hollow needle engaged in the closure and having an intermediate port opening to the end chamber and an interior open end within the interior chamber. To close the passageway, one need only push the needle into the enclosure until the intermediate port passes through the header. To connect the interior chamber to atmosphere, one may uncover the exterior end of the hollow needle.

Where feasible, the end chamber alone may be evacuated eliminating the need for bleed passageways or valves.

A receptacle is provided having a cylindrical open-ended socket, the closed end having a cannula with sharp needlelike points inside and outside of the closed end, the cannula being coaxial with the receptacle. The socket acts as a guide for the closed end connecting vessel. The exterior point of the cannula is pierced into the patient's vein and thereafter the connecting vessel is telescopically introduced into the socket and pushed home upon the interior point of the cannula, this latter piercing the diaphragm of the closure. Since the end chamber of the collecting vessel has been evacuated and the open ends of the lengths of capillary tubing communicate with the end chamber and are also evacuated, the vacuum will draw blood directly from the vein into the end chamber and thence into the several lengths of capillary tubing, filling them. The cannula is then withdrawn from the patient's blood vessel and the collecting vessel removed, retaining on its interior the plurality of filled lengths of capillary tubing. At the laboratory the collecting vessel is centrifuged, without opening it, thereby centrifuging all of the lengths of capillary tubing simultaneously. Thereafter, the vessel is disassembled and each of the lengths of tubing is further treated as described in said copending application.

If the interior chamber has not been opened to atmosphere previously, it may be done before withdrawing the header carrying the lengths of capillary tubing.

Preferably, the header or plug in which the lengths of capillary tubing are engaged is sealed or otherwise secured into a removable closure, such as the rubber stopper and diaphragm which closes off the open end of the collecting vessel. Thus, after centrifuging, removal of the closure from the remainder of the vessel carries all of the lengths of capillary tubing with it, and the technician may carefully pluck each length from the header and further process the same in accordance with the teachings of said copending application. Apparatus may readily be a device for obviating the need for manual handling, such as for example, automatic means for withdrawing all of the lengths of tubing for the header and feeding them to other processing apparatus or holding them in a suitable magazine or carrier ready for use by the technician.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, partially in section, showing the use of apparatus constructed in accordance with the invention in drawing blood from the vein of a patient;

FIG. 2 is a median sectional view taken through one form of the apparatus of the invention;

FIG. 3 is a sectional view taken generally along the line 3—3 of FIG. 2 and in the direction indicated, but on an exaggerated scale;

FIG. 4 is a fragmentary sectional view taken generally along the line 4—4 of FIG. 2 and in the direction indicated;

FIG. 5 is a fragmentary sectional view taken through a modified form of apparatus constructed in accordance with the invention;

FIG. 6 is a median sectional view taken through another modified form of the invention, showing the bleed valve in position connecting the end and interior chambers;

FIG. 7 is a fragmentary sectional view of the structure of FIG. 6 showing the valve in position closing off the end chamber;

FIG. 8 is a fragmentary median sectional view through still another form of the invention having a bleed valve, the valve being in bleed position;

FIG. 9 is a view similar to FIG. 8 but showing the bleed valve in closed position;

FIG. 10 is a view similar to FIG. 9 but showing the bleed valve in position to connect the interior chamber with atmosphere; and

FIG. 11 is a fragmentary median sectional view of still another modified form of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As previously mentioned, the invention comprises a closed-end collecting vessel having a plurality of lengths of capillary tubing mounted therein, and the arrangement is such that all of them are filled simultaneously at the bedside of the patient. The description herein is detailed with respect to venous blood, but obviously the invention is capable of being used for the sampling of other fluids from other sources. Likewise, the cannula described in the details is in the form of a double-ended hypodermic needle, but the exterior end of the cannula need not be sharp if liquids other than venous blood are to be drawn. Any conduit having a sharp interior end in the receptacle will suffice.

In FIG. 1 there is illustrated a portion of a patient's arm **10** having a vein exposed at **12**, and the apparatus **14** is being used to draw a plurality of blood samples simultaneously. The apparatus itself comprises two parts, the receptacle or guide means **16** is of known construction, and it comprises a hollow cylindrical member **20** having an open end **22** and forming a socket **24**. The closed end **26** has a threaded opening **28** into which the screw-threaded plug **30** is securely mounted, this plug having a cannula **32** sealed therein. The exterior end of the cannula **32** is pointed as shown at **34** and the interior end **36** is also sharply pointed. There is a flange **38** to facilitate handling of the receptacle or guide means **16**.

As mentioned, the guide means is of a well-known construction, usable for example, with the apparatus disclosed in said U.S. Pat. No. 2,460,641, and hence is readily available commercially. The body **20** and the plug **30** are made from sterilizable synthetic resins or plastics, and the cannula is of sterilizable metal, such as stainless steel.

The closed-end collecting vessel **18** is formed of a glass tube **40** having a stopper or closure **42** of rubber or the like material, this material being nonporous to retain the vacuum which will be established on the interior of the collecting vessel **18**. The closure **42** has a relatively thick-walled cylindrical body **44** which is necked at **46** where it is forced into the open end of the glass tube **40**. The tube **40** has a blind bottom end **48**, but obviously its top end is open until sealed by the closure **42**. The end wall of the closure **42** forms the end wall of the closed-end collecting vessel **18** and it is thinned as shown at **50** to form what has been referred to herein as a pierceable diaphragm. This type of structure is used in packages of pharmaceuticals, and often, the closure end is reenforced with metal ferrules. The purpose of the diaphragm is to contain the vacuum until it is desired to use the apparatus, while also presenting a readily penetrable wall for entry of the sharp point **36** of the cannula **32**.

On its interior, the vessel **18** is provided with a bottom plug **51** which is of no particular configuration, and a top plug or header **52**. The header **52** fits tightly into the closure **42** and has a concave end face **54** thereby giving rise to a lenticular end chamber **56** formed between the end face **54** and the diaphragm **50**. As best shown in FIG. **4**, the plug or header **52** has perforations or orifices therein, one of which is indicated at **57**, these being enlarged toward the bottom of the header as shown at **58**. Into each orifice there is inserted the open end **60** of a length of capillary tubing **62**, the bottom end of each length being flame closed as indicated at **64**. The enlarged passageways **58** provide piloting means to assist in the insertion of the capillary tubing lengths **62**, and the open ends **60** all are flush with the end face **54** or may protrude slightly into end chamber **56**.

The bottom plug **51** may be formed by means of a suitable elastomer which is poured into the tube **40** in liquid form and then air cured. Thus, the lengths of capillary tubing **62** are mounted in the header **52** of the closure **42** in such a manner that the closure **42** may be removed from the tube **40** and will carry all of the lengths with it. The plug **51** should freely be removable from the blind end of the tube to permit this. Alternately, the plug **51** may be a thin disc or spider forming a partition slidably to mount the lower ends of the lengths of capillary tubing **62** so that the same are readily removable when it is desired to disassemble the structure.

The header **52** may be formed of some type of rubber or plastic, such as nylon or tetrafluroethylene and should be molded or otherwise produced in a manner to provide a firm connection with the closure **42**. Any convenient number of lengths of capillary tubing may be used, eight being shown in FIG. **3**. The number of such lengths shown in FIGS. **2** and **5** is minimum to illustrate the structure clearly. The collecting vessel **18** is assembled in vacuo so that when completed there is a vacuum on the interior thereof. There may be a bleed or equalizing passageway **66** at one or more locations in the header **52** to equalize the vacuum between the end chamber **56** and the interior chamber **68** of the tube **40**. A similar passageway **66** is shown in FIG. **5** or one length of capillary tubing may be open at its bottom end to serve this purpose.

The principal purpose for the bleed passageway **66** is to preserve the vacuum in the end chamber **56** as long as possible and in addition to enable ready removal of the closure **42** after the lengths of capillary tubing have been filled. It is feasible to eliminate the bleed passageway in which case the interior chamber **68** will not be connected with the end chamber **56**. Assuming packaging of several of the devices in containers, which themselves are evacuated, the vacuum in the chamber **56** will be maintained for a sufficient time to enable use of the apparatus after removal from its carrying container.

In lieu of bleed passageways, the invention contemplates the use of valving arrangements as described in detail in connection with FIGS. **6** through **11**. In such case, the end chamber **56** and the interior chamber **68** are connected by a movable tubular valve member so that the vacuum therein is equalized. When it is desired to use the apparatus, the tubular valve member is moved to break the connection between the two chambers so that fluid drawn into the chamber **56** will enter only into the lengths of tubing and will not leak into the chamber **68**. If desired, the same or a different tube may be used to connect the interior chamber **68** with the atmosphere either before use of the apparatus or after use thereof. If the connection of the header within the closure is liquidtight and airtight, it is immaterial whether the interior chamber **68** is at atmospheric pressure or not. For withdrawal of the closure with its connected header and the capillary tube lengths, it is

desirable that the interior chamber 68 be at atmospheric pressure. It is also feasible through the use of the tubular valve members to apply pressure on the interior of the chamber 68 for forcing the closure member out of the glass tube when it is desired to disassemble the same.

In the use of any forms of the invention, the technician inserts the end 34 into the patient's vein 12 and thereafter telescopically inserts the closed-end vessel 18, closure end first, into the socket 24 until the sharp needle end 36 pierces the diaphragm 50. When this occurs, the vacuum on the interior of the vessel 18 draws blood into the chamber 56 and the vacuum in the respective lengths of capillary tubing 62 draws the blood into these lengths. Since the tube 40 is preferably made of glass, the technician can see when the capillary tube lengths are filled and will remove the cannula from the patient's vein. The technician removes the vessel 18 from the receptacle 16 and will discard the receptacle at this point. The vessel 18 is clearly marked with patient identification, if not already done, and when brought to the laboratory, the technician has a plurality of samples all identical and all identified mounted in the vessel 18. The entire vessel is placed in the centrifuge for centrifuging, and thereafter, the closure 42 is removed from the vessel 18, and the vessel discarded. Thereafter the individual lengths of capillary tubing 62 are further processed.

In the case of the structure of FIG. 5, the lengths of tubing are secured at their open ends 60 in the perforations of a header 52 which is flat on its end face 54 (only two lengths are shown, for clarity). The closure 42' in this case has the same general construction as the closure 42 but a shoulder 70 is formed on its interior to seat the header 52 spaced from the diaphragm 50 to provide the necessary chamber 56. To keep the header 52 in position, a metal sleeve 72 may be forced into the interior of the closure 42 against the bottom of the header. The cylindrical body 44 is of sufficient flexibility frictionally to hold the sleeve 72 in position. The header 52 is the equivalent of the plug or header 52 of FIGS. 1 to 4.

As pointed out above, it is preferred that the bleeder passageway or passageways 66 be blocked off at the time that the device is used to prevent the fluid such as blood and the like from entering the interior chamber 68. This normally would preserve a vacuum within the chamber 68 making removal of the closure 42 or 42' difficult. The structures shown in FIGS. 6 through 11 obviate these disadvantages and provide additional advantages.

The structures illustrated in FIGS. 6 through 11 are characterized by the provision of a tubular valve member which is capable of movement so that it may establish a connection between the interior chamber 68 and the end chamber 56. Preferably, each of the structures has means for connecting the inner chamber to the atmosphere as well.

In FIGS. 6 and 7, the closed-end vessel 18' is constructed very similar to those heretofore described. There is a closure 42 carrying a header 52 which provides an end chamber 56. The end chamber 56 is proportionally larger than the lenticular chamber 56 previously described, having an extension 56' in the form of a well into which the lengths 62 open. Instead of a bleed passageway through the header 52 as described, there is a lateral passageway 80 connected to the end chamber 56. A valve 82 in the form of a hollow tube passes through the closure 42 alongside of the chamber 56 and the header 52 and intersects the lateral passageway 80. The valve member 82 is in the form of a hollow needle such as, for example, a hypodermic needle, having a central bore 84 formed in the outer tubular body 86. Its lower end 88 may be pointed as shown so that it can be pierced through the closure 42. Its upper end is provided with a cap or plug as shown at 90 which may be removable. Between its ends, there is a lateral perforation or port 92.

In FIG. 6 the valve member 82 has been pushed through the closure so that its lower end 88 opens to the interior chamber 68 and its perforation or lateral port 92 is aligned with the passageway 80. It will be seen that this arrangement connects the interior chamber 68 with the end chamber 56 so that both are subjected to vacuum when the apparatus is assembled. In this condition, the storage life of the vacuum will be substantial.

When it is desired to use the apparatus, the valve member 82 is pushed downwardly until the plug or cap 90 engages the top of the closure 42. This condition is shown in FIG. 7. The insertion of the closed-end vessel 18' into the guide means 16 may automatically provide for this function in which case the valve member 82 should be long enough to assure that the movement which is described will occur. Otherwise, the technician may press the valve member 82 downwardly before inserting the closed-end vessel 18' into the guide means 16.

As seen in FIG. 7, when this has been done, there is no connection between the interior chamber 68 and the end chamber 56. Thus, when used and blood is drawn into the end chamber 56, it cannot find its way into the interior chamber 68.

When it is desired to remove the closure 42, together with the header 52 in order to further process the samples, the removal of the entire valve member 82 will connect the interior chamber 68 to the atmosphere or, if the resulting passageway produced by the insertion of the valve member 82 may contract as would be the case if the closure 42 was made of rubber or other resilient material, then removing the cap 90 will accomplish the same purpose. This can be unscrewed or broken off as desired and it connects the atmosphere directly to the interior chamber 68 without affecting the end chamber 56. When the closure 42 has been removed from the glass vessel 40, header 52 is easily separated from the closure 42 by breaking the vacuum in any desired manner. Actually, the degree of vacuum is small and no difficulties should be experienced.

The structure 18'' illustrated in FIGS. 8, 9, and 10, utilizes a valve member 82' in which the tube 86 has an additional lateral perforation 92', with a plug in the tube at 96 between the perforations, the upper end of the valve 82' being open to the atmosphere at 98 but having a shouldered flange 100 formed thereon. In its normal position, as shown in FIG. 8, the end chamber 56 and interior chamber 68 are connected together. This is the condition of storage so that there is a vacuum in both chambers with the equalizing passageway represented by that portion of the bore 84' of the valve member 82' below the plug 96. When it is desired to use the device 18'', the technician pushes the valve member 82' downwardly a sufficient distance so that the perforation 92 is no longer connected with the passageway 80. Thus, as shown in FIG. 9, the connection between the chambers 56 and 68 is blocked. In this condition, the structure 18'' may be used and blood drawn into the chamber 56. There is still a vacuum in the chamber 68. After filling the lengths of tubing 62, the technician will push valve member 82' all the way home and this automatically connects the chamber 68 to atmosphere through the perforation 92' and the upper bore 84 of the valve member 82'. If desired, the intermediate position represented by FIG. 9 need not be used but the vacuum condition in the chamber 56 must be maintained until use.

In FIG. 10, in the event the closure 42 is very tightly engaged in the glass tube 40, one may introduce a jet of air through the opening 98 and thereby force the closure 42 out of the tube 40 from the interior.

The structure 18''', shown in FIG. 11, uses two valve members which are here designated 102 and 104. The valve member 102 has its upper end closed off by a cap or plug 106 and is opened at its bottom end 108 so that through the side perforation 110 it provides communication between the end chamber 56 and the interior chamber 68. The valve member 104, on the other hand, has its upper end 112 open to the atmosphere and its lower end 114 closed. There is a side perforation 116. In the condition shown in FIG. 11, there is no communication between the interior chamber 68 and the atmosphere.

Before use, the technician pushes the valve member 102 downwardly thereby disconnecting the chambers 68 and 56

from one another. Thereafter, he pushes the second valve member **104** down and this connects the interior chamber **68** to the atmosphere. It will be noted that the valve member **104** protrudes upwardly of the closure **42** somewhat less than the valve member **102** so that if the technician inserts the closed-end vessel **18'''** into the guide means **16** and pushes the same home, the first thing that will happen is that the end plug **106** will engage the inner surface of the end of the guide member and close off the connection between the two chambers **56** and **68** after which the interior chamber **68** will be opened to atmosphere.

The structure of the invention is quite versatile and need not be used exclusively in the collection of body fluids from patients. It could be used to collect liquids from any sources, and hence the form of cannula could be different. It need not be of the type to pierce any body, but could be connected to another vessel or receptacle already containing the liquid. It would follow, therefore, that the invention contemplates that the manufacturer of the apparatus would produce the closed-end vessel **18**, all ready to be used, leaving the user or purchaser to acquire his own form of receptacle **16** or other apparatus for utilizing the said closed-end vessels **18**. The manufacturer conveniently will package the vessels **18** in quantity in a hermetically sealed canister under vacuum, much as tennis balls are packaged at this time. The double protection will preserve the vacuum within the closed vessels **18** indefinitely, and render them efficient when the canister is opened for use. One would not open the canister until a plurality of such closed vessels is needed, so that no requirement exists for storing them in an effort to preserve their internal vacuum for more than a few days.

It is believed that the invention additionally resides in the combination of the known receptacle **16** and the closed vessel of the construction inasmuch as the functions of such receptacle are increased because of the invention. Such increased functions were not previously contemplated or believed obvious to those skilled in the art. The cannula cooperates with the chamber **56** to distribute the fluid drawn into the vessel **18** to the capillary tube lengths. Obviously, it may be advantageous for matching receptacles to be sold with the closed vessels to provide the optimum of the advantages of the invention.

What it is desired to secure by Letters Patent of the United States is:

1. Apparatus for obtaining multiple samples of blood or the like fluid, which comprises:

A. a closed-end evacuatable vessel having an open end provided with a closure and the vessel capable of holding a pressure less than atmospheric pressure and having

i. an assembly of lengths of capillary tubing mounted therein, each length having a closed end and an open end,

ii. a fluid receiving end chamber formed interior of said vessel adjacent the closure thereof, and said lengths each having its open end in communication with said end chamber, and

B. means for connecting said end chamber to a source of fluid through said closure of said vessel, whereby when said connection is established, a quantity of said fluid will be drawn from said source into said end chamber and thence into said lengths of capillary tubing.

2. The apparatus as claimed in claim **1** in which said closure comprises a flexible diaphragm and said means for connecting includes a sharp-ended cannula adapted to pierce said diaphragm.

3. The apparatus as claimed in claim **2** in which means are provided for mounting said cannula with its sharp end in position to pierce said diaphragm, said mounting means including structure to guide movement of said vessel to bring said diaphragm into engagement with said sharp end.

4. The apparatus as claimed in claim **3** in which said vessel is of substantially elongate cylindrical configuration and the mounting means and structure for guiding comprise a generally hollow cylindrical member of internal diameter larger than the outer diameter of said closed-end vessel, having an open end into which said vessel may be introduced telescopically, and a closed end with said cannula mounted coaxially therein with its sharp end on the interior of said cylindrical member.

5. The apparatus as claimed in claim in which said cannula includes a second sharp end on the exterior of said hollow cylindrical member.

6. Apparatus for obtaining multiple samples of blood or the like fluid, which comprises:

A. a closed-end vessel having an open end provided with a closure and the vessel adapted to be evacuated and having

i. an assembly of lengths of capillary tubing mounted therein, each length having a closed end and an open end,

ii. a fluid receiving end chamber formed in said vessel adjacent the closure thereof, and said lengths each having its open end in communication with said end chamber, and

B. means for connecting said end chamber to a source of fluid through said closure of said vessel, whereby when said connection is established, a quantity of said fluid will be drawn from said source into said end chamber and thence into said lengths of capillary tubing and said assembly includes a header adjacent said closure and spaced therefrom to separate substantially the larger portion of said vessel from said closure, and the said end chamber is formed between said closure and said header while an interior chamber is formed between said header and the closed end of the vessel.

7. The apparatus as claimed in claim **6** in which said closure comprises a flexible pierceable diaphragm and said means for connecting includes a hollow sharp member capable of piercing said diaphragm whereby liquid may be introduced into said end chamber by a pressure differential at opposite ends of said sharp member.

8. The apparatus as claimed in claim **6** in which each of said lengths of capillary tubing has at least that portion adjacent its open end removably engaged in said header with said open end in communication with said end chamber.

9. The apparatus as claimed in claim **6** in which an equalizing passageway is provided through said header connecting said end chamber with said interior chamber.

10. The apparatus as claimed in claim **9** in which valve means are provided to enable the equalizing passageway to be selectively closed or opened without removing said closure from said vessel.

11. The apparatus as claimed in claim **10** in which said valve means comprise an elongate needlelike member having an exterior end on the exterior of the said closure, extending through the closure and having an interior end of the interior chamber, a lateral passageway from the end chamber to the elongate needlelike member, at least a portion of the needlelike member having a hollow bore from the intersection of said lateral passageway to its exterior end, a port in the needlelike member at said intersection, and said equalizing passageway comprising said lateral passageway, port and the hollow bore from said port to said interior end, said needlelike member being slidable by manipulation of said exterior end to move said port out of alignment with said lateral passageway.

12. The apparatus as claimed in claim **11** in which said hollow bore extends the entire length of said needlelike member and a removable cap is provided at said exterior end whereby removal of said cap connects said bore with the atmosphere.

13. Apparatus as claimed in claim **11** in which there is an enlargement on the said exterior end to limit movement of said needlelike member into said closure.

14. Apparatus as claimed in claim **11** in which said needlelike member has a second hollow bore at its upper end blocked from said first hollow bore but open to the atmosphere, a second port communicating with said second hollow bore but not with said lateral passageway, and the length

of the needlelike member being such that it can be moved a sufficient distance into the closure to bring said second part into said interior chamber whereby to connect said interior chamber to atmosphere through said second port and the second hollow bore.

15. Apparatus as claimed in claim 10 in which said valve means enable selective connection of said interior chamber to atmosphere.

16. Apparatus as claimed in claim 15 in which said valve means comprise two needlelike members extending into said closure, one needlelike member having a hollow bore at the bottom thereof and the other needlelike member having a hollow bore at the top thereof, each needlelike member having a port connected to its bore, the port of the said one needlelike member being in communication with said end chamber while its bore communicates with said interior chamber and adapted to be moved blocking its port, the other needlelike member having its port blocked while the bore is connected to atmosphere but adapted to be moved to bring the port into communication with said interior chamber.

17. Apparatus as claimed in claim 16 in which said needlelike members have portions of different length protruding out of said closure and said means for connecting includes a pusher movable against the closure in an axial movement to move said portions into said closure at different times.

18. The apparatus as claimed in claim 17 in which one needlelike member has a longer protruding portion than the other.

19. The apparatus as claimed in claim 18 in which said pusher comprises a cylindrical member having a cannula in one end wall with one sharp end on the exterior of said end wall and a second sharp end on the interior of said end wall, and adapted to be engaged on the interior of said cylindrical member so that the second sharp end may pierce said closure while the first end is piercing a source of blood or the like fluid, said end wall adapted to come into engagement with said protruding lengths.

20. The apparatus as claimed in claim 8 in which said header supports each of said lengths at the open end thereof and means are provided in said vessel for supporting the closed ends of said lengths.

21. The apparatus as claimed in claim 1 in which said closed-end vessel is formed of a transparent tubular body portion having a blind end.

22. The apparatus as claimed in claim 1 in which said assembly comprises a pair of spaced-apart plugs, each length of capillary tubing being secured to both plugs and all being arranged substantially parallel to one another, and said plugs being telescopically and removably engaged with said vessel.

23. A sampling device for use with a cylindrical member having a cannula in one end wall thereof with one sharp end on the exterior of said end wall and a second sharp end on the interior of said end wall, and adapted to be engaged on the interior of said cylindrical member so that the second sharp end piece may pierce said sampling device while the first sharp end is piercing a source of blood or the like fluid, said sampling device comprising:

A. an enclosed evacuatable vessel and having a pierceable end,

B. a partition in said vessel adjacent to but spaced interior from said pierceable end to form a fluid accumulating chamber thereat,

C. a plurality of lengths of capillary tubing disposed on the interior of said vessel and extending through said partition,

i. each length having an open end on the side of said partition forming said chamber and a closed end on the opposite side of said partition.

24. The sampling device as claimed in claim 23 in which there is an equalizing passageway through said partition.

25. The sampling device as claimed in claim 23 in which said partition is removable from said vessel so that all of said lengths of tubing may be installed or removed together.

26. The sampling device as claimed in claim 23 in which there is a second partition in said vessel spaced from the first partition and supporting all of the closed ends of said lengths.

27. The sampling device as claimed in claim 24 in which means are provided selectively to block said equalizing passageway.

28. The sampling device as claimed in claim 27 in which said blocking means include the end wall of said cylindrical member.

29. A sampling device comprising:

A. an enclosed evacuated vessel having an end wall normally blocking admission to said vessel but capable of being unblocked to permit introduction of liquid into said vessel therethrough,

B. a partition in said vessel adjacent to but having at least a portion thereof spaced from said end wall to form a fluid receiving and distributing chamber between said partition and wall,

C. a plurality of lengths of capillary tubing disposed on the interior of said vessel supported by said partition and each having an open end communicating through said partition with said chamber and a closed opposite end.

30. The device of claim 29 in which the vessel has a closure, the end wall is on said closure and the partition is secured to said closure.

31. The device as claimed in claim 29 in which the larger portion of the volume of said vessel is on the side of said partition opposite said chamber and there is an equalizing passageway through said partition.

32. The device as claimed in claim 31 in which means are provided selectively to block said equalizing passageway.

* * * * *

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,645,252 Dated February 29,1972

Inventor(s) SAUL R. GILFORD

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 19, change "3,460,641" to--2,460,641--; column 2, line 73, change "for" to --from--; column 8, line 6, insert --4-- after "claim"; column 8, line 58, change "exterior" to --interior--; and column 8, line 65, insert --throughout--after "extends".

Signed and sealed this 8th day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents