United States Patent

[11] **3,596,515**

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[54] **DROP FLOW SENSOR AND RESILIENT CLAMP THEREFOR**
10 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** ..... 73/194 R
[51] **Int. Cl.** G01p 5/00
[50] **Field of Search** 73/194; 250/43.5, 218, 222; 340/239; 356/39, 41

[56] **References Cited**

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Attorney—Fulwider, Patton, Rieber, Lee and Utecht

ABSTRACT: Apparatus for monitoring drop flow in the drip chamber of an intravenous set and including a sensor housing containing a reference light source located a fixed distance from a photocell to define a fixed optical sensing gap therebetween, with a reference light beam normally impinging upon the photocell. The housing can be selectively clamped upon the drip chamber with the drip chamber positioned within the sensing gap to intercept the reference beam. A falling drop of fluid within the drip chamber interrupts the reference beam, and the variation in the electrical response of the photocell is communicated to an indicator to indicate the presence of a drop. A spring-biased sleeve clamps the housing onto any size drip chamber without altering the size of the sensing gap. The clamping sleeve is provided with rods which extend radially outward from opposite sides of the sleeve and, in conjunction with one end of the housing, define a syringe-type grip for positioning the sleeve.

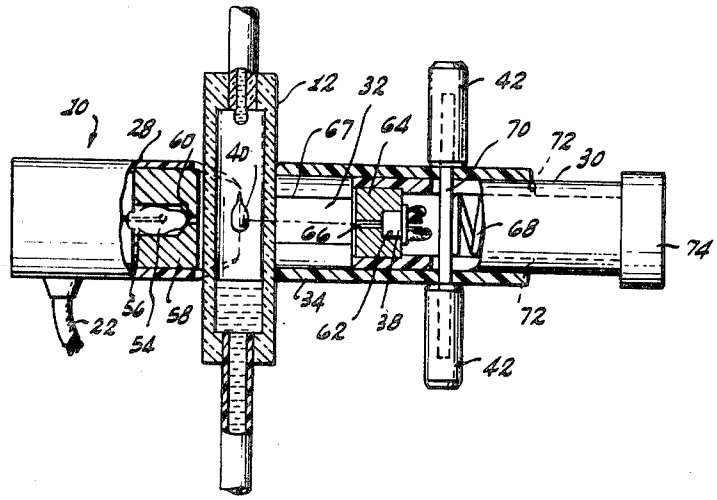


Fig. 1

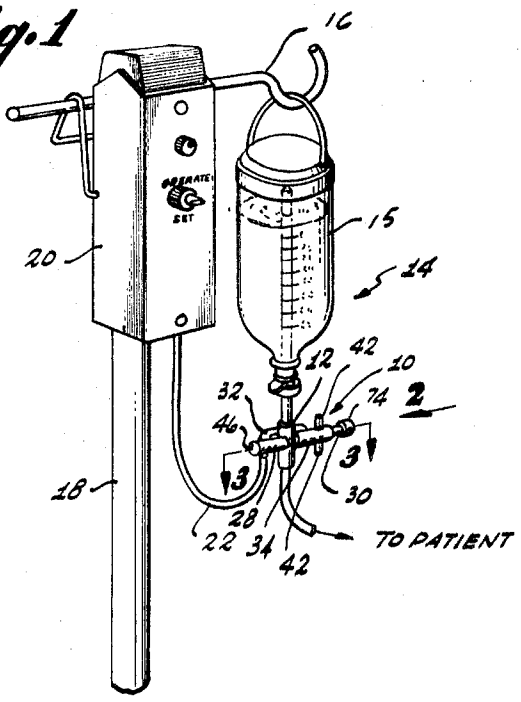


Fig. 2

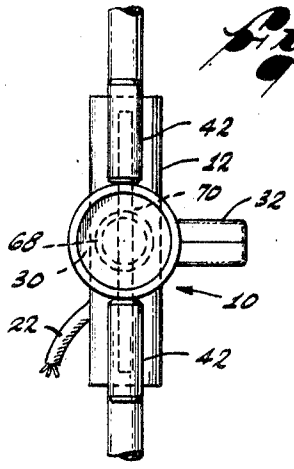


Fig. 3

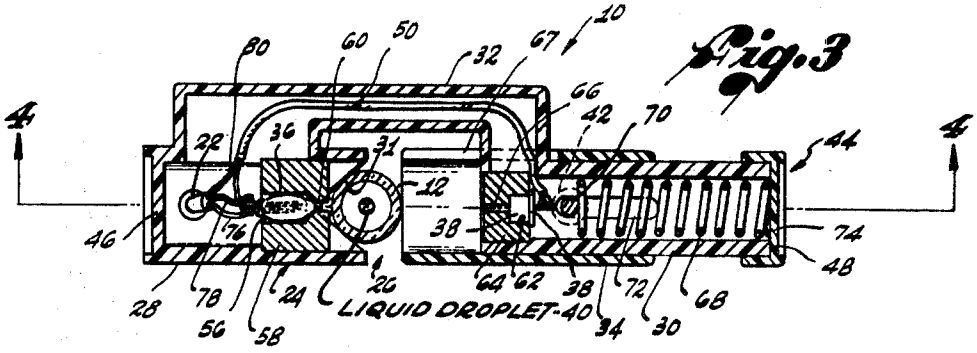


Fig. 4

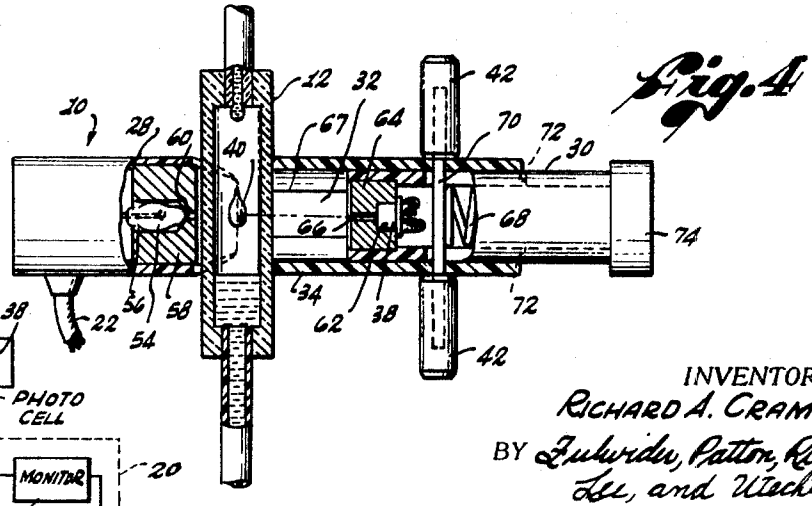
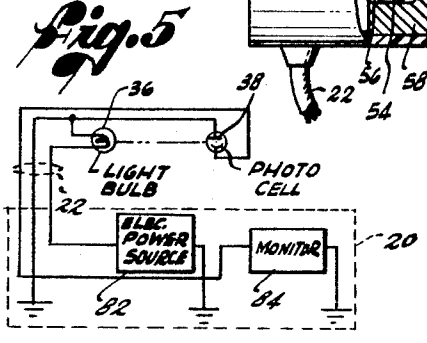


Fig. 5



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DROP FLOW SENSOR AND RESILIENT CLAMP THEREFOR

BACKGROUND OF THE INVENTION

The present invention relates generally to drop flow sensing devices and, more particularly, to a new and improved device for sensing the presence of a drop of fluid in the drip chamber of an intravenous set or the like used in medical applications.

The usual medical procedure for the gradual intravenous introduction of fluids into the human body, such as liquid nutrients, blood or plasma makes use of apparatus which is commonly referred to in the medical arts as an intravenous set. The intravenous set comprises a bottle of fluid, normally supported in an inverted position, and a valve mechanism which allows the fluid to drip out of the bottle at a controlled rate into a drip chamber below the bottle. The drip chamber serves the dual function of allowing a nurse or other attendant to observe the rate at which the fluid drips out of the bottle and also creates a reservoir for the fluid at the lower end of the chamber to insure that no air enters the main feeding tube leading to the patient.

While observation of the rate of drop flow via the drip chamber is a simple and effective way of controlling the amount of fluid fed to a patient over a period of time, its ultimate effectiveness requires that a relatively constant vigil be maintained on the drop flow, lest it cease due to exhaustion of the fluid supply or become a continuous stream and perhaps increase the rate of fluid introduction to the patient to a dangerous level.

In recent years, electronic monitoring systems have been developed to automatically sense and indicate drop rate, either at the feeding site or at a remote location. Such electronic devices can also activate an aural or visual alarm when a potentially dangerous condition exists, thus freeing medical personnel for other duties. While such electronic drop rate monitoring systems have generally served their purpose, they have not proven entirely satisfactory from the standpoint of compactness, ease of installation and removal, and consistency of sensing calibration for different sizes of drip chambers. The present invention obviates these difficulties.

SUMMARY OF THE INVENTION

Briefly, and in general terms, the present invention is directed to improvements in sensing devices for detecting the presence of a falling drop at a specified location in a drop flow system, such as an intravenous set or the like.

In a presently preferred embodiment of the sensing device of the present invention, a relatively narrow reference beam of light enters one side of a drip chamber or the like and strikes a photocell located on the opposite side of the chamber A drop of fluid falling through the drip chamber interrupts the reference beam, and the resultant change in the electrical response of the photocell indicates the presence of the drop.

The light source and photocell may be mounted in two respective, axially aligned sections of a substantially tubular housing. A sensing gap between the two sections is externally bridges by a fixed member. The light source and photocell are thus maintained at a constant distance from each other. Clamping means are provided for mounting the sensing device without altering the distance between the light source and photocell, thus resulting in a uniform response characteristic for different sizes of the drip chamber.

In the preferred embodiment of the invention the clamping means may comprise a concentric sleeve surrounding one of the housing sections and spring-biased to move across the sensing gap so that the sensing device can be mounted on a drip chamber with the chamber clamped between one of the housing sections and the sleeve.

The spatial relationship between the light source, drip chamber and photocell is such that the light source is closest to the drip chamber, so that a falling drop interrupts a relatively large part of the reference light beam.

The clamping sleeve may be provided with rodlike extensions on opposite sides of the sleeve so that the overall structure resembles the conventional syringe familiar to most hospital personnel. Such personnel can thus grip the sensing device naturally for attachment to or detachment from a drip chamber.

The present invention therefore provides a sensing device which is structurally compact, provides uniform response for any size drip chamber, can be quickly and easily installed or removed, and is naturally handled with confidence and ease by hospital personnel.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a presently preferred embodiment of a sensing device, in accordance with the present invention, the sensing device being shown installed on a conventional intravenous set and electrically connected to an appropriate electronic indicator;

FIG. 2 is an enlarged, end elevational view taken in the direction of the arrow 2 in FIG. 1;

FIG. 3 is an enlarged sectional view, taken along the line 3–3 in FIG. 1;

FIG. 4 is a sectional view, taken along the line 4–4 in FIG. 3; and

FIG. 5 is a combined block diagram and electrical schematic of a complete drop flow monitoring system utilizing the sensing device of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, and particularly to FIG. 1 thereof, a presently preferred embodiment of a sensor 10, constructed according to the present invention, is shown clamped onto a drip chamber 12 of an intravenous set 14. In operation, a bottle 15 of the intravenous set 14 is suspended from a hook 16 extended from a vertical pole 18. An electronic indicator 20 is shown in FIG. 1 mounted upon the pole 18, and an electric cable 22 connects the indicator to the sensor 10.

While the sensor 10 is illustrated and described in connection with its application in a monitoring system for intravenous feeding, it is to be understood that this is only by way of example, and the sensor 10 may be utilized in any drop flow sensing application without departing from the spirit and scope of the present invention.

As best observed in FIGS. 3 and 4, the sensor 10 generally comprises a tubular housing 24 constructed with a centrally located sensing gap 26 between a combined lamphouse and clamping section 28 and a coaxial transducer section 30. The two sections 28, 30 are supported in fixed spatial relationship by an external bridge member 32. The sensor 10 is adapted to be detachably secured to the drip chamber 12 by frictional engagement between the clamping section 28 and a spring-biased concentric sleeve 34 slidably mounted on the transducer section 30. The internal end of the clamping section 28 is provided with a substantially V-shaped notch 31 defining a clamping jaw for firmly engaging the chamber 12.

A reference beam of light from a light source 36 in the section 28 projects through the drip chamber 12 onto a photocell 38 in the transducer section 30 of the housing 24. The reference light beam is interrupted whenever a fluid drop 40 falls through the drip chamber 12, and this interruption is electrically communicated to the indicator 20 via the cable 22.

A pair of finger grip rods 42 extend radially outward from opposite sides of the sleeve 34 and, in conjunction with the outer sealed end 44 of the transducer section 30 of the housing 24, forms a syringe-type grip for selectively retracting the sleeve to enable mounting or removal of the sensor 10 with respect to the drip chamber 12.

The housing 24 of the sensor 10 is preferably formed of molded plastic or the like An integrally formed end wall 46 seals the external end of the clamping section 28. As best observed in FIG. 3, the bridge member 32 of the housing 24 is

hollow to accommodate a pair of electrical conductors 50 for connection to the photocell 38.

The the cavity source 36 is in a central cavity 56 provided in a mounting block 58 positioned just behind the notch 31 in the clamping section 28. A relatively small columnating aperture 60 extends from the cavity 56 through the block 58 and defines a relatively narrow reference light beam. The spatial relationship between the aperture 60, the mounting block 58 and the notch 31 is such that the reference light beam passes approximately through the center of the drip chamber 12 when it is positioned in the notch.

The photocell 38, preferably of the germanium-type, is mounted in a close-fitting cavity 62 provided in a mounting block 64 which is positioned at the internal end of the transducer section 30 of the housing 24. A columnating aperture 66 extends from the cavity 62 to the outermost face of the mounting block 64. The light source 36, columnating apertures 60, 66, and the photocell 38 are coaxially aligned to define an optical axis for the sensing system, and to minimize off axis photocell response to stray light.

When the sensor 10 is mounted on the drip chamber 12, the sleeve 34 is urged toward the drip chamber 12 by means of a compressed coil spring 68 in the transducer section 30 of the housing 24. The sleeve 34 is concentric with and slidable along the transducer section 30 of the housing 24, with clearance for the bridge member 32 being provided by means of a slot 67 in the sleeve.

One end of the spring 68 abuts a pin 70 which passes through the section 30 and sleeve 34 and is affixed to the sleeve. The pin 70 travels in a pair of aligned slots 72 in opposite sides of the transducer section 30 (see FIGS. 3 and 4). The finger grip rods 42 are mounted on the outer ends of the pin 70 projecting beyond the external surface of the sleeve 34. The end of the spring 68 opposite that in abutment with the pin 70 abuts an end cap 74 which snaps over the open end 48 of the transducer section 30.

The capped end 44 of the transducer section 30 of housing 24 and the finger grip rods 42 form a syringe-type grip familiar to most hospital personnel. The sensor 10 is mounted upon the drip chamber 12 by retracting the spring-biased sleeve 34, positioning the drip chamber in the sensing gap 26, and then releasing the sleeve 34 to engage the chamber.

The light source 36 and photocell 38 are electrically connected to the indicator 20 by means of cable 22 which enters the clamping section 28 of the housing 24. One conductor 76 is connected to one terminal of the light source 36 and a second conductor 78 is connected to the other terminal of the light source. The second conductor 78 is common to both the light source circuit and the photocell circuit and is also connected by means of one of the conductors 50 to one terminal of the photocell 38. The third conductor 80 in the cable is connected to the other conductor of the conductor pair 50 and is thereby electrically connected to the second terminal of the photocell 38.

The manner in which the light source 36 and photocell 38 are connected to a power source 82 and monitor 84, respectively, in the indicator 20 is illustrated schematically in FIG. 5.

The sensing device of the present invention satisfies a long existing need in the art for a compact, reliable, versatile, and easily utilized drop flow sensor.

It will be understood that, while a particular form of the invention has been illustrated and described, various modifications of design and construction can be made without departing from the spirit and scope of the invention Hence, the invention is not to be limited except as defined by the appended claims.

I claim:

1. A sensing device adapted to be mounted on the drip chamber of an intravenous set, said sensing device comprising:
- a generally oblong housing having a sensing gap therein, said gap being adapted to receive said drip chamber;
- a light source positioned in a first end of said housing, the light from said light source being formed into a narrow reference beam directed through said sensing gap and any drip chamber contained therein;
- photosensitive means positioned in a second end of said housing said photosensitive means being in the path of said reference beam;
- a hollow conduit communicating with said first end and said second end of said housing and establishing the spacing therebetween;
- means within said conduit for electrically interconnecting said light source and said photosensitive means;
- clamping means for detachably clamping said device to said drip chamber, said clamping means comprising a sleeve disposed around one of said first and second ends of said housing in sliding relationship therewith, said sleeve being resiliently urged across said gap, and at least one grip rod extending from said sleeve, said grip rod forming a syringe-type grip in conjunction with an external face of said one of said first and second ends of said housing; and
- means for electrically connecting said photosensitive means to an indicating means.

2. The sensing device of claim 1, wherein said photosensitive means is spaced a fixed distance from said light source, said clamping means serving to detachably clamp said device to said drip chamber without altering the spacing between said light source and said photosensitive means.

3. sensing apparatus for sensing drop flow in a fluid conduit, comprising:
- a light source;
- photosensitive means;
- housing means for supporting said light source and said photosensitive means in fixed spatial relationship relative to each other, whereby said light source and said photosensitive means are spaced apart by a predetermined distance defining a sensing gap;
- means for defining a reference light beam from said light source, said reference beam being directed across said sensing gap to impinge upon said photosensitive means; and
- resiliently urges clamping means adjacent said sensing gap for retaining a fluid conduit within said gap in the path of said reference beam, said clamping means including a spring biased sleeve surrounding at least a part of said housing means, and at least one grip rod extending from said sleeve to define a syringe like grip with one end of said housing means, said clamping means enabling retention of different size conduits within said sensing gap without altering the size of said gap.

4. Sensing apparatus as set forth in claim 3, and further including means cooperatively associated with said light source and said clamping means for positioning a conduit closer to said light source than to said photosensitive means.

5. Sensing apparatus as set forth in claim 3, said housing means including:
- a first substantially tubular housing for said light source; and
- a second substantially tubular housing for said photosensitive means.

6. Sensing apparatus as set forth in claim 5, wherein said spring biased sleeve surrounds and is concentric with at least one of said substantially tubular housings.

7. Sensing apparatus as set forth in claim 6, wherein said sleeve surrounds only said second housing.

8. Sensing apparatus as set forth in claim 6, wherein said means for defining said reference beam includes means for defining at least one columnating aperture within at least one of said housings.

9. Sensing apparatus as set forth in claim 6, including a pair of grip rods extending outwardly from said sleeve on opposite sides thereof to define a syringe-type grip with one end of said housings.

10. Sensing apparatus as in claim 3, wherein said clamping means includes coil spring means within said housing for urging said sleeve across said sensing gap.

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,596,515 Dated August 3, 1971

Inventor(s) RICHARD A. CRAMER

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 53, after "chamber" insert a --.-- (period).

Line 60, before "by" delete "bridges" and insert therefor --bridged--.

Column 2, Line 73, after "like" insert a --.-- (period).

Column 3, Line 3, before "in" delete "The the cavity source 36 is" and insert therefor --The light source 36 is mounted--.

Line 12, after "the" delete "germanium-type" and insert therefor --germanium type--.

Line 64, after "invention" insert a --.-- (period).

Column 4, Line 39, after "resiliently" delete "urges" and insert therefor --urged--.

Signed and sealed this 28th day of March 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents