US 20020150502A1

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2002/0150502 A1
Weigl (43) Pub. Date: Oct. 17, 2002

(54) SURFACE TENSION REDUCTION CHANNEL

(76) Inventor: **Bernhard H. Weigl**, Seattle, WA (US)

Correspondence Address:
JERROLD J. LITZINGER
SENTRON MEDICAL, INC.
4445 LAKE FOREST DR.
SUITE 600
CINCINNATI, OH 45242 (US)

(21) Appl. No.: **10/114,864**

(22) Filed: **Apr. 3, 2002**

Related U.S. Application Data

(60) Provisional application No. 60/281,114, filed on Apr. 3, 2001.

Publication Classification

(51) Int. Cl.[7] G01N 21/05
(52) U.S. Cl. 422/58; 422/55; 422/68.1

(57) ABSTRACT

A structure for use with a microfluidic channel to reduce the effects of surface tension and capillary forces. A macroscale reservoir is connected to a microscale channel by a microscale section extending from the reservoir, which fills with fluid and flows smoothly into the microscale channel.

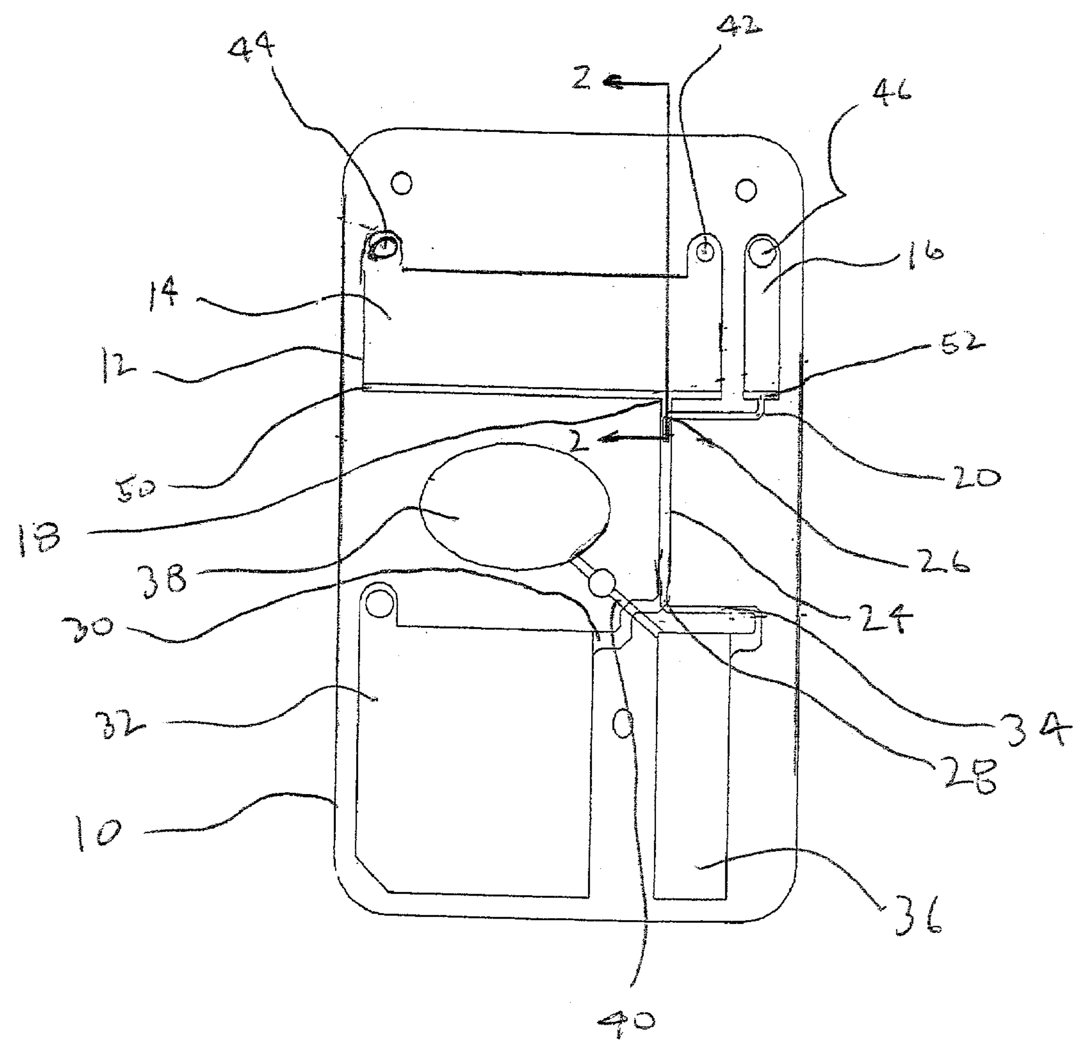


FIG. 1

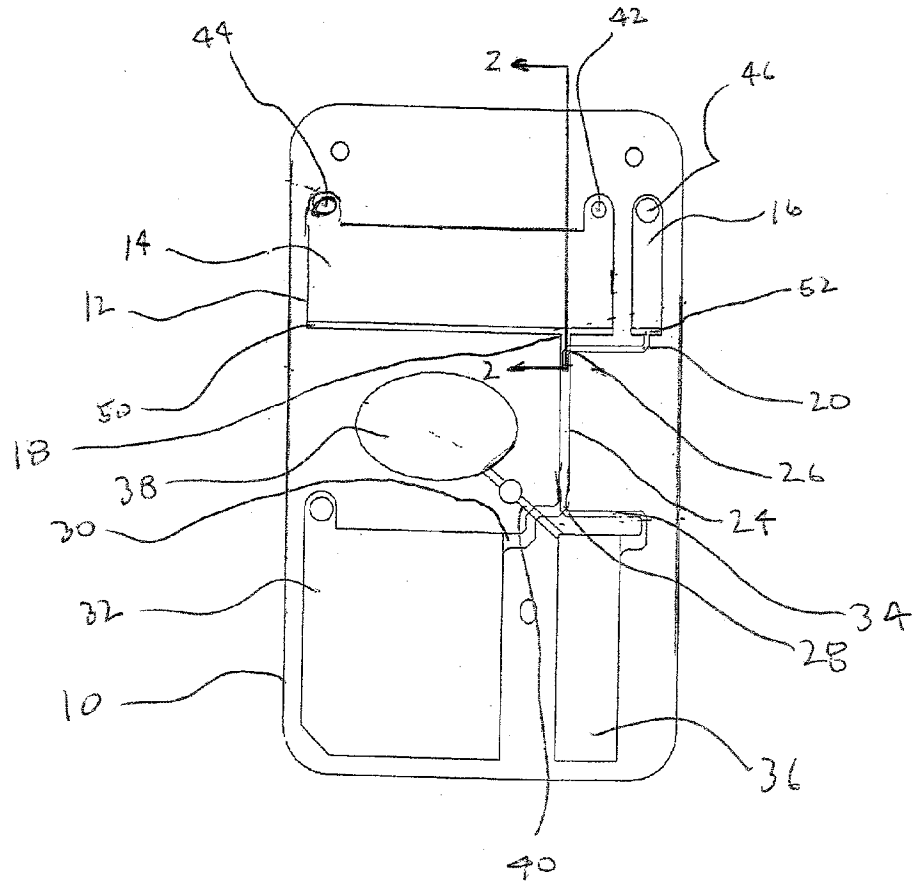
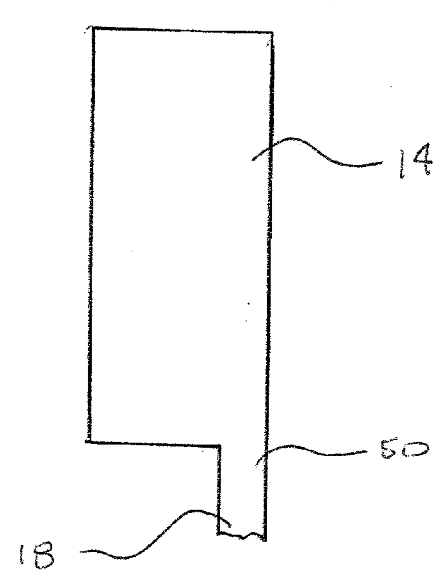


FIG. 2



SURFACE TENSION REDUCTION CHANNEL

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit from U.S. Provisional Patent Application Serial No. 60/281,114, filed Apr. 3, 2001, which application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates generally to microfluidic devices for performing analytic testing, and, in particular, to a device for reducing the effect of surface tension on fluids flowing in microfluidic channels.

[0004] 2. Description of the Related Art

[0005] Microfluidic devices have recently become popular for performing analytic testing. Using tools developed by the semiconductor industry to miniaturize electronics, it has become possible to fabricate intricate fluid systems which can be inexpensively means produced. Systems have been developed to perform a variety of analytical techniques for the acquisition of information for the medical field.

[0006] Microfluidic devices may be constructed in a multi-layer laminated structure where each layer has channels and structures fabricated from a laminate material to form microscale voids or channels where fluid flow. A microscale channel is generally defined as a fluid passage which has at least one internal cross-sectional dimension that is less than 500 μm and typically between about 0.1 μm and about 500 μm. The control and pumping of fluids through these channels is affected by either external pressurized fluid forced into the laminate, or by structures located within the laminate.

[0007] U.S. Pat. No. 5,716,852 teaches a method for analyzing the presence and concentration of small particles in a flow cell using diffusion principles. This patent, the disclosure of which is incorporated herein by reference, discloses a channel cell system for detecting the presence of analyte particles in a sample stream using a laminar flow channel having at least two inlet means which provide an indicator stream and a sample stream, where the laminar flow channel has a depth sufficiently small to allow laminar flow of the streams and length sufficient to allow diffusion of particles of the analyte into the indicator stream to form a detection area, and having an outlet out of the channel to form a single mixed stream. This device, which is known at a T-Sensor, may contain an external detecting means for detecting changes in the indicator stream. This detecting means may be provided by any means known in the art, including optical means such as optical spectroscopy, or absorption spectroscopy of fluorescence.

[0008] U.S. Pat. No. 5,932,100, which patent is also incorporated herein by reference, teaches another method for analyzing particles within microfluidic channels using diffusion principles. A mixture of particles suspended in a sample stream enters an extraction channel from one upper arm of a structure, which comprises microchannels in the shape of an "H". An extraction stream (a dilution stream) enters from the lower arm on the same side of the extraction channel and due to the size of the microfluidic extraction channel, the flow is laminar and the streams do not mix. The sample stream exits as a by-product stream at the upper arm at the end of the extraction channel, while the extraction stream exits as a product stream at the lower arm. While the streams are in parallel laminar flow is in the extraction channel, particles having a greater diffusion coefficient (smaller particles such as albumin, sugars, and small ions) have time to diffuse into the extraction stream, while the larger particles (blood cells) remain in the sample stream. Particles in the exiting extraction stream (now called the product stream) may be analyzed without interference from the larger particles. This microfluidic structure, commonly known as an "H-Filter," can be used for extracting desired particles from a sample stream containing those particles.

[0009] Surface effects describe the character of a surface on a micro scale. Materials often have unbound electrons, exposed polar molecules, or other molecular level features that generate a surface charge or reactivity characteristic. Due to scaling, these surface effects or surface forces are substantially more pronounced in microstructures than they are in traditionally sized devices. This is particularly true in microscale fluid handling systems where the dynamics of fluid movement are governed by external pressures and by attractions between liquids and the materials they are flowing through.

[0010] This invention deals with the passive control of fluids within a microfluidic circuit. The passive control is generated by using the natural forces that exist on a microscale, specifically capillarity, which is caused by the attraction or repulsion of a fluid toward certain materials.

SUMMARY OF THE INVENTION

[0011] It is therefore an object of the present invention to provide a device for reducing the effect of surface tension on fluids flowing within a microfluidic channel.

[0012] It is a further object of the present invention to provide a microfluidic structure in which fluids flow from a macrochannel into a microchannel to insure smooth flow within the microfluidic structure.

[0013] These and other objects of the present invention will be more readily apparent from the description and drawings that follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** is a plan view of a microfluidic structure including an H-Filter using the principles of the present invention; and

[0015] **FIG. 2** is a fragmentary, cross-sectional side view of the microfluidic structure shown in **FIG. 1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] **FIG. 1** shows a microfluidic analysis card **10** which contains an H-Filter **12**, which structure is described in detail in U.S. Pat. No. 5,932,100, incorporating the present invention. H-Filter **12** includes a first reservoir **14** and a second reservoir **16**. An outlet channel **18** of reservoir **14** and an outlet channel **20** of reservoir **16** are both connected to a flow channel **24** at a first end **26**. A second end **28** of flow channel **24** is coupled to an exit channel **30**, which is connected to a reservoir **32** and also to an exit channel **34**, which is coupled to a reservoir **36**. Reservoir **36** is also coupled to a bellows **38** via a channel **40**. It should be understood that H-Filter **12** will also operate using gravity as a driving force.

[**0017**] Reservoir **14** contains a vent hole **42** and an inlet port **44**, while reservoir **16** contains an inlet port **46**. Reservoir **14** also contains a narrowed lower section **50**, which extends across the lower length of reservoir **14**, while reservoir **16** also contains a similarly narrowed lower section **52** across the lower length of reservoir **16**.

[**0018**] Operation of H-Filter **12** is as follows: a sample fluid is placed into inlet port **46** of reservoir **16** while an extractor solution is placed into port **44** of reservoir **14**. The fluids form a stream and flow through channels **20, 18** respectively to end **26** of channel **24**. The fluids form a stream and flow laminarly within channel **24** while particles from the sample fluid diffuse across the laminar junction into the extractor fluid. As the stream reaches end **28** of channel **24**, the extractor fluid containing particles flow through channel **30** into reservoir **32**, while the sample fluid flows through channel **34** into reservoir **36**.

[**0019**] Narrowed section **50** of reservoir **14** fills with sample fluid when the sample is loaded into inlet port **44**. Since the structure of reservoir **14** is not microscale, and outlet channel **18** is of a microscale dimension, the effect of surface tension would generally prevent the fluid from flowing smoothly from reservoir **14** to channel **18**. However, as can be clearly seen in **FIGS. 1 and 2**, the narrow lower section **50**, which runs the entire length of reservoir **14**, is of essentially the same microdimensions of channel **18**; thus, fluid moves smoothly and consistently from reservoir **14** into channel **18** and through the rest of the H-Filter structure. This is also true for fluids flowing from reservoir **16** into channel **20**, as the narrow lower section **52** of reservoir **16** fills with fluid and flows smoothly into channel **20** with little or no surface tension effect.

[**0020**] While the present invention has been shown and described in terms of a preferred embodiment thereof, it will be understood that this invention is not limited to this particular embodiment and that changes and modifications may be made without departing from the true spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A microfluidic device, comprising:

a first fluid vessel having only macrofluidic dimensions;

a second fluid vessel having at least one microfluidic dimension;

a microfluidic channel having first and second ends, said first end attached to at least one portion of at least one side of said first fluid vessel and said second end attached to at least one portion of at least one side of said second fluid vessel such that said attachment to said first vessel is larger in at least one dimension than said attachment to said vessel.

* * * * *