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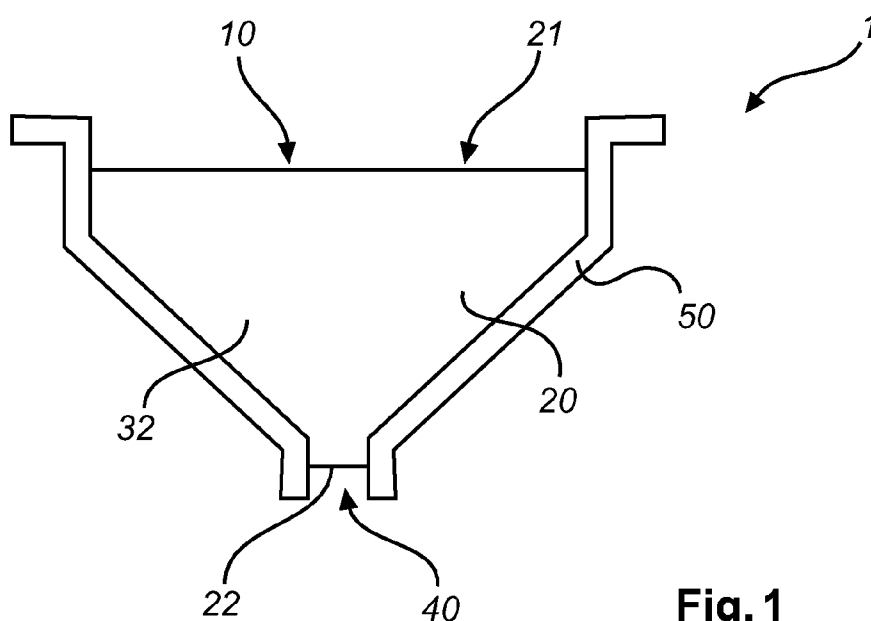


Fig. 1

(57) Abstract: Bulk blood filter having a filter volume with a first particle bulk in order to provide a quick and efficient blood filter-
ing and separation.

Bulk Blood Filter

FIELD OF THE INVENTION

The present invention relates to a device for blood filtering, in particular to a bulk blood
5 filter allowing a quick and simple filtration process for the separation of blood cells.

BACKGROUND OF THE INVENTION

Blood filtering is required for the separation of the specific components of the human
blood. In particular, the separation is required as particular analysis may be carried out
10 on particular components of the human blood only, wherein other blood components
may disturb the analysis. The human blood has different components, for example
erythrocytes, i.e. red blood cells, which may have a size of about 7.5 microns,
leucocytes, i.e. white blood cells, which may have a size of about 8 to 20 microns, and
thrombocytes, i.e. platelets, which may have a size of about 1.5 to 3 microns, as well
15 as the blood plasma/serum. The erythrocytes, the leucocytes, and the thrombocytes
represent more than 40 volume percent of the whole blood. In order to separate the
different components of the human blood, a centrifugation process is established.
However, a centrifugation process requires a considerable amount of time and a
considerable complexity of an apparatus.

20 For particular purposes, it may be required to obtain a separation of the blood
components in a short time and with a minimum complexity of apparatus.

SUMMARY OF THE INVENTION

25 The present invention provides a bulk blood filter and a use of a bulk blood filter
allowing a quick separation of blood components and a reduced complexity in
apparatus.

According to an exemplary embodiment of the invention, a bulk blood filter comprises a
30 feeding opening, an outlet opening, a filter volume, and a first particle bulk, wherein the
feeding opening communicates with a raw side of the filter volume and the outlet
opening communicates with a clean side of the filter volume, wherein the filter volume
contains the first particle bulk.

35 Thus, it is possible to separate the blood components by a filter volume containing a
particle bulk. This allows a quick filtering without a complex centrifugation process, so
that such a bulk blood filter may be used for example for urgent blood samples or at the

point of collection and other similar applications. Such a continuous system would allow a flexible analysis of the samples: Urgent samples from emergency patients could be processed with a higher priority without any need of interrupting a running centrifugation process or of waiting for the centrifugation process to be finished. The bulk blood filter in particular may be a bulk whole blood filter. In particular, it is possible to obtain a blood plasma/serum, while filtering out the erythrocytes, the leucocytes, and the platelets. In particular, the aforementioned bulk blood filter may induce no or only a low degree of hemolysis, i.e. the destruction of the erythrocytes, so that a subsequent optically based plasma/serum analysis is possible.

A subsequent whole blood separation into plasma / serum after blood withdrawal can be advantageous for Point-of-Care testing devices, which are used to provide a quick blood analysis at / near the patient to get a quick blood analysis result outside of a clinical laboratory to make immediate decisions about patient care. Typically Point-of-Care testing is performed by non-laboratory personnel. A quick foregoing plasma filtration process facilitates the quick blood analysis and enables new operating conditions for Point-of-Care devices, since most of them work with whole blood or with the microdevices which lead to a very small yield of plasma / serum volume. The whole blood separation process can also be integrated within the Point-of-Care device.

According to an exemplary embodiment of the invention the first particle bulk comprises a first type of particles having a volumetric median size of $27\mu\text{m}$ to $36\mu\text{m}$, wherein at least 90% of the first type of particles have a size between $0.5\mu\text{m}$ and $100\mu\text{m}$, preferably between $3\mu\text{m}$ and $80\mu\text{m}$ and a specific surface area between 0.4 and $0.8\text{ m}^2/\text{ccm}$.

According to an exemplary embodiment of the invention the first type of particles are hydrophilic particles, preferably glass particles or other materials made of spherical particles.

The provision of glass spheres provides a good filtering result, in particular as glass spheres with this particular particle size distribution do not induce hemolysis during filtration and may provide a reproducible size distribution of particles.

According to an exemplary embodiment of the invention the first type of particles is made of soda lime glass.

According to an exemplary embodiment of the invention, at least a portion of the first type of particles comprises a hydrophobic surface, in particular a hydrophobic surface coating.

Providing hydrophobic particles of a different material or hydrophobic coating may improve the flow characteristic of the bulk blood filter. 0 to 100%, preferably 0 to 75%, more preferable 0 to 50%, and more preferable 0 to 40% of the particles in the first bulk may have a hydrophobic coating, and may be mixed up with the uncoated glass powder.

According to an exemplary embodiment of the invention, the glass spheres have a sphericity between 0.8 and 1.0, particularly between 0.85 and 0.995, and more particularly between 0.9 and 0.995. The sphericity can be calculated by the equation

$$\Psi = \frac{\pi^{\frac{1}{3}}(6V_p)^{\frac{2}{3}}}{A_p}$$

wherein V_p is the volume of the particle and A_p is the surface area of the particle.

According to an exemplary embodiment of the invention, the first particle bulk as particles comprises a bed of glass powder.

The provision of glass powder as particles for the particle bulk allows a proper filtering process, wherein glass powder may be manufactured reproducibly.

According to an exemplary embodiment of the invention, the filter volume further contains a second particle bulk, wherein the second particle bulk is downstream of the first particle bulk.

In particular, the first particle bulk upstream of the second particle bulk may provide a filtering, wherein the second particle bulk may provide a draining property for the plasma/serum. In particular, the first particle bulk may be adapted to retain the cells,

like for example the leucocytes. In particular, this bulk filter construction may avoid that the filter clogs.

According to an exemplary embodiment of the invention the second particle bulk
5 comprises a second type of particles, at least weight 90% thereof have a size $>150\mu\text{m}$, preferably $>500\mu\text{m}$ and $<1000\mu\text{m}$. The second particle bulk may be also mixed with the particles from the first particle bulk.

The size of the second type of particles may allow an improved plasma/serum transport
10 to the outlet opening due to the reduced inner surface of the bulk. The second type of particles may be a granulate material. The granulate material may be hydrophilic or hydrophobic. The granulate material may be of glass or of a polymer material, e. g. polypropylene.

According to an exemplary embodiment of the invention, the first particle bulk and the
15 second particle bulk represent two layers within the filter bulk and can be separated. A separation of the first particle bulk and the second particle bulk may avoid a mixing of the particles from the first particle bulk and the second particle bulk. In particular, the separation may provide a clear localization for the particular filter functions.

According to an exemplary embodiment of the invention, the filter volume is tapered
20 from the raw side to the clean side.

Thus, the cross-section of the raw side is large, so that the bulk blood filter does not
25 clog when filtering large cells or higher cell concentrations close to the raw side.

According to an exemplary embodiment of the invention, the filter volume is conical.

According to an exemplary embodiment of the invention, in particular for a linearly
tapered filter volume a ratio between a diameter of the raw side (21) and a length of
30 tapering is <1 , preferably between 0.7 and 0.9.

According to an exemplary embodiment of the invention, in particular for a trumpet
tapered filter volume a ratio between a diameter of the raw side (21) and a length of
tapering is between 1 and 2, preferably between 1.4 and 1.6.

Thus, the filter process may be optimized and the filter volume may be minimized to reduce plasma/serum loss by adherence to the bulk material.

According to an exemplary embodiment of the invention, the filter volume is trumpet
5 tapered.

Thus, it is possible, to provide an optimum between the filtering characteristic and the required particles in the particle bulks. It should be understood, that the shape of the trumpet may be varied according to the size and filtering characteristic of the particles
10 and the respective particle bulks. The shape of the tapering may also follow the filtering characteristic, which depends on the fluid to be filtered and the filter characteristic of the bulk.

According to an exemplary embodiment of the invention, a cross-section ratio between
15 the raw side and the clean side is between 1 and 100, preferably between 5 and 50, more preferably between 10 and 50.

According to an exemplary embodiment of the invention, the raw side of the filter
20 volume comprises a fluid diffuser and/or a fluid distributor for distributing an inlet flow.

Thus, it is possible to distribute the inlet flow of blood, so that the entering blood may be distributed over the entire raw side entering opening to wet homogeneously the inlet surface. In particular, it may be avoided that a center portion of the bulk blood filter
25 clogs earlier than an edge portion and it may be ensured that the whole particle volume is utilized. In particular, a diffuser and/or distributor may equally distribute the load of the bulk blood filter.

According to an exemplary embodiment of the invention, the first particle bulk on the raw side of the filter volume is covered and separated over the feeding opening by a
30 first cover.

Thus, it may be avoided that the particles of the first particle bulk enter the upstream volume. Further, it may be avoided that the geometry of the particle bulk changes. In particular, the geometry of the particle bulk may be kept constant and reproducible
35 when covering the first particle bulk over the raw side.

According to an exemplary embodiment of the invention, the first cover comprises a fiber filter layer.

- 5 Thus, it may be provided a proper cover allowing the blood to pass and to keep the particles of the particle bulk in place.

According to an exemplary embodiment of the invention, the first cover comprises a first permeable polymer foam layer.

10

Thus, it may be avoided that the particles of the first particle bulk move or the geometry of the first particle bulk changes, wherein the first permeable polymer foam layer may let pass the blood to be filtered.

- 15 According to an exemplary embodiment of the invention, the first permeable cover compresses the first particle bulk.

Thus, it is possible to maintain the geometry of the first particle bulk, in particular when the bulk blood filter underlies a shock impact, as it may occur during transport, or an expansion/contraction owing to temperature changes.

20

According to an exemplary embodiment of the invention, the first permeable polymer foam layer is hydrophobic and non-swelling.

- 25 Thus, a proper flow may be maintained and an adhesion of blood to the permeable polymer foam layer may be avoided.

According to an exemplary embodiment of the invention, the first particle bulk and the second particle bulk are separated by a separator.

- 30 Thus, it may be avoided that the first particle bulk and the second particle bulk change their geometry. In particular, it may be avoided that particles of the first particle bulk enter the second particle bulk, and that particles of the second particle bulk enter the first particle bulk. In particular, the separator may maintain a reproducible cross-section between the first particle bulk and the second particle bulk. Further, the separator may
35 have a particular shape in order to provide a particular clean side shape of the first

particle bulk and a particular raw side shape of the second particle bulk. The separator may have the shape of a convex or concave sphere.

5 According to an exemplary embodiment of the invention, the filter volume on the clean side is covered by a second cover over the outlet opening.

Thus, it may be avoided that particles of the second particle bulk may enter the fluid resulting from the filtering process. In particular, the particles of the second particle bulk may be kept in place and the geometry of the second particle bulk may be kept
10 unchanged.

According to an exemplary embodiment of the invention, the second cover comprises a second permeable polymer foam layer.

15 According to an exemplary embodiment of the invention, the second permeable polymer foam layer is hydrophilic to absorb the filtrate for further process steps.

Thus, a proper flow condition of the fluid may be maintained.

20 According to an exemplary embodiment of the invention, the second cover comprises a membrane covering the outlet opening.

According to an exemplary embodiment of the invention, the second permeable membrane cover is hydrophilic to let pass the liquid to the outlet.
25

Thus, in particular small particles in the second particle bulk may be kept in place by using a membrane covering the outlet opening.

According to an exemplary embodiment of the invention, the second cover comprises a
30 woven mesh as a physical stabilizer downstream of the membrane.

Thus, the entire filter volume and in particular the second particle bulk may be kept in position. In particular, the filter volume may be physically stabilized.

According to an exemplary embodiment of the invention, at least one of the first particle bulk and the second particle bulk is press-fitted into the filter volume.

Thus, it is possible to provide a reproducible geometry of the first particle bulk and the
5 second particle bulk, respectively.

According to an exemplary embodiment of the invention, at least one of the first cover, the second cover, and the separator is mounted so as to maintain a tension onto an adjacent one of the first particle bulk and the second particle bulk.

10

Thus, it is possible to maintain the tension on the respective particle bulk, in particular when a shrinking of the particle bulk is expected, which may happen owing to the wetting due to the fluid.

15 According to an exemplary embodiment of the invention, the bulk blood filter further comprises a two-part housing having a housing body for accommodating the filter volume and a housing cover accommodating an inlet opening.

Thus, it is possible to provide the first particle bulk and possibly the second particle
20 bulk in the housing body, wherein for example the distributor may be provided in the housing cover. This allows an easier manufacturing process, in particular when providing a tapered filter volume which may correspond to a tapered housing body.

According to an exemplary embodiment of the invention, the first cover is sealingly
25 pressed between the housing body and the housing cover, such that the first particle bulk is fixed in the filter volume.

Thus, the first cover may serve not only for keeping the first particle bulk in position, but also for sealing the housing cover over the housing body.

30

According to an exemplary embodiment of the invention, the filter volume is between 1 cmm and 10 ccm, preferably between 1 ccm and 2 ccm. It should be noted that also larger filter volumes may be applied, e.g. between 3 and 10 ccm, preferably between 4 and 8 ccm.

35

The bulk blood filter may be adapted to filter a blood sample having a size between 1 cmm and 100 ccm, preferably between 0.5 ccm and 3.0 ccm, in particular for a linearly tapered filter volume. It should be noted that also larger filter volumes may be applied, e.g. between 3 and 10 ccm, preferably between 4 and 8 ccm, in particular for a trumpet tapered filter volume.

According to an exemplary embodiment of the invention, there is provided the use of a bulk blood filter as described for whole blood filtering, wherein at least one of the first particle bulk and the second particle bulk are adapted to filter whole blood so as to gain plasma with less than 100mg hemoglobin per 100ml plasma, preferably 50mg hemoglobin per 100ml plasma.

It should be noted that the above features may also be combined. The combination of the above features may also lead to synergetic effects, even if not explicitly described in detail.

These and other aspects of the invention will become apparent from and be elucidated with reference to the embodiments described hereinafter.

The bulk blood filter according to the present invention may also be used as a solid-liquid or liquid-liquid separation tools in other fields, e.g. in veterinary medicine, food technology, environmental sciences, and in scientific laboratories in general. In particular, the bulk blood filter can be used in efficient and mild separation methods of highly concentrated suspensions, cellular systems and sensitive particular systems. It is highly preferred to use the bulk blood filter according to the present invention in filtration processes, wherein the volume of the sample to be separated and the volume of the filtrate is small, e.g. less than 20 ml, preferably less than 10 ml, which is e.g. the case in the analytical quality assurance in production processes.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention will be described in the following with reference to the following drawings.

Fig. 1 illustrates a cross-section of a bulk blood filter according to an exemplary embodiment of the invention;

Fig. 2 illustrates a further exemplary embodiment of a bulk blood filter having a first and a second particle bulk;

Fig. 3 illustrates a bulk blood filter having a trumpet tapered filter volume;

Fig. 4 illustrates an exemplary embodiment of the invention, wherein the bulk blood filter comprises a diffusor or distributor.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The following definitions are used: The raw side of a filter is the side or surface through which the fluid enters the filter element, filter volume, filter medium etc. It is considered as the entering side or surface. The clean side of a filter is the side or surface through which the fluid exits the filter element, filter volume, filter medium etc. It is also considered as the exit side or surface.

Fig. 1 describes a cross-section of a bulk blood filter which may be used as a whole blood filter. The bulk blood filter 1 has a filter volume 20. The filter volume has a raw side 21 of the filter, and a clean side 22 of the filter. The fluid to be filtered, which may be human blood, may enter the filter volume 20 through the raw side 21 of the filter.

The fluid will be filtered and may exit the filter volume through the clean side 22 of the filter. The filter volume may be disposed in a filter housing 50, which filter housing 50 may have a feeding opening 10 and an outlet opening 40. The bulk blood filter in Fig. 1 has a tapered filter volume, so that in the upper part of the filter volume being close to the raw side, larger cells may be filtered without directly clogging the filter volume. In particular, the large diameter or large cross-section of the raw side allows a large amount of liquid to enter the filter volume. Thus, a bottle neck effect of the filtering process may be avoided. The filter volume may comprise particles which may be for example a glass powder or glass spheres, or other materials being suitable for filtering blood, in particular human blood. It should be noted that the particles in the filter volume may be distributed or arranged in layers, so that for example the pure particle powder may be arranged close to the feeding opening, wherein the particle powder mixed with a coarse granulate may be provided close to the outlet opening. Thus, the characteristic of the filtering process may be set within the filter volume, so that a proper filtering process may be provided.

Fig. 2 illustrates a further exemplary embodiment of a bulk blood filter according to the invention. Fig. 2 illustrates a filter housing 53, 54, which filter housing comprises a main filter housing body 54 and a filter housing cover 53. The embodiment illustrated in Fig. 2 further illustrates the provision of two separate particle bulks 32 and 34. The filter volume 20 may be separated over the raw side 21 of the bulk blood filter 1 by a first cover which may serve a first bulk cover 55. Thus, it is possible to maintain the particles of the filter volume in place and to provide a large cross-section for the raw side or the entering surface of the filter volume, while providing a smaller feeding opening. The feeding opening may be for example adapted to receive a feeding device, like for example a tube or a syringe. The blood enters the filter housing through the filter housing inlet opening 51 and then distributes over the raw side entering surface 21 so as to enter the filter volume on a broad surface. The first cover 55 maintains the particles of the particle bulks in place, but let pass the blood to enter the filter volume. Fig. 2 illustrates two separate particle bulks, a first particle bulk 32 and a second particle bulk 34. The first particle bulk 32 is upstream of the second particle bulk 34. The first particle bulk and the second particle bulk may be separated by a separator 57 maintaining the particles of the respective particle bulk in place and avoiding the mixture thereof. However, instead of a separator, the particles may be kept in place by a press fitting of an upper or lower cover, 55, 59. The first particle bulk 32 may have smaller particles 37 than the particles 38 in the second particle bulk 34. Thus, cells in the blood may be filtered within the first particle bulk 32 so that the plasma/serum may properly drain. A clogging of in particular the second particle bulk 34 may be avoided. The second particle bulk may be covered by a second cover 59 on the clean side. The second bulk may also comprise a mixture of the first particle type 37 and a second particle type 38. The filter volume also may be considered as a three bulk structure, wherein the upper bulk only comprises first type particles 37, the lower bulk may comprise only second type particles 38 and the intermediate bulk may comprise a mixture of the first and second particle types 37, 38. The second cover 59 may separate the second particle bulk 34 over the outlet opening. In particular, the second cover may avoid loss of particles from the second particle bulk 34. The result of the filtering process may exit the filter housing through filter housing outlet opening 52.

Fig. 3 illustrates a further exemplary embodiment of the invention, wherein the filter volume 20 is trumpet tapered. The trumpet tapering allows to particularly adapt the filter volume distribution over the filter length, so that the filter volume close to the raw

side has a large cross-section, whereas the filter volume close to the clean side has a small cross-section. Thus, the cross-section of the filter volume and the distribution of the particles may be adapted according to the expected filtering characteristic, so that an optimized filter geometry may be provided according to the filter characteristic of the filter volume. It should be noted that the remaining components are similar to those of Fig. 2, so that equivalent reference numerals are used for Fig. 3 and for particular description it is referred to Fig. 2.

Fig. 4 illustrates a further exemplary embodiment of the invention, wherein the bulk blood filter is provided with a diffuser or distributor 56. The fluid entering the feeding opening 10 will be properly distributed to the raw side 21 when passing the diffuser or distributor 56. Thus, a more or less equal distribution of entering blood to the raw side 21 may be established, so that the filter capacity of the bulk blood filter may be properly used. It should be noted that the remaining components are similar to those described with respect to Fig. 2.

It should be noted that the term “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. Also elements described in association with the different embodiments may be combined.

It should be noted that the reference signs in the claims shall not be construed as limiting the scope of the claims.

Claims

1. Bulk blood filter comprising:
a feeding opening (10),
5 an outlet opening (40),
a filter volume (20),
a first particle bulk (32),
wherein the feeding opening communicates with a raw side (21) of the filter
volume and the outlet opening communicates with a clean side (22) of the filter
10 volume,
wherein the filter volume contains the first particle bulk (32).
2. Bulk blood filter according to claim 1, wherein the first particle bulk (32)
comprises a first type of particles (37) having a median size of 27 μ m to 36 μ m,
15 wherein 90% of the first type of particles have a size between 3 μ m and 80 μ m and
a specific surface area of 0.4 to 0.8 m²/ccm.
3. Bulk blood filter according to claim 2, wherein the first type of particles (37) are
glass particles, preferably glass spheres.
20
4. Bulk blood filter according to any one of claims 2 and 3, wherein the first type of
particles (37) is made of soda lime glass.
5. Bulk blood filter according to any one of claims 2 to 4, wherein at least a part of
25 the first type of particles (37) comprises a hydrophobic surface.
6. Bulk blood filter according to any one of claims 3 to 5, wherein the glass spheres
have a sphericity between 0.8 and 1.0, particularly between 0.85 and 0.995, and
more particularly between 0.9 and 0.995.
30
7. Bulk blood filter according to any one of claims 1 to 6, wherein the first particle
bulk (32) comprises a first type of particles (37) in form of glass powder.

8. Bulk blood filter according to any one of claims 1 to 7, wherein the filter volume (20) further contains a second particle bulk (34), wherein the second particle bulk is downstream of the first particle bulk (32).
- 5 9. Bulk blood filter according to claim 8, wherein the second particle bulk comprises a second type of particles have a size $>150\mu\text{m}$, preferably $>500\mu\text{m}$ and $<1000\mu\text{m}$.
- 10 10. Bulk blood filter according to any one of claims 8 and 9, wherein the first particle bulk (32) and the second particle bulk (34) are separated.
11. Bulk blood filter according to any one of claims 1 to 10, wherein the filter volume (20) is tapered from the raw side (21) to the clean side (22).
- 15 12. Bulk blood filter according to any one of claims 1 to 11, wherein the filter volume (20) is conical.
13. Bulk blood filter according to claim 12, wherein a ratio between a diameter of the raw side (21) and a length of tapering is <1 , preferably between 0.7 and 0.9.
- 20 14. Bulk blood filter according to any one of claims 1 to 11, wherein the filter volume (20) is trumpet tapered.
15. Bulk blood filter according to claim 14, wherein a ratio between a diameter of the raw side (21) and a length of tapering is between 1 and 2, preferably between 1.4 and 1.6.
- 25 16. Bulk blood filter according to any one of claims 1 to 15, wherein a cross section ratio between the raw side (21) and the clean side (22) is between 1 and 100, preferably between 5 and 50, more preferably between 10 and 50.
- 30 17. Bulk blood filter according to any one of claims 1 to 16, wherein the raw side of the filter volume comprises a fluid diffusor and/or fluid distributor for distributing an inlet flow.
- 35

18. Bulk blood filter according to any one of claims 1 to 17, wherein the first particle bulk (32) on the raw side (21) of the filter volume (20) is covered and separated over the feeding opening (10) by a first cover (55).
- 5 19. Bulk blood filter according to claim 18, wherein the first cover (55) comprises a fiber filter layer.
20. Bulk blood filter according to any one of claims 18 and 19, wherein the first cover (55) comprises a first permeable polymer foam layer.
- 10 21. Bulk blood filter according to claim 18 and 19, wherein the first cover is a permeable cover, which compresses the first particle bulk (32).
22. Bulk blood filter according to any one of claims 1 to 21, wherein the filter volume (20) on the clean side (22) is covered by a second cover (59) over the outlet opening (40).
- 15 23. Bulk blood filter according to claim 22, wherein the second cover (59) comprises a second permeable polymer foam layer.
- 20 24. Bulk blood filter according to any one of claims 22 and 23, wherein the second permeable polymer foam layer is hydrophilic.
25. Bulk blood filter according to any one of claims 22 to 24, wherein the second cover (59) comprises a membrane covering the outlet opening (40).
- 25 26. Bulk blood filter according to any one of claims 22 to 25, wherein the second cover (59) comprises a woven mesh as a physical stabilizer for the membrane.
- 30 27. Bulk blood filter according to any one of claims 1 to 26, wherein at least one of the first particle bulk (32) and the second particle bulk (34) is press fitted into the filter volume (20).
28. Bulk blood filter according to any one of claims 17 to 27, wherein at least one of the first cover (55) and the second cover (59) is mounted so as to maintain a

tension onto an adjacent one of the first particle bulk (32) and the second particle bulk (34).

- 5 29. Bulk blood filter according to any one of claims 1 to 28, further comprising a two-part housing (50) having a housing body (54) for accommodating the filter volume (20) and a housing cover (53) accommodating an inlet opening (51).
- 10 30. Bulk blood filter according to claim 29, wherein the first cover (55) is sealingly pressed between the housing body (54) and the housing cover (53) such that the first particle bulk (32) is fixed in the filter volume (20).
31. Bulk blood filter according to any one of claims 1 to 30, wherein the filter volume (20) is between 1cmm and 10ccm, preferably between 1ccm and 2ccm.
- 15 32. Bulk blood filter according to any one of claims 23 to 31, further comprising an additional third permeable polymer foam downstream the filter housing outlet opening (52) for soaking up plasma/serum exiting the filter outlet opening (52).
- 20 33. Use of a bulk blood filter (1) according to any one of the preceding claims for whole blood filtering, wherein at least one of the first particle bulk (32) and the second particle bulk (34) are adapted to filter whole blood so as to gain plasma with less than 100mg hemoglobin per 100ml plasma, preferably 50mg hemoglobin per 100ml plasma.

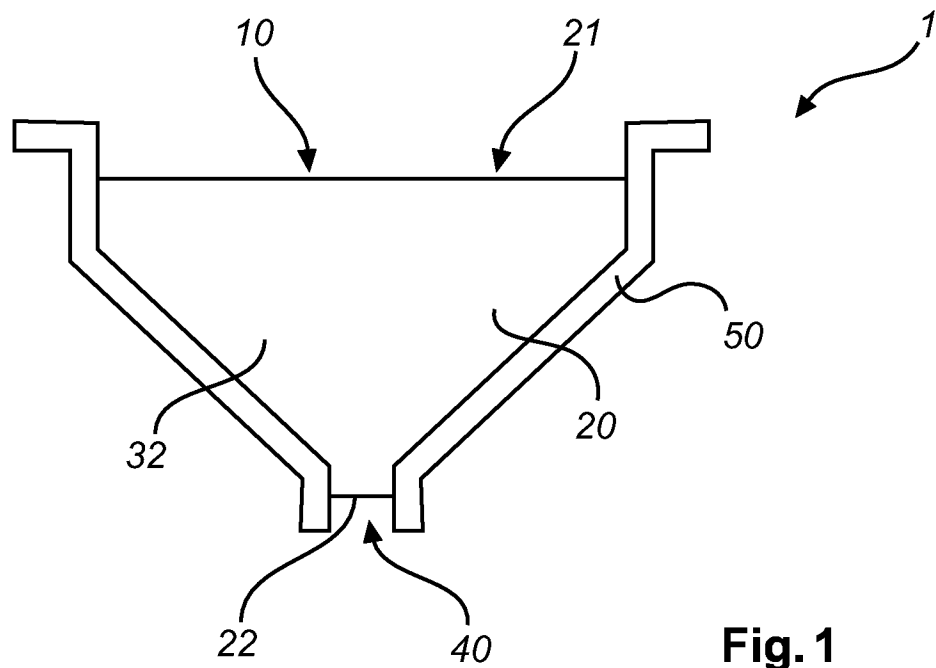
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Fig. 1

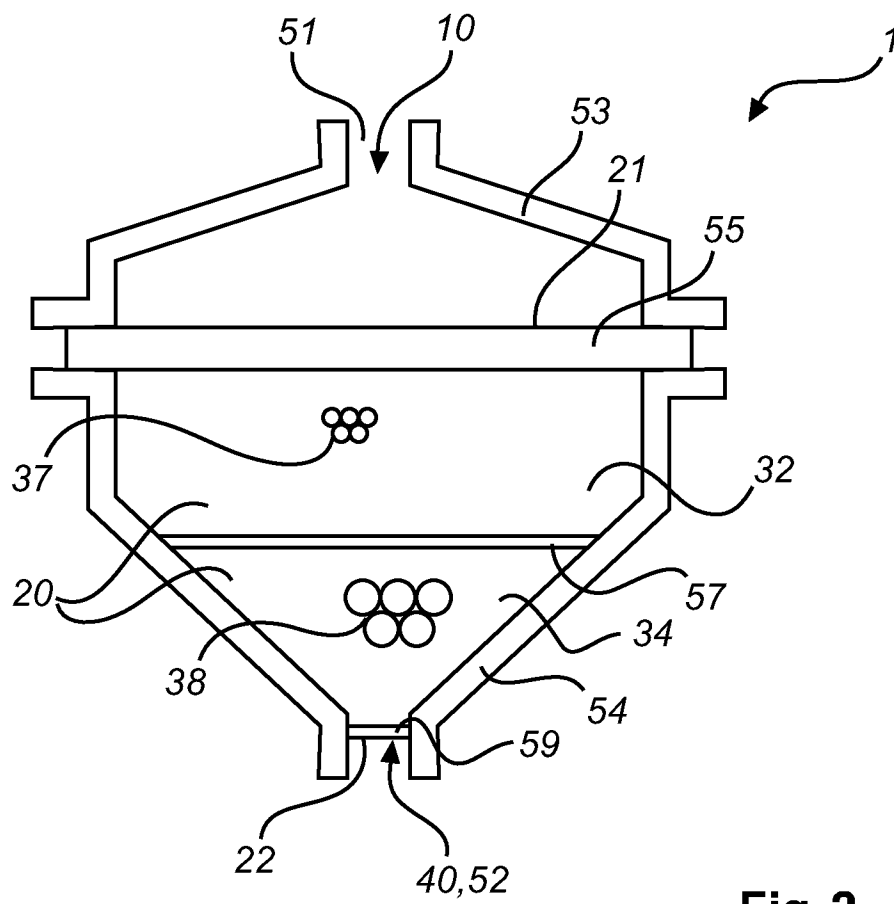
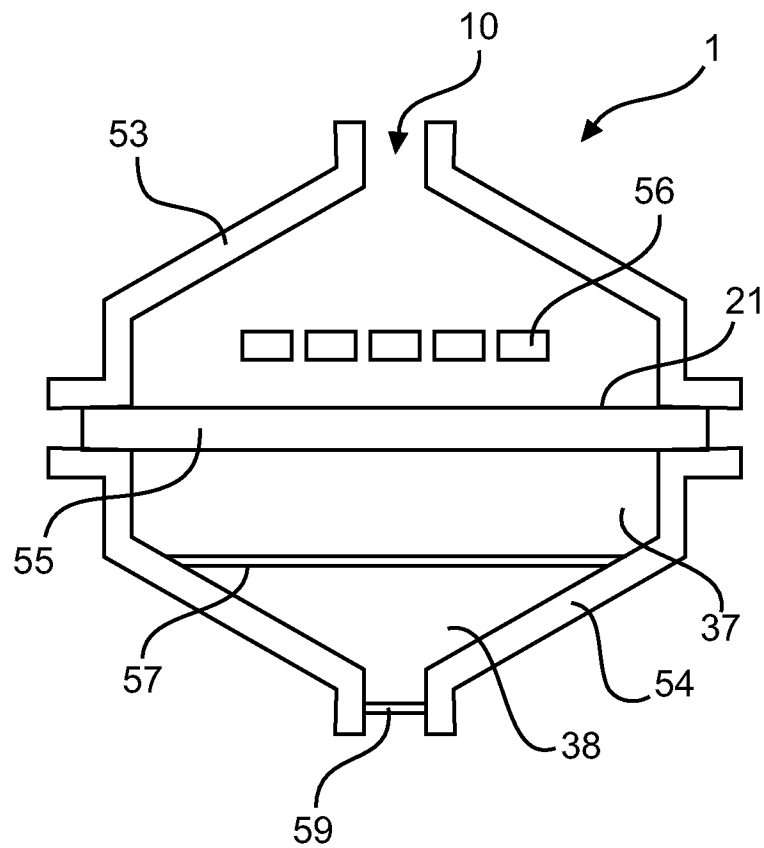
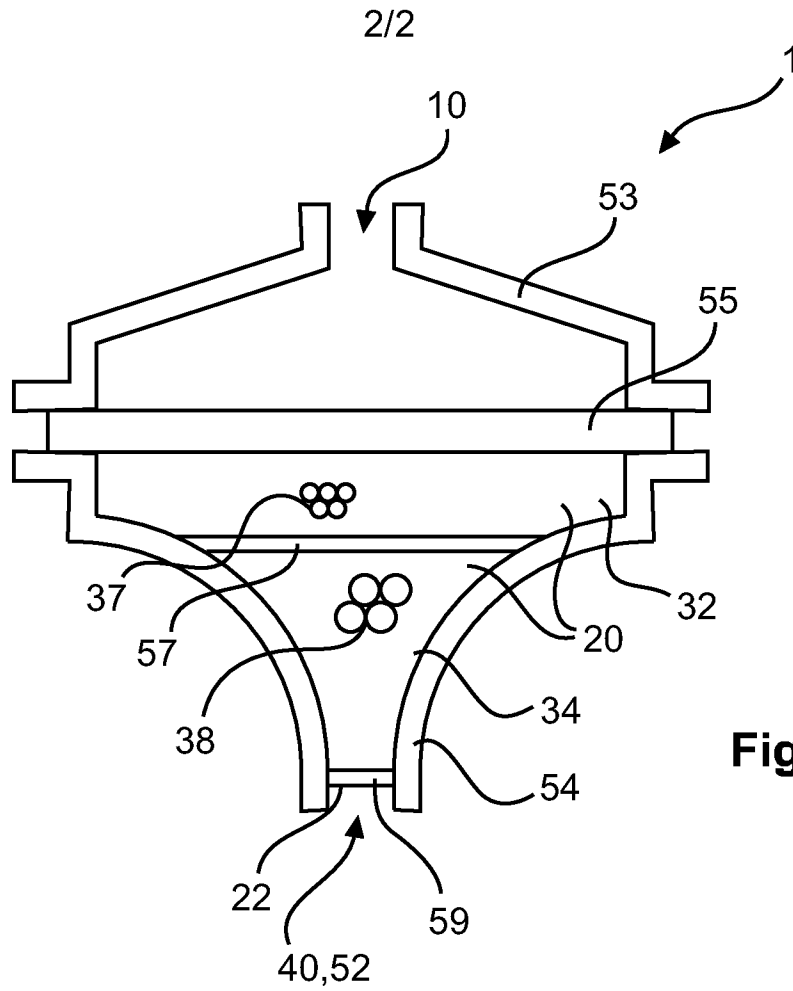


Fig. 2



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
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ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 492 396 A (DALTON EDWARD K ET AL) 27 January 1970 (1970-01-27) column 2, line 36 - column 3, line 71; figures 1-7	1-33
X	----- US B 302 271 I5 (HARGEST THOMAS S) 28 January 1975 (1975-01-28) abstract; figures 1,2	1,3, 7-10,33
A	----- US 6 140 040 A (PALM SCOTT K [US] ET AL) 31 October 2000 (2000-10-31) column 3, line 66 - column 9, line 58; figures 1-3	1-33



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

23 October 2014

Date of mailing of the international search report

03/11/2014

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2014/065322

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 3492396	A	27-01-1970	NONE	
US B302271	I5	28-01-1975	NONE	
US 6140040	A	31-10-2000	NONE	