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Willock

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[54] **DROP BULB PRESSURE-MEASURING DEVICE**

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[52] **U.S. Cl.** ..... **73/389,** 128/214 E

[51] **Int. Cl.** **G01l 19/00**

[58] **Field of Search** ..... 73/388, 389, 406; 128/214 C, 214 E, 214 F, DIG. 13; 210/91

[56] **References Cited**

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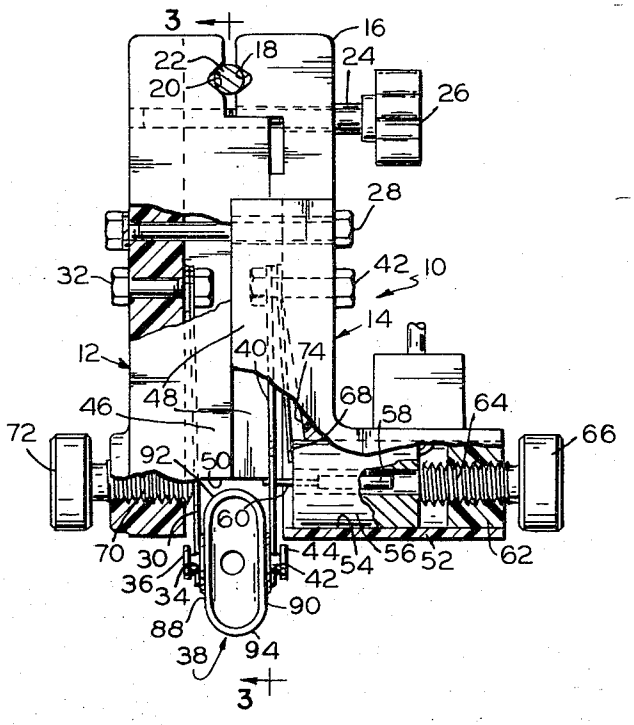
Primary Examiner—Donald O. Woodiel

Attorney, Agent, or Firm—Klarquist, Sparkman, Campbell, Leigh, Hall & Whinston

[57] **ABSTRACT**

A blood set for a dialysis system is provided with a drip bulb having flexible side walls and a transducer responsive to the relative position thereof whereby pressure within the drip bulb is ascertained.

12 Claims, 3 Drawing Figures



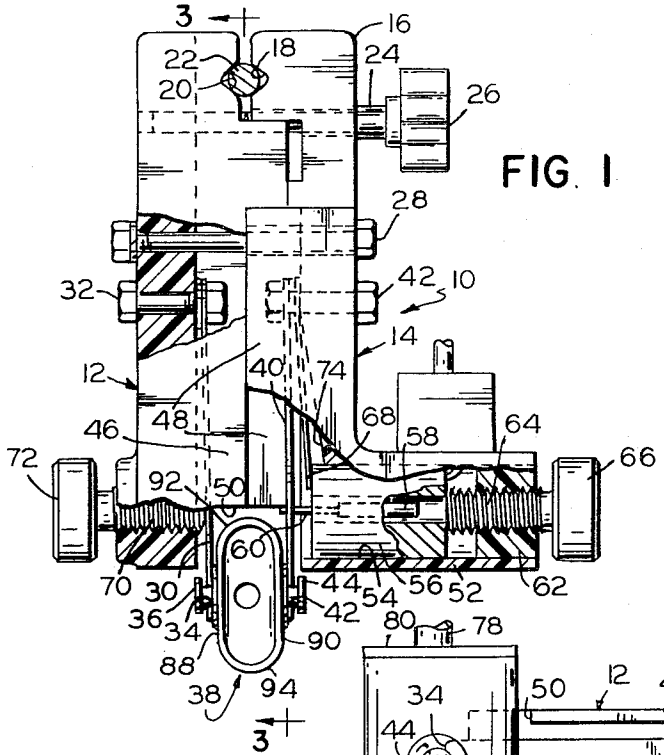


FIG. 1

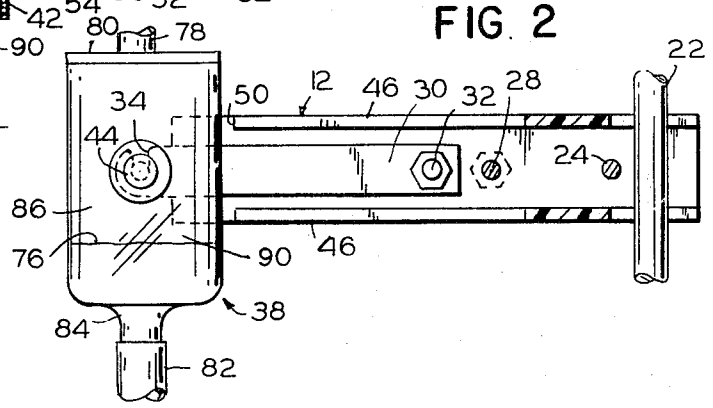


FIG. 2

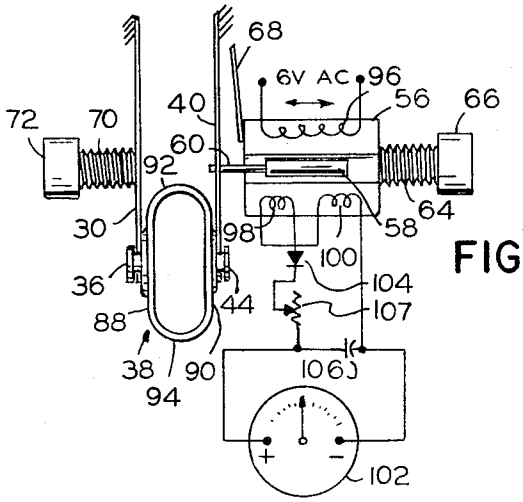


FIG. 3

DROP BULB PRESSURE-MEASURING DEVICE

BACKGROUND OF THE INVENTION

A conventional dialysis system includes a drip bulb of round cross section into which a needle is inserted for connection via tubing to a conventional diaphragm pressure gauge by means of which pressure within the drip bulb is measured. It is then possible to terminate system operation or take corrective action if the pressure in the system is improper. In the case of dialysis, blood circulates through the blood set and contamination of the blood can occur as when blood backs up into the measuring system. Furthermore, such backup can have a deleterious effect on the proper pressure readings and results in contamination and possible damage to the pressure-measuring equipment.

SUMMARY OF THE INVENTION

A drip bulb according to the present invention comprises a unitary pressure-measuring device for avoiding contamination of the transported liquid and contamination of external pressure-measuring equipment. The drip bulb is provided with a flexible wall to which a movement sensitive transducer is coupled for ascertaining the pressure within the closed drip bulb.

In accordance with a preferred embodiment of the present invention, a drip bulb having an elongate cross section and a pair of adjacent flexible walls is disposed in a frame wherein the spacing between the walls due to gaseous pressure can be measured. An electromagnetic transducer includes a movable core coupled to a support of one of said flexible walls, and a differential electrical output is produced corresponding to pressure within the bulb.

Accordingly, an object of the present invention is to provide an improved pressure-measuring device for a blood set.

Another object of the present invention is to provide an improved means for ascertaining the gaseous pressure within a drip bulb.

It is a further object of the present invention to provide an improved, unitary, pressure-measuring drip bulb device wherein connection of remote pressure gauges to such drip bulb is avoided.

It is another object of the present invention to provide an improved pressure-measuring drip bulb which avoids contamination of fluid passing therethrough and contamination or damage to pressure-measuring apparatus.

The subject matter which I regard as my invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. The invention, however, both as to organization and method of operation, together with further advantages and objects thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings wherein like reference characters refer to like elements.

DRAWINGS

FIG. 1 is a plan view, partially broken away, of pressure-measuring apparatus according to the present invention;

FIG. 2 is a cross-sectional view taken at 2—2 in FIG. 1; and

FIG. 3 is a schematic representation of the pressure-measuring apparatus according to the present invention including electrical circuitry associated therewith.

DETAILED DESCRIPTION

Referring to the drawings, and particularly to FIGS. 1 and 2, pressure-measuring apparatus according to the present invention comprises a U-shaped frame generally indicated at **10** including a first leg **12** and a second substantially parallel leg **14**, both of which are formed of plastic material. The rearward portion of leg **14** is extended rearwardly by a movable member **16** interfitting with leg **12** and having a notch **18** aligned with a notch **20** on leg **12** and for engaging a vertical support rod **22**. The notched members are joined together in clamping relation to the support rod by means of screw threaded rod **24** engaging threads in member **12** and having a shoulder bearing against member **16**. Rod **24** is provided with an adjusting knob **26** for rotating the same.

Legs **12** and **14** are secured together with a bolt **28**. Leg **12** forms the base for a somewhat flexible metal support strap **30** extending along the inside of leg **12** and secured to leg **12** by means of a bolt **32**. The support strap **30** extends beyond the open end of the U-shaped frame where it is provided with a vertically upward opening notch **34** for receiving an attachment button **36** of drip bulb **38**. Also, a second somewhat flexible metal support strap **40** is secured to leg **14** by means of bolt **42** and extends along the inside of leg **14** and beyond the open end of the U-shaped frame where the support strap **40** is provided with an upward opening notch **42** for receiving a second attachment button **44** of the aforementioned drip bulb **38**. Leg **12** has upper and lower flanges **46** which meet with upper and lower flanges **48** of leg **14** to enclose the central portion of the U-shaped frame up to a forward opening **50** where the flanges are foreshortened so that drip bulb **38** can be partially accommodated within the opening of the U.

A housing **52** extends at right angles to leg **14** near the open end of the U-shaped frame and is provided with an inside cylindrical chamber or bore **54** opening adjacent support strap **40** inside the frame. Chamber or bore **54** receives a cylindrical transducer **56** comprising a metal enclosed coil bobbin having a movable core **58** slidably received therewithin, the latter being formed of magnetically permeable material. The core **58** is threaded on one end to receive a threaded hard rubber connecting rod **60** which is attached to support strap **40**, the rod **60** extending through a small aperture in strap **40** where the two are substantially joined. Flexure of strap **40** moves connecting rod **60**, which, in turn, changes the axial position of core **58** within bobbin **56**. The transducer comprising bobbin **56** and core **58** is suitably a model **225A-050** transducer manufactured by Robinson-Halpern of West Conshohocken, Pennsylvania.

Chamber or bore **54** is provided with a solid plug **62** on one end thereof which is internally threaded to receive a threaded adjusting screw **64** having a head **66** for rotating the same. The remote end of transducer bobbin **56** is retained by a leaf spring **68** which urges the bobbin **56** toward adjusting screw **64** such that rotation of screw **64** is effective for adjusting the position of the bobbin in the direction toward or away from

metal strap **40**. Thus, the bobbin **56** is moved by such adjustment relative to the core **58**. Leaf spring **68** is secured to leg **14** by means of bolt **42**, and leg **14** is relieved at **74** so that the leaf spring can be effective in moving bobbin **56** back and forth. A second adjusting screw **70**, provided with a head **72** for rotating the same, is threadably received through the opposite wall of leg **12**, in substantially axial alignment with adjusting screw **64** and the transducer. Screw **70** bears against strap **30** for positioning strap **30**.

Drip bulb **38** is a container suitably elongated in the vertical direction and supported vertically so that a liquid **76**, e.g., blood, intravenous solution, or the like, is held in the lower part thereof. Ingress of liquid is provided via tube **78** secured to plastic cap **80** while egress of liquid is provided by tube **82** joined to lower funnel-shaped outlet **84** of the drip bulb, wherein tubes **78** and **82** may form part of a blood set utilized in dialyzer operation of the like. The liquid is conventionally introduced via tube **78** as droplets falling to liquid level **76** through a gaseous region or air space **86** thereabove.

The drip bulb according to the present invention is desirably elongate or flattened in cross section as illustrated in FIG. **3** so as to be provided with flexible, facing side walls **88** and **90** of larger dimension, and shorter curved end walls **92** and **94**. The drip bulb is suitably formed of a transparent plastic material adapting side walls **88** and **90** to flex or move toward and away from one another according to the pressure in gaseous region **86** within the drip bulb. The side walls **88** and **90** are provided respectively with attachment buttons **36** and **44** which are rigidly secured to the side walls and which are respectively received within the upwardly facing notches of support straps **30** and **40**. ConsequentlY, as pressure changes within the drip bulb, the side wall **90** moves away from or toward side wall **88** and will flex the support strap **40** relative to support strap **30**. Since hard rubber connecting rod **60** is joined to strap **40**, flexure of strap **40** in this manner will move magnetically permeable core **58** back and forth with respect to bobbin **56**.

The upper U-shaped notches **34** and **42** in support straps **30** and **40** are narrowed slightly at the top as can be seen in FIG. **2**, whereby the neck portions of the attachment buttons **36** and **44** snap into place, so the drip bulb **38** is securely held. However, the bulb can be removed from strap supports **30** and **40**, for replacement, by urging the same upwardly.

Reference is now made to FIG. **3** illustrating a circuit arrangement according to the present invention and schematically illustrating the connection of the transducer including the above-mentioned bobbin **56**. Bobbin **56** is provided with a primary winding **96**, suitably connected to a 6volt alternating current source, and a pair of differentially related secondary windings **98** and **100**. The secondary windings **98** and **100** are reversely connected in series in the usual manner for the transducer such that, for a given central position of core **58**, a voltages induced in secondary windings **98** and **100** balance, and substantially no net output results. Adjusting screw **70** is set for the proper positioning of drip bulb **38** with respect to support strap **40**, taking into consideration the width of the bulb. Thus, movement of adjusting screw **70** adjusts the static pressure applied to the drip bulb since screw **70** bears upon support strap **30** on one side of drip bulb **38** while support strap **40** bears on the remaining side of drip bulb **38**. The pressure applied in this manner is desirably such that the drip bulb can either expand or contract as a result of gaseous pressure therewithin. Adjusting screw **64**, which moves the transducer bobbin **56** back and forth, is employed for centering meter **102** which is coupled to the secondary coils. Meter **102** desirably has a zero center position, and when bobbin **56** is positioned by screw **64** such that the voltages induced in windings **98** and **100** are equal, meter **102** is centered. Then, as the drip bulb expands or contracts, resulting in the movement of core **58**, a differential output as between the coils will cause the meter to read in the positive or negative direction. The meter is suitably calibrated according to the pressure within the drip bulb.

The windings **96**, **98** and **100** are illustrated schematically in FIG. **3**, it being understood the same will generally be wound around bobbin **56**. A rectifying diode **104** and an adjustable resistance **107** are serially disposed between one leg of the secondary coil connection and meter **102**, while a capacitor **106** shunts the meter to provide d.c. charge storage and higher meter readings. It will be appreciated that an amplifier may be disposed between the coils and the diode if desired so that more sensitive pressure readings can be taken. Furthermore, the pressure indicating electrical output may be connected to automatic control circuitry for taking a desired action in response to a pressure reading, for example shutdown of treatment equipment in response to incorrect pressure. In any case, the disadvantages of prior art systems wherein a remote pressure diaphragm is connected to a drip bulb are alleviated. Damage to and contamination of pressure-measuring equipment is avoided, and contamination of the liquid, e.g., blood in the case of a dialysis system, is also avoided.

While I have shown and described a preferred embodiment of my invention, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from my invention in its broader aspects. I therefore intend the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

I claim:

1. A drip bulb adapted to be supported in a vertical position for providing the vertical dispensing of liquid droplets through a gaseous region into a quantity of liquid contained in said drip bulb, and adapted to be pressure-responsive, said drip bulb comprising;

a container body for holding said quantity of liquid, said body having an opening proximate the top thereof for ingress of liquid and having an opening proximate the bottom thereof for egress of liquid,

wherein said drip bulb is provided with at least one flexible side wall,

and movement-responsive means adapted to detect movement of said side wall as the result of pressure changes within said drip bulb.

2. The drip bulb according to claim **1** wherein said flexible wall is one of a pair of spaced flexible walls of said drip bulb.

3. The drip bulb according to claim **1** wherein said drip bulb is elongate in horizontal cross section, said flexible wall being one of a pair of spaced larger walls of said drip bulb providing said drip bulb with a flattened, pressure-responsive configuration.

4. The drip bulb according to claim 2 provided with attachment buttons secured to the spaced walls of said drip bulb wherein said buttons are engageable for ascertaining relatve movement between said walls.

5. Pressure gauge means comprising:

a drip bulb adapted to receive liquid and having a gaseous layer above a quantity of liquid in said drip bulb, said drip bulb having a flexible wall responsive in movement to pressure within said drip bulb,

a movement-responsive transducer adapted to provide an output related to relative movement,

and means for coupling said transducer to said flexible wall whereby the movement of said flexible wall causes a change in output from said transducer.

6. The apparatus according to claim 5 wherein said transducer comprises plural electrical coil means one of which is connected to a source of alternating current, said transducer further including a movable core coupled by said coupling means to the wall of said drip bulb whereby movement of said wall changes the electromagnetic coupling between one of said coil means and other coil means of said transducer.

7. The apparatus according to claim 6 including a pressure-reading meter coupled to said other coil means.

8. A pressure-measuring device comprising:

a drip bulb having upper and lower liquid connections and having a pair of facing flexible walls provided with attachment means wherein a variation of pressure inside said bulb expands and contracts said walls toward and away from one another,

a first support for engaging one of said attachment means,

a second support for engaging the remaining attachment means, said second support being relatively movable as said facing walls of said drip bulb move toward and away from one another,

and a transducer having a movable element attached to said second support for providing an output as said second support moves relative to said first support.

9. The apparatus according to claim 8 further including a chamber for slidably receiving the transducer,

adjustment means for slidably moving said transducer in said chamber relative to the movable element of said transducer,

and spring-biasing means for urging said transducer in said chamber toward said adjustment means.

10. The apparatus according to claim 9 further including second adjustment means for moving said first support toward said drip bulb.

11. The apparatus according to claim 8 further including a substantially U-shaped frame having said supports attached to the inside legs of the U, said drip bulb being partially received between the legs of the U.

12. The apparatus according to claim 8 wherein said frame includes an adjustable clamp for securing said frame to a vertical support rod.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,841,157

DATED : October 15, 1974

INVENTOR(S) : Charles B. Willock

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

In the title, "DROP" should be --DRIP--.
Column 3, line 19, "of" should be --or--.
Column 3, line 35, "ConsequentlY" should be --Consequently--.
Column 3, line 54, "6volt" should be --six-volt--.

Signed and sealed this 20th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks