United States Patent [19]

Leibinsohn

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[45] **July 10, 1973**

[54] **DRIP CHAMBER**

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[52] **U.S. Cl.** ..... **128/214 C**
[51] **Int. Cl.** **A61m 05/16**
[58] **Field of Search** ..... 128/214 R, 214 C, 128/214.2; 210/94

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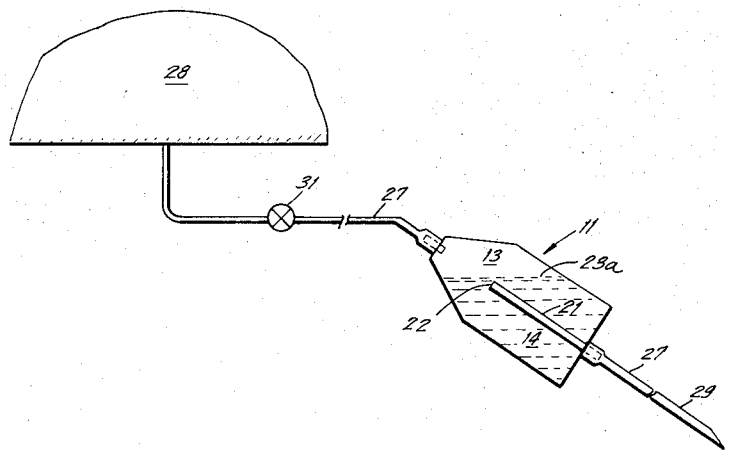
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Attorney—Ostrolenk, Faber, Gerb & Soffen

[57] **ABSTRACT**

A drip chamber for use in an infusion set for feeding blood, saline solution or other liquids from a container to a catheter or needle for administration to a patient. The drip chamber comprises an inlet section and a larger volume outlet section, liquid filling the latter section before it can escape from the chamber outlet and, when in use, covering the outlet irrespective of the orientation of the drip chamber, such that air bubbles can not escape from the drip chamber to the catheter or needle of the infusion set and thence to the patient.

3 Claims, 9 Drawing Figures



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FIG. 1.

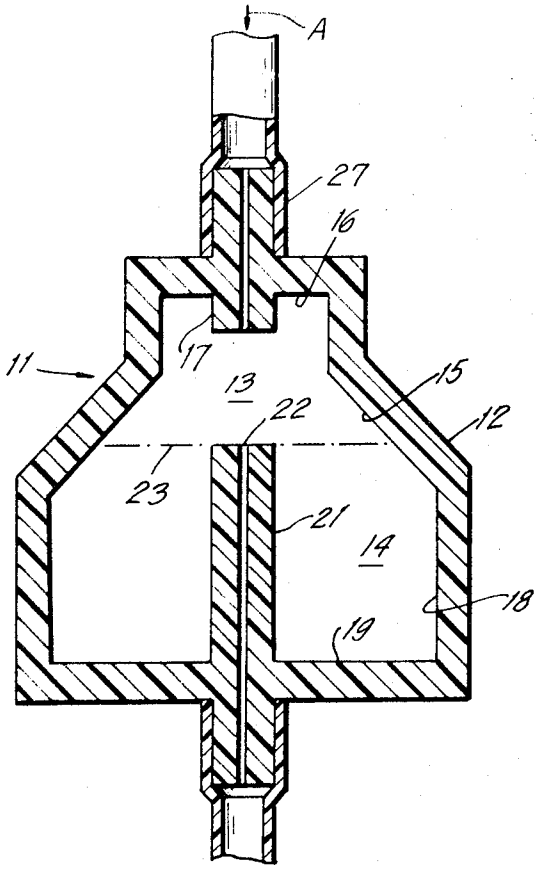


FIG. 4.

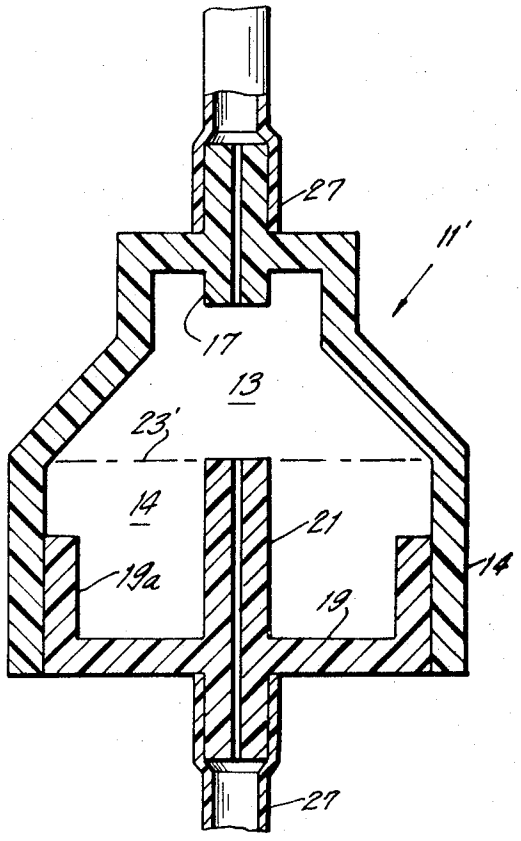


FIG. 2a.

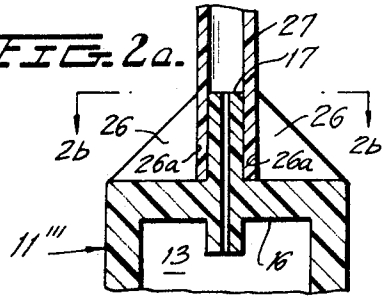


FIG. 2b.

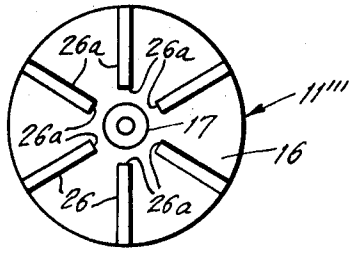
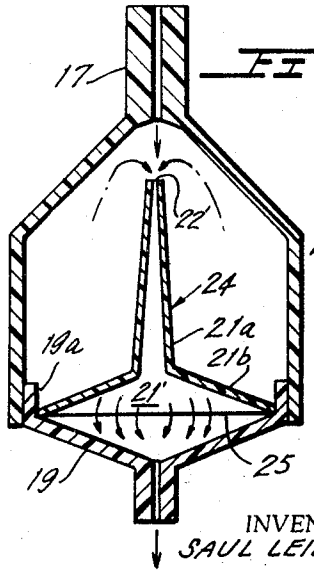


FIG. 5.



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FIG. 6a.

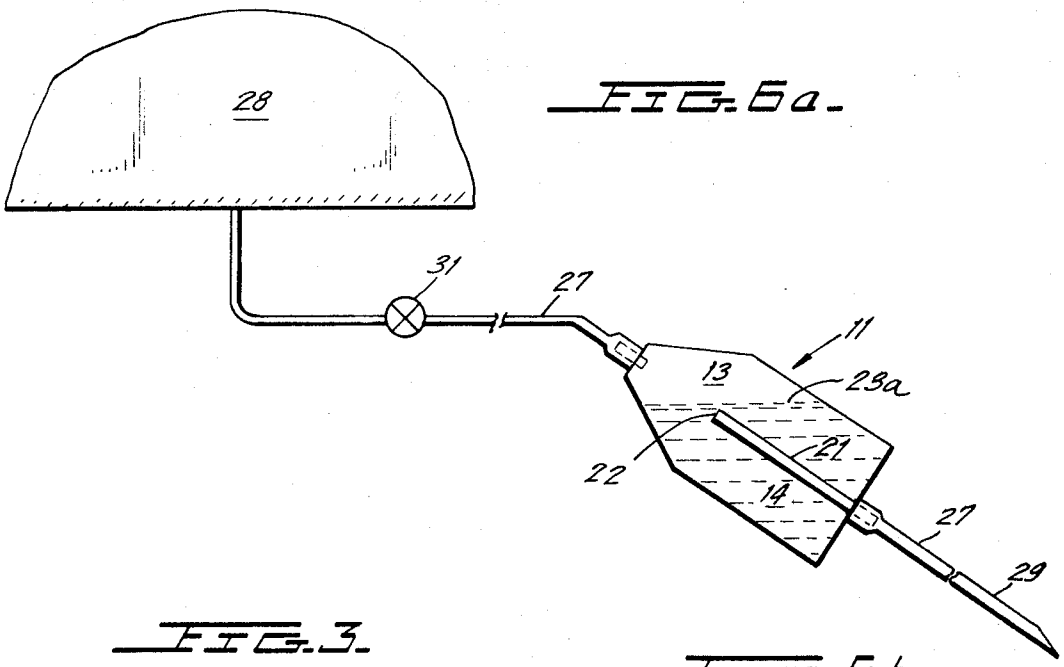


FIG. 3.

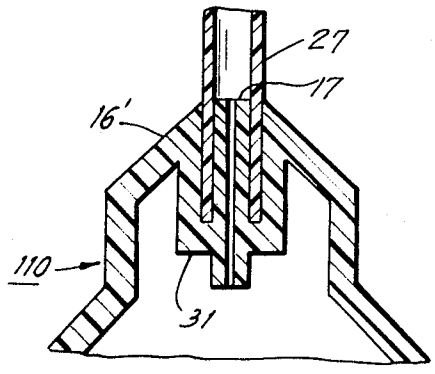


FIG. 6b.

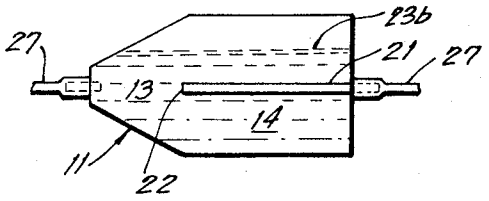
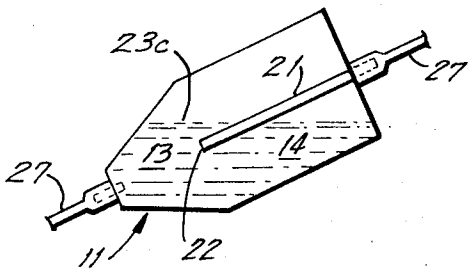


FIG. 6c.



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BACKGROUND OF THE INVENTION

The present invention relates to infusion apparatus and more particularly to a novel drip chamber for use there-with to prevent the passage of air through its exit opening.

Drip chambers are typically used in conjunction with infusion sets to determine liquid flow. A major disadvantage in conventional drip chambers is their failure to prevent air bubbles from exiting therethrough. In addition, drip chambers comprising parts of infusion sets employed in the field (e.g., on a battlefield or during disasters) must be adapted to withstand rough handling while preventing air from passing through the infusion set into the patient's body.

SUMMARY OF THE INVENTION

The present invention is characterized by providing a drip chamber for use with an infusion set which is designed to prevent the passage of air through its exit chamber and which is ruggedized to withstand rough handling without suffering any damage.

In one preferred embodiment, the tubing interconnecting the container for the liquid to be infused and the hypodermic needle or catheter used, for example, for administration to the patient is provided with a drip chamber of a design which is uniquely adapted to prevent air from entering into the liquid flow, regardless of any change or deviation in the orientation of the drip chamber. The drip chamber, which may be made of glass, plastic or any other suitable transparent material, comprises a hollow housing having an inlet at its narrower end and an outlet at its wider end. The inside of the housing defines a first, inlet section adjacent the inlet end of the chamber and a second, outlet section of greater volume adjacent the outlet end of the chamber. An outlet tube extends into and through at least the outlet section of the drip chamber, the inner end of the tube having an outlet opening communicating with the inlet section of the housing. The interior walls defining the principal inside surfaces of the inlet section taper inwardly from at least the portion of such section adjacent the outlet tube opening toward the inlet end of the drip chamber, such that liquid fed into the drip chamber fills at least the outlet section thereof prior to overflowing through the outlet tube opening and exiting through such tube. The liquid in the drip chamber thus provides a liquid seal preventing the escape of air bubbles from the drip chamber through the outlet tube, irrespective of the orientation of the drip chamber.

Any disruption or deviation in the orientation of the drip chamber, whether deliberate or accidental, will have no effect upon the flow or direction of flow of the infusion liquid. This results from the fact that the volume of the inlet section of the drip chamber is significantly less than the volume of the outlet section of the drip chamber, thereby assuring that the opening of the outlet tube from the chamber will remain covered by the liquid so as to absolutely prevent the escape of air bubbles through such opening.

The outer ends of the inlet and outlet tubes may be connected with appropriate tubing to the container for the infusion liquid, the administering needle or catheter and, if desired, to a suitable stopcock or other valve. In order, however, to provide a drip chamber which is adaptable for use in a wide variety of applications, the drip chamber housing, in one preferred embodiment, is provided with reinforcing ribs arranged in a starburst fashion about each of the outwardly extending inlet and outlet tubes to prevent breakage thereof during storage or handling. As another alternative embodiment, the housing is designed to provide for recessed tubular interconnections to prevent breakage or separation of the several components of the infusion set during storage, handling or use.

It is, therefore, among the objects of the present invention to provide a simple, ruggedly designed drip chamber for use with infusion sets and the like to determine the flow rate of a sterile liquid, while simultaneously preventing air bubbles from passing through the drip chamber to the patient being treated.

THE DRAWINGS

The preceding as well as other objects and advantages of the invention will be apparent from the following description of a number of preferred embodiments of the drip chamber hereof shown in the accompanying drawings, in which:

FIG. **1** shows a sectional view of a drip chamber designed in accordance with the principles of the present invention;

FIGS. **2***a* and **2***b* are sectional and plan views, respectively, showing an alternative arrangement for the drip chamber of FIG. **1**;

FIG. **3** is a sectional view of a portion of a drip chamber showing a further modification of the embodiment of FIG. **1**;

FIG. **4** is a sectional view showing another alternative embodiment of the present invention;

FIG. **5** is a sectional view showing an alternative embodiment of the drip chamber; and

FIGS. **6***a*, **6***b* and **6***c* are schematic views, partially in section, showing a drip chamber as a component of an infusion set (with the drip chamber enlarged for purposes of clarity), and illustrating the liquid levels maintained in the drip chamber when its orientation is changed, whether accidentally or otherwise, during use.

THE PREFERRED EMBODIMENTS

A sectional view of a drip chamber **11** designed in accordance with the principles of the present invention is shown in FIG. **1**. The drip chamber comprises a hollow housing indicated generally at **12** and defining an upper or inlet section **13** and a lower, larger volume outlet section **14**. The housing inlet section **13** has inwardly tapering walls **15** extending toward inlet wall portion **16** of the drip chamber housing. An inlet tube **17** extends through such wall portion **16** and into the inlet section **13** of the drip chamber.

The outlet section **14**, on the other hand, is defined by generally cylindrically shaped walls **18** and an adjoining outlet wall portion **19**. An outlet tube **21** is formed integrally with such wall portion extending into and through the outlet section **14** of the drip chamber. Outlet tube **21** has an outlet opening or port **22** communicating with the interior of the drip chamber housing **12**. The outlet tube is of a length such that the outlet port thereof communicates with inlet section **13** of the chamber housing. Thus, the tube may extend to the interface **23'** between the inlet and outlet sections **13** and **14** (FIG. **4**) or to some further plane **23** intersect-

ing the inwardly tapering interior walls **15** of the drip chamber inlet section.

Inlet and outlet tubes **17** and **21** which may, as shown, be aligned with one another, suitably possess relatively small internal diameters such that the liquid passed through the inlet tube will form discrete droplets which may be counted as they pass from the inlet tube into the drip chamber housing. The internal diameters of both such tubes may, for example, be of the order of 2 mm. When the tubes are formed with these diameters the liquid droplets pass through the inlet section and are collected in the outlet section **14** of the drip chamber housing rather than passing directly into the outlet portion **22** of the outlet tube.

As the droplets collect in the outlet section **14**, no liquid thus escapes from the drip chamber through the outlet tube. Rather, it is not until the liquid level reaches plane **23** (FIG. **1**) or **23'** (FIG. **4**) that any liquid can overflow through the outlet port **22** and exit from the drip chamber via outlet tube **21**. During continuous operation the discrete droplets of the liquid whose rate of flow is to be counted pass into the drip chamber housing, the liquid continuously overflowing through outlet port **22** and exiting from the drip chamber.

The normal orientation for the drip chamber is as shown in FIG. **1** with the inlet port being positioned directly above the outlet port so that their openings are substantially vertically aligned. If the orientation of the drip chamber **11** is either deliberately or accidentally altered from the vertical alignment as shown, the configuration of the drip chamber is such as to prevent the air which may have collected in the inlet section **13** of the drip chamber housing (i.e., in the region above the level **23** or **23'**) from exiting from outlet port **22**. By providing adjoining inlet and outlet sections within the drip chamber housing, the former of which is of smaller volume and which is defined by inwardly tapering (conical, as shown in the drawings) wall surfaces, and extending the outlet tube into and through the outlet section such that the outlet opening communicates with the inlet section of the drip chamber housing, the liquid which overflows through the outlet opening acts as a liquid seal preventing the escape of air therefrom. Moreover, by incorporating inwardly tapering inlet section wall surfaces **15**, air bubbles such as might form with orthogonally directed wall surfaces are not produced. Thus, any disorientation of the drip chamber merely displaces the liquid level without permitting air to escape through outlet port **22**. Such is the case whether the drip chamber is either momentarily disturbed or is disturbed for longer intervals of time.

FIG. **4** shows a slightly modified embodiment from that shown in FIG. **1** wherein like components are designated by like numerals. The basic difference between the arrangement of FIG. **4** and that shown in FIG. **1** is that the outlet section **14** of the drip chamber **11'** is open ended and that the outlet or base wall portion **19** is provided with an upwardly extending circular flange **19*a*** which may be press fitted into the interior of outlet section **14** in the manner shown. This arrangement simplifies the production techniques employed in producing the drip chamber. Alternatively, the inlet section **13** of the housing **12** may be designed in a similar fashion with the upper or inlet wall portion **16** being provided with a similar flange to be fitted into an open-ended inlet section.

FIG. **5** shows still another alternative embodiment in which the outlet tube assembly **21'** incorporates a separate member **24** having a slightly tapered hollow conical portion **21*a*** integral with a hollow conical skirt **21*b*** of greater taper. This member is preferably press fitted into the outlet surface **19** having an upwardly extending flange **19*a***. A porous filter sheet **25** is positioned between the lower edge of member **24** and the outlet surface **19**. Sterile liquid is collected in the embodiment of FIG. **5** in a manner similar to that described hereinabove with regard to the embodiment of FIG. **1** until the liquid level reaches the height of the outlet port **22'** of the member **24**, at which time the liquid is then free to pass therethrough and through porous member **25** outwardly from the drip chamber. The porous filter member **25** acts to prevent any foreign matter from exiting through the outlet tube assembly and may be replaced at any time by a fresh filter member, if desired.

FIGS. **2*a*** and **2*b*** show a portion of a drip chamber, including the inlet section **13**, incorporating a modified structure which may be employed with any of the drip chambers shown in FIGS. **1**, **1*a*** or **4**. As shown therein, the inlet section **13** of a drip chamber **11'''** is provided with a plurality of radially aligned ribs **26** each having a triangular configuration. The lower horizontal edge of each rib **26** is integrally joined to the upper surface of inlet wall portion **16**. Each of the vertically aligned edges **26*a*** of ribs **26** lies a spaced distance from the outer surface of the inlet tube **17**. The vertically aligned edges **26*a***, together with the outer surface of the inlet tube **17**, form a hollow annular region surrounding the inlet tube wherein a flexible connector **27** may be force fitted to provide a tight fitting between members **17** and **27**. The radially aligned ribs **26** serve the dual functions of protecting the inlet tube **17** against undue bending and/or breakage, while simultaneously providing an improved fitting. Whereas six ribs are shown as illustrative in the embodiments of FIGS. **2*a*** and **2*b***, it should be understood that greater or lesser numbers of reinforcing ribs may be provided, if desired.

It should further be understood that a substantially similar arrangement may be employed to protect the outlet tube **21** and to provide an improved fitting therewith. In a preferred embodiment, both the inlet and outlet tubes **17** and **21** are preferably so designed.

FIG. **3** shows another alternative embodiment for providing an improved fitting between the drip chamber and external connectors **27**. In this form of the invention the inlet wall portion **16** of the drip chamber housing comprises a tapered surface which defines an annular opening together with the outer surface of the inlet tube **17** recessed within the opening. In this manner, the inlet tube is protected against undue bending and/or breakage which may occur as a result of rough handling. In addition thereto, the annular opening provides a press fit between the flexible connector **27** and inlet tube **17**.

The outlet wall portion **19** of housing **12** (see FIG. **1**) may be tapered in a fashion similar to that shown in FIG. **4** so as to provide a recessed arrangement for protecting and coupling the outlet tube **21** to an internal connector.

The use of a typical drip chamber **11** of the present invention as part of an infusion set is illustrated in FIGS. **6*a***, **6*b*** and **6*c***. In these drawings there is schematically illustrated an infusion set comprising a bag, bottle or other container **28** for the blood, saline solution or

other infusion liquid, a catheter or needle **29**, and flexible connectors **27** coupling the liquid container, the drip chamber, and the administering needle or catheter. Preferably, the infusion set additionally includes a valve **31** for regulating the flow of the liquid infused consistent with the desired drip rate determined by periodic inspection of the feed of droplets through the drip chamber. Any conventional stopcock may be used as such valve means; preferably, however, infusion sets incorporating the novel drip chamber hereof additionally include stopcocks of the type described in my application Ser. No. 714,644 filed Mar. 20, 1968, entitled "Stop Cock", now abandoned and the continuation-in-part thereof, Ser. No. 48,807 filed June 8, 1970, now Pat. No. 3,678,960 granted on July 25, 1972.

The drip chamber hereof may be advantageously employed in the novel infusion set described in my copending application Ser. No. 132,516 filed Apr. 8, 1971 entitled "Non-Gravitational Infusion Set". The rugged construction of the drip chamber of this invention and the fact that such prevents air leakage through the administering needle or cannula irrespective of the orientation thereof makes it particularly useful in the infusion set described in the said application, which set is particularly useful for battlefield or like application in which it may be subjected to adverse conditions.

In FIGS. **6***a*, and **6***b* and **6***c* the drip chamber **11** is diagrammatically shown in three varying orientations to illustrate the liquid seal formed therein during use which prevents the escape of air bubbles from the chamber irrespective of the orientation thereof. Since the outlet tube **21** of the chamber extends into the inlet section of the chamber housing and such section possesses a smaller volume than the outlet section **14** thereof, more than half of the chamber volume is filled with liquid before any can overflow through the outlet port and through the connector **27** to the administering needle or catheter **29.** The liquid levels **23***a*, **23***b* or **23***c* illustrated in the respective views are thus above the level of the outlet port **22,** irrespective of the orientation of the drip chamber. In this manner the desired liquid seal is maintained and air bubbles cannot escape from the inlet section **13** of the drip chamber through the connecting tube to the administering needle or other device.

It may be seen from the foregoing description that the present invention provides a novel drip chamber for determining the flow of a liquid to be administered to a patient by means of an infusion set incorporating the same. Such drip chamber is both simple and rugged in design and construction and may, therefore, be utilized in a wide variety of applications. Moreover, the drip chamber design is such as to prevent the escape of air bubbles from the drip chamber and into the administering needle or catheter, irrespective of the accidental or intentional disorientation of the drip chamber from the vertical. It will be understood that other modifications of the preferred embodiments of the drip chamber described hereinabove may be made without departing from the scope of the present invention. The preceding description should, therefore, be construed as illustrative and not in a limiting sense.

I claim:

1. A drip chamber for determining the rate of flow of a liquid comprising:

a. a hollow housing having a first inlet section and a second, larger volume outlet section;

b. an outlet tube extending into and through at least the outlet section and having an outlet opening communicating with the inlet section of the housing;

c. interior walls defining the principal inside surfaces of the inlet section and tapering inwardly from at least the portion of the inlet section adjacent to the outlet tube opening toward the inlet end of the drip chamber;

d. an inlet tube extending from the inlet end of the drip chamber through a portion of the inlet section and having an inlet opening communicating with the inlet section and spaced from the outlet tube opening;

e. means secured to the outside of the housing adjacent to the external opening of the inlet and/or outlet tubes thereof providing a bearing surface spaced from and substantially parallel to the longitudinal axis of such tube and defining a hollow annular region for receiving and securing a tubular connector to either side tube, said means comprising a plurality of radially aligned ribs secured to the adjacent housing portion each of which ribs has an edge substantially parallel to the longitudinal surface of the adjacent inlet and/or outlet tube and which edges define said bearing surface;

liquid fed into the drip chamber filling at least the outlet section thereof prior to overflowing through the outlet tube opening and exiting through such tube, said liquid defining a liquid seal preventing the escape of air bubbles from the drip chamber through the outlet tube irrespective of the orientation thereof.

2. A drip chamber for determining the rate of flow of a liquid comprising:

a. a hollow housing having a first inlet section and a second, larger volume outlet section;

b. an outlet tube extending into and through at least the outlet section and having an outlet opening communicating with the inlet section of the housing;

c. interior walls defining the principal inside surfaces of the inlet section and tapering inwardly from at least the portion of the inlet section adjacent to the outlet tube opening toward the inlet end of the drip chamber;

d. said outlet section of the housing comprising a cylindrically shaped element open at one end, a disc-shaped member supporting the outlet tube, and a flange formed integrally with and extending circumferentially of the disc-shaped member and adapted to be press fitted into the open end of the cylindrically shaped element; and

e. said outlet tube being provided with a skirt portion flaring outwardly toward the open end of the cylindrically shaped element, the edge of said skirt being adapted to engage and be supported by the inner surface of the flange of the disc-shaped member;

liquid fed into the drip chamber filling at least the outlet section thereof prior to overflowing through the outlet tube opening and exiting through such tube, said liquid defining a liquid seal preventing the escape of air bubbles from the drip chamber through the outlet tube irrespective of the orientation thereof.

3. The device of claim **2,** further comprising a sheet of porous filter material disposed between the outlet tube and the inner surface of the disc-shaped member which is adapted to close off the open end of the cylindrically shaped element.

* * * * *