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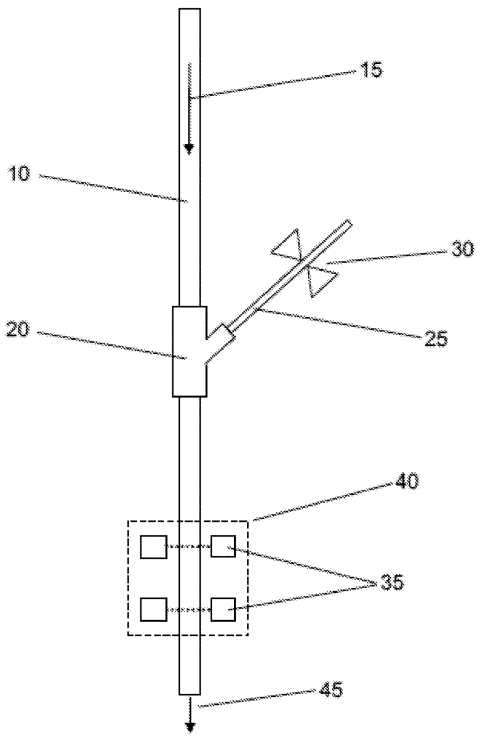
(56) Documents Cited:
GB 2119927 A
DE 019547624 A1
US 3693436 A
JP S62233721
WO 2010/084268 A1
US 5355735 A

(58) Field of Search:
INT CL **G01F**
Other: **EPODOC, WPI**

(54) Title of the Invention: **Flow monitoring device**
Abstract Title: **Liquid flow monitoring device with gas bubble injection and downstream measuring unit**

(57) A liquid flow monitoring device comprises a tubing 10 filled with a liquid, an injection port 20 connecting a tubing 25 containing air or gas to the tubing filled with the liquid. A valve 30 is arranged as for controlling the inlet of gas or air into the liquid of the tubing filled with liquid and a measuring unit 40 is arranged downstream of the inlet port. The valve may be a solenoid valve. The measuring unit may have two light barriers 35 and the tubing between the light barriers may be translucent. The flow rate may be calculated using the measured time for a first bubble to pass the light barriers and the length of the measuring track. A second bubble may be injected when the first has completely passed the light barriers. The flow rate may be controlled by comparison to a desired value.

Figure 1



GB 2537165 A

Figure 1

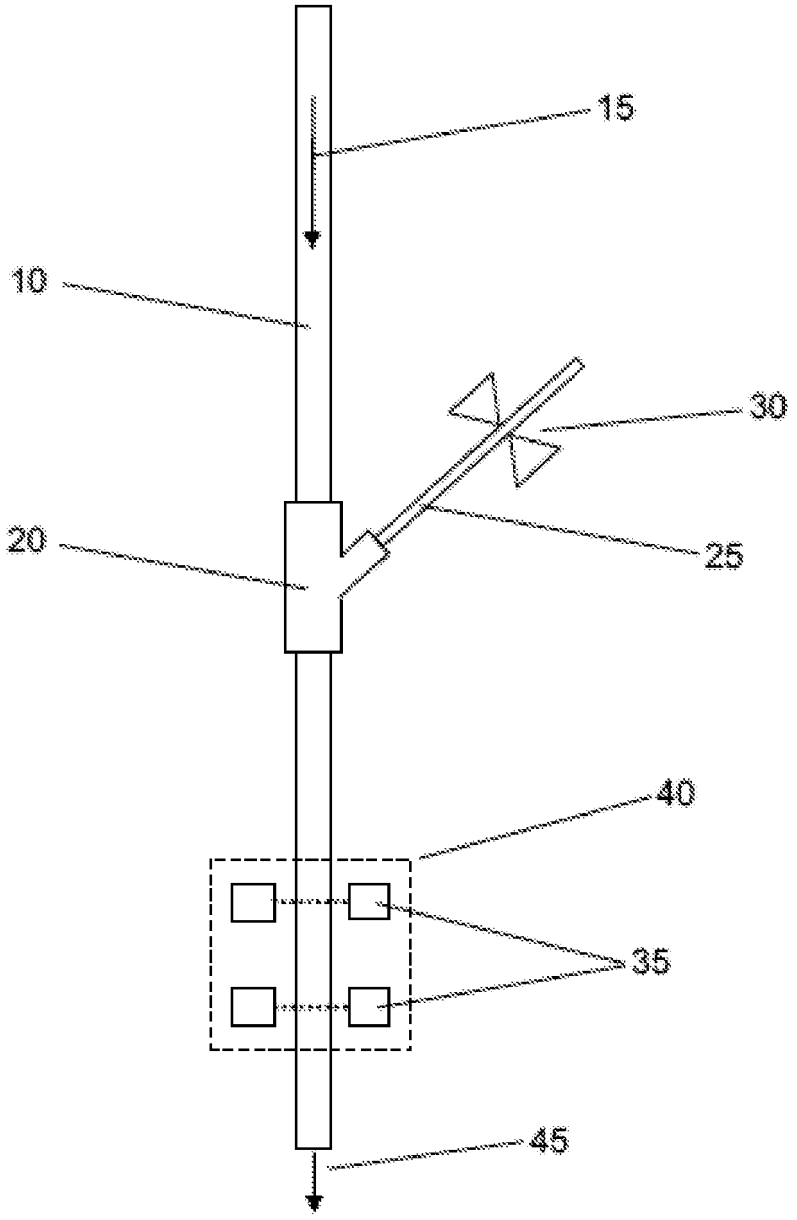
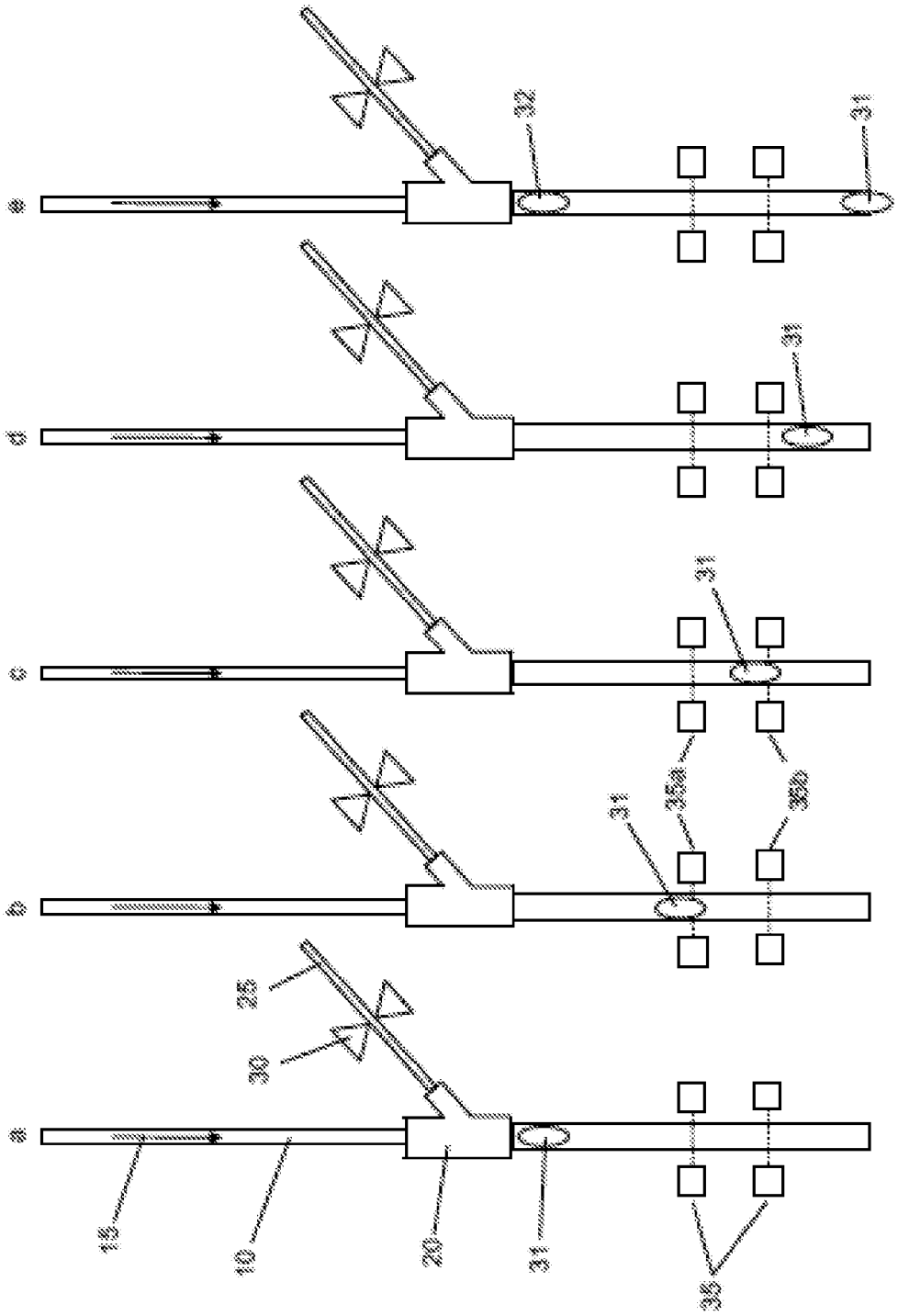


Figure 2



Title: Flow monitoring device

Field of the Invention

[0001] The field of the invention relates to a flow monitoring device.

Background of the invention

[0002] In automatic analyser systems for clinical diagnostics liquids have to be provided to the system to perform tests. It is necessary to monitor the flow rates of several liquid outlets in order to be able to control the liquid process paths. This allows on the end of liquid paths an in-process verification, especially in microfluidic applications where low flow-rates are generated in the microfluidic structures.

[0003] For liquids, various units are used for the flow rate, depending upon the application and industry, but might include gallons (U.S. liquid or imperial) per minute, liters per second, or, when describing river flows, cumecs (cubic metres per second) or acre-feet per day.

[0004] Several shelf liquid-flow meter types are available. Such flow meters comprise for example mechanical flow meters using a gear wheel or turbine or electrical flow meters using thermal or ultrasonic flow measurement. The most methods are based on measuring the time that a liquid needs to pass or fill a defined volume to be able to calculate the flow rate.

[0005] An alternative to measure or monitor the flow rate is to add coloured beads to a liquid or gas. By determining the time the beads need to pass a light barrier it is possible to calculate the flow rate. This method has the disadvantage that foreign matter is added to the liquid or gas.

[0006] Thus there is a need for a device and method for monitoring the flow rate of a liquid, which is not related to complex mechanical instruments or the addition of foreign matter to a liquid.

Object of the Invention

[0007] It is an object of the present invention to provide a device for monitoring the flow of a liquid.

Summary of the Invention

[0008] The present disclosure relates to a device for monitoring liquid flow, the device comprising a tubing filled with a liquid, an injection port connecting a tubing comprising air or gas to the tubing filled with the liquid, a valve arranged at the tubing comprising air or gas for controlling the inlet of gas or air into the liquid of the tubing filled with liquid and a measuring unit arranged downstream of the inlet port.

[0009] The valve can be a solenoid valve and the measuring unit may comprise two light barriers.

[0010] It is further envisaged that at least the tubing between the light barriers can be translucent so that the bubble of air or gas can be detected.

[0011] Another object of the instant disclosure is a method for monitoring the flow rate of a liquid. The method comprises the steps of injecting a first bubble of air or gas into a flowing liquid; measuring the time of transition of the first bubble between two light barriers and calculating the flow rate.

[0012] The method may further comprise that the section of the tubing between the light barriers, measured time for passing the section and the length of the measuring track are used for calculating the flow rate.

[0013] It is further envisaged that a second bubble can be injected. Injecting further bubbles allows monitoring the flow rate. The second bubble may be injected when the first bubble has completely passed the light barriers.

[0014] The determined flow rate may be compared with a desired value. Thus, it will be possible to adjust the flow rate to the desired value. It is intended to use the result of the comparison is used for adjusting the flow rate to the desired value.

[0015] Another object of the instant disclosure is a use of a device of a device of the disclosure for monitoring the flow rate of a liquid.

Summary of the Figures

[0016] The invention will be described on the basis of figures. It will be understood that the embodiments and aspects of the invention described are only examples and do not limit the protective scope of the claims in any way. The invention is defined by the claims and their equivalents. It will be understood that features of one aspect or embodiment of the invention can be combined with a feature of a different aspect or aspects and/or embodiments of the invention. It shows:

[0017] Figure 1 Schematic overview showing the arrangement of the components

[0018] Figure 2 Schematic overview on the sequence of procedural steps

Detailed Description of the Invention and the Figures

[0019] The present disclosure provides a device and a method for monitoring the flow rate of a liquid. The provided device and method can easily be realized and can even be retrofitted in existing automated analyser systems. A further advantage of the proposed device and method is that the liquid will bot be contaminated with foreign matter.

[0020] The invented method uses the principle of a bubble sensor with optical detection and is able to monitor low flow rates of 0 to 10 ml/min.

[0021] The device of the instant disclosure can be provided as separate flow through module having connections for the liquid tubing. The tubing, control valve and a connection for air or gas supply for providing bubbles are part of the module.

[0022] It is intended that air or gas are supplied under pressure from an external gas or air container. Whether air or a specific gas is to be used depends on the liquid whose flow rate has to be monitored. Thus, it is possible to choose a gas that will preferably not interact with the liquid in any manner.

[0023] Figure 1 shows a liquid tubing 10 with a continuous liquid flow 15. The liquid tubing 10 is attached to an air or gas tubing 25 for supplying air or gas from an external container

(not shown). The air or gas tubing 25 ends in the connection port 20, where both tubings 10, 25 are attached.

[0024] A control valve 30 is arranged at the air or gas tubing 25 for controlling the inlet of a defined amount of air or gas supplied by the air or gas tubing 25. The time of opening control valve 30 regulates the amount of air or gas and thus the size (or length) of the bubble that will be formed within the liquid flow.

[0025] Downstream of connection port 20 is a measuring unit 40 arranged, which comprises two light barriers 35. The arrow at the left side of the measuring unit 40 indicates the measuring track. The flow comprising bubbles will leave the liquid tubing at the liquid outlet 45.

[0026] Figure 2 shows a schematic overview of a sequence of procedural steps of a method according to the instant disclosure from left to right (a – e). The liquid tubing 10 is at the connection port 20 attached to the air or gas tubing 25. The control valve 30 is arranged at the air or gas tubing 25. Downstream of the connection port 30 is the measuring unit 40 with two light barriers 35 arranged.

[0027] Figure 2a can shows a first bubble 31, which is entering the continuous liquid flow 15 directly at the connection port 20. In figure 2b the first bubble 31 arrived at the measuring unit 35 at the first light barrier 35a. The time for transition of the first bubble 31 within the measuring unit 35 is determined by using a second light barrier 35b. Figure 2d shows the first bubble 31 leaving the measuring unit 35. Thus, it is possible to calculate the flow rate using the known diameter of the liquid tubing, length between first and second light barrier 35a, 35b and the measured time for transition of the bubble 31 from first to second light barrier 35a. 35b.

[0028] A second bubble 32 can be injected into the continuous flow 15 for a continuous monitoring of the flow rate. The injection of the second bubble 32 may be triggered after a previous bubble has passed the second light barrier 35b (comp. figure 2e).

Reference Number List

10	liquid tubing
15	continuous liquid flow
20	connection port
25	air or gas tubing
30	control valve 30
31	first bubble
32	second bubble
35	light barrier
35a	first light barrier
35b	second light barrier
40	measuring unit
45	liquid outlet

Claims

1. A device for monitoring liquid flow, the device comprising a tubing filled with a liquid, an injection port connecting a tubing comprising air or gas to the tubing filled with the liquid, a valve arranged at the tube comprising air or gas for controlling the inlet of gas or air into the liquid of the tubing filled with a liquid and a measuring unit arranged downstream of the inlet port.

2. The device of claim 1, wherein the valve is a solenoid valve.

3. The device of claim 1 or 2, wherein the measuring unit comprises two light barriers.

4. The device of one of claims 1 to 3, wherein at least the tubing between the light barriers is translucent.

5. A method for monitoring the flow rate of a liquid, comprising the steps of injecting a first bubble of air or gas into a flowing liquid; measuring the time of transition of the first bubble between two light barriers and calculating the flow rate.

6. The method of claim 5, wherein section of the tubing between the light barriers, the measured time for passing the light barriers and the length of the measuring track are used for calculating the flow rate.

7. The method of one o claims 5 or 6, wherein a second bubble is injected.

8. The method of one clams 5 to 7, wherein a second bubble is injected when the first bubble has completely passed the light barriers.

9. The method of one of claims 5 to 8, wherein the determined flow rate is compared with a desired value.

10. The method of claim 9, wherein the result of the comparison is used for adjusting the flow rate to the desired value.

11. A use of a device of one of claims 1 to 5 for monitoring the flow rate of a liquid.

Application No:	GB1506103.9	**Examiner:**	Ralph Cannon
Claims searched:	xxxxx	**Date of search:**	12 October 2015

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-11	US 5355735 A (MILLER) figs. 1-4 and related passages
X	1-11	WO 2010/084268 A1 (INSTITUT NATIONAL DES SCIENCES APPLIQUEES DE TOULOUSE) figs. 1-3 and related passages
X	1-11	GB 2119927 A (JOHN MICHAEL WOOD) fig. 1 and related passages
X	1-11	DE 19547624 A1 (HAHN SCHICKARD) figs. 1, 2 and related passages
X	1-11	US 3693436 A (GILDNER) figs. 4, 7, 9, 12, 13 and related passages
X	1-11	JP S62233721 A (NISSAN MOTOR CO) figures and abstract

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

G01F

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
G01F	0001/708	01/01/2006