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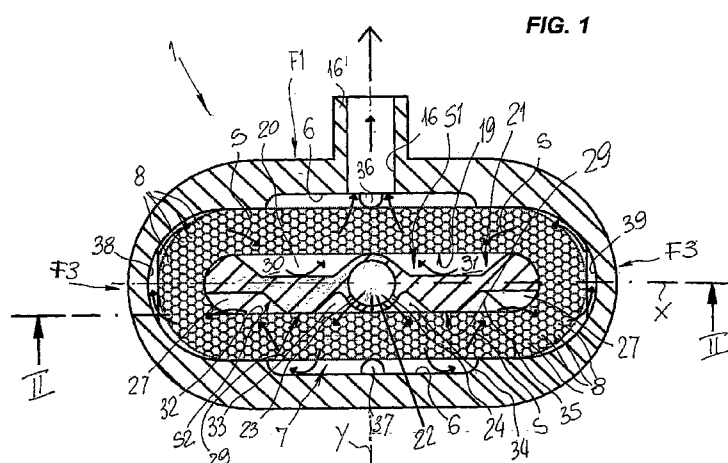
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(54) Title: OXYGENATOR DEVICE



(57) **Abstract:** The oxygenator device (1) comprises: a container (2) having a first end (4) and a second end (5) opposite thereto, as well as a peripheral wall (3) internally delimiting an oxygenation chamber (6) which is designed to be passed through by a fluid to be oxygenated and in which a winding (7) of a plurality of gas-permeable hollow fibers (8) is arranged, which are designed to be lapped by said fluid to be oxygenated; an internal seat (20) centrally defined in said winding (7); a diaphragm (21) for deflecting flows of said fluid to be oxygenated, which is arranged in said internal seat (20); at least one outlet (16) that connects said oxygenation chamber (6) with the outside, characterized in that said diaphragm (21) comprises: at least one inlet duct (22) for receiving said fluid to be oxygenated and two flows deflecting wings (25, 26) which extend from said duct (22) in opposite directions to contact with said peripheral wall (3) and which define longitudinal paths (30-38) between them and said peripheral wall (3).

OXYGENATOR DEVICE

Field of the invention

The present invention relates to a blood oxygenator device having a substantially cylindrical structure, comprising an inner wall and an outer wall, which delimit a portion of space to contain a layer of capillaries made of a microporous membrane and designed to be externally lapped with blood flowing in a direction substantially perpendicular to the portion of space, which also has passages for communication with the outside.

Background art

Disposable oxygen exchanging devices have been long known and used in the medical field, with the purpose of releasing oxygen to blood and removing excess carbon dioxide in patients during extracorporeal circulation treatments.

These prior art devices consist of substantially cylindrical bodies, which enclose an oxygenating chamber with an exchanging unit arranged therein.

The latter typically consists of a multitude of substantially parallel hollow fibers, having a lumen as large as a few hundreds of microns, and formed of a flexible membrane, which is only gas- and not fluid-permeable.

The ends of the hollow fibers are held in two corresponding connection elements, known as "pottings", which are typically formed of polyurethane-based glues.

In practice, the container bodies of these oxygenator devices have a first blood inlet and outlet pair, with blood being forced to flow in a predetermined path within the oxygenator and to lap the hollow fibers in a direction substantially perpendicular thereto, thereby becoming richer in oxygen and releasing carbon dioxide, and a second inlet and outlet pair, designed both for supplying oxygen gas, in pure form or diluted with other gases, such as nitrogen, and for discharging the carbon dioxide released to blood during oxygenation.

In practice, for operation of these devices the blood to be oxygenated, that comes from the patient and is carried by a transport line, shall enter the

oxygenator through the inlet therefore, lap the multitude of hollow fibers having oxygen, or a mixture of oxygen and other diluting gases, flowing therethrough, receive oxygen and release carbon dioxide as a result of differential concentrations, and flow out of the outlet in an oxygen-enriched state, to reach the patient through a return connection line.

Oxygen, or the oxygen-containing gas mixture, enters its inlet and is released to blood while carbon dioxide is released by blood to the hollow fibers and discharged through its outlet.

The motion of blood flow that comes from the patient, passes through the oxygenator and goes back to the patient may be generated and maintained either by the action of a pump that may be mounted along a circuit of ducts that form the fluid connection line between the patient and the oxygenator, or simply by gravity, i.e. by a piezometric head differential, either by placing the oxygenator lower than the patient or by putting two vascular accesses of the latter in communication, i.e. by addressing the blood flow of an artery to a vein, by means of the pressure gradient caused by heartbeat, to generate a blood flow in the device, and hence without any external pump, according to an arteriovenous model.

In any case a pressure higher than atmospheric pressure is generated in the oxygenator, to overcome the sum of the mechanical resistances encountered by blood as it flows within the pipes through the device which has the hollow fibers and those of the peripheral circulatory system of the patient held therein, to ensure that circulation is maintained active all along the oxygenation path.

An additional requirement to be met by these oxygenators is to provide an effective exchange surface relative to their overall size, which has to be maintained within strict limits both due to bulk limitation and handling requirements, and because a fraction of blood has to be removed from the patient to fill the device and the circuit attached thereto, even though it is diluted with salines.

An oxygenator as described above is known from US 5,817,278.

This document discloses an oxygenator having a cylindrical body

which is composed of an outer wall and an inner wall which is concentric with the outer wall and has a smaller diameter, so that an oxygenator chamber is defined between these inner and outer walls.

5 This oxygenation chamber, which has inlet and outlet paths in communication with the outside, holds a set of hollow fibers arranged therein, which are made in a well-known manner from a gas permeable membrane, in which oxygen is caused to flow.

10 This set of hollow fibers has such a volume as to wrap the inner wall and lap the outer wall, and is kept at a distance therefrom at certain predetermined points by means of a series of longitudinal ribs that project out of the inner and outer walls and act as spacers.

Thus, free longitudinal passages are defined between the set of hollow fibers and the inner and outer walls, which passages are filled with the blood flow as it passes through the oxygenator and generate a substantially undulated flow that passes through the winding of hollow fibers thereby capturing the oxygen flowing therethrough and releasing the carbon dioxide carried to the outside.

Another oxygenator device is known from EP 1 557 185.

20 This document discloses an oxygenator having a hollow cylindrical body that defines an internal exchange chamber within which a winding of hollow fibers is arranged.

Once again, the ends of the hollow fibers are held by two corresponding end elements known as "pottings", and formed of plastic material.

25 The oxygenation chamber is composed of two half-chambers, each holding a corresponding winding of hollow fibers, which are arranged perpendicular to an inlet and an outlet for the blood to be oxygenated, and in opposed relation.

30 Each of the windings of hollow fibers defines a smaller chamber at its center, which contains a substantially flat and monolithic diaphragm, impermeable to blood flow, whose ends are held in contact with the winding of hollow fibers.

This diaphragm has a cross section with surfaces that push back the blood flow as it tries to pass through it in the path between the inlet and the outlet and deflect it towards the winding of hollow fibers, thereby imparting an undulating motion in the blood flow to be oxygenated, which is thus caused to
5 pass through the winding of hollow fibers at multiple areas, thereby creating the desired exchange between oxygen and blood and between the carbon dioxide released from the blood and the hollow fibers that form the winding.

Two adjacent, isolated chambers are defined in the body of the oxygenator according to this document, which chambers are arranged in
10 mirror-like arrangement with respect to a median plane of symmetry.

Furthermore, a series of longitudinal parallel passages are provided, also in mirror-like arrangement, which facilitate the passage of blood flows and form chambers for accumulation of carbon dioxide to be expelled outwards through apertures especially provided therefor.

15 This prior art suffers from certain drawbacks.

A first drawback is that the increase of pressure losses caused in prior art oxygenators by resistance to blood flow motion damages the red cells membranes and causes hemolysis.

Another drawback is that prior art oxygenators have a very complex
20 structure and that they require long and costly manufacturing processes.

A further drawback is that prior art oxygenators must be filled with a considerable volume of blood, to be withdrawn and removed from the patient for extracorporeal circulation and possibly compensated for with adequate volumes of diluents.

25 A further drawback is that prior art oxygenators tend to be affected by spontaneous creation of blood flow stagnation areas, which cause conditions for fast degeneration of gas exchange performance and formation of clots, very dangerous for patients.

Yet another drawback is that if prior art oxygenators are not used
30 within a short time from their fabrication, they tend to be exposed to degradation of plastic materials with time.

This degradation may generate deformations of components and thus

create undesired gaps that will act as free passages for blood that will flow through them without previously lapping the hollow fibers and without being adequately oxygenated and washed out of excess carbon dioxide, before reaching back the patient.

5

Disclosure of the invention

It is an object of the invention to improve the prior art.

Another object of the invention is to provide an oxygenator device that allows satisfactory oxygenation of patient blood, relative to its size, that should be as small as possible.

10

A further object of the invention is to provide an oxygenator device that only requires withdrawal of small amounts of blood from the patient, to be filled and operate properly.

Another object of the invention is to provide an oxygenator device that can operate even at very low pressures and that can both ensure better integrity of red cell membranes, and operate even without the help of a pump, by only utilizing either the pressure gradient between the patient or the device or an arteriovenous model, i.e. based on the differential pressure between two vessels.

Another object of the invention is to provide an oxygenator device that can equally and consistently oxygenate the blood flow that passes through it during use and for the whole life of the device, in spite of progressive and inevitable ageing and degradation of materials.

A further object of the invention is to provide an oxygenator device that prevents the formation of emboli and generally has a substantially simplified construction as compared with prior art oxygenators, and thus has a relative lower cost and allows easier and quicker assembly.

In one aspect, as defined in claim 1, the invention addresses an oxygenator device comprising a container having a first end and a second end opposite thereto, as well as a peripheral wall internally delimiting an oxygenation chamber which is designed to be passed through by a fluid to be oxygenated and in which a winding of a plurality of gas-permeable hollow fibers is arranged, which are designed to be lapped by said fluid to be

oxygenated; an internal seat centrally defined in said winding; a diaphragm for deflecting flows of said fluid to be oxygenated, which is arranged in said internal seat; at least one outlet that connects said oxygenation chamber with the outside, characterized in that said diaphragm comprises: at least one inlet
5 duct for receiving said fluid to be oxygenated and two flow deflecting wings which extend from said duct in opposite directions to contact with said peripheral wall and which define longitudinal paths between them and said peripheral wall.

The invention allows the creation of flows in the oxygenator device that
10 have a geometric undulating path, as the conformation of the oxygenator device forces the fluid to be oxygenated to repeatedly pass through the winding of hollow fibers, which improves gas exchange therewith and also prevents the formation of clots that can generate dangerous thrombo-emboli.

Brief description of the drawings

15 Further features and advantages of the invention will be more readily apparent from the detailed description of a few preferred non exclusive embodiments of an oxygenator device of the invention, which are shown as a non limiting example with the help of the annexed drawings, in which:

FIG. 1 is a magnified view of a cross section of an oxygenator device
20 of the invention, as taken along a plane I-I of Figure 2;

FIG. 2 is a smaller-scale view of a longitudinal section of an oxygenator device of the invention, as taken along two offset planes II-II of Figure 1;

FIG. 3 is a smaller-scale view of a longitudinal section of an
25 oxygenator device of the invention, as taken along a plane planes III-III of Figure 2;

FIG. 4 is a perspective view of a flow deflecting diaphragm removed from the oxygenator device of Fig. 1;

FIG. 5 is a cross sectional view of an oxygenator device of the
30 invention, as taken along a plane V-V of Figure 6;

FIG. 6 is a diagrammatic view of the oxygenator device of Fig. 2;

FIG. 7 is a cross sectional view of a further version of an oxygenator

device of the invention;

FIGS. 8, 9, 10 are diagrammatic views of three possible embodiments of a connection circuit for connecting the oxygenator device of the invention to a patient;

5 FIG. 11A is a diagrammatic cross sectional view of a further possible version of an oxygenator device of the invention, having a first thermostatisation element for thermostating the fluid to be oxygenated;

10 FIG. 11B is a diagrammatic cross sectional view of a further possible version of an oxygenator device of the invention, having a second thermostatisation element for thermostating the fluid to be oxygenated;

FIGS. 12 and 13 are front and rear perspective views of a flow deflecting diaphragm removed from the oxygenator device of Fig. 11 and having blood thermostating passages.

Detailed description of one preferred embodiment

15 Referring to the above figures, numeral 1 generally indicates an oxygenator device designed to oxygenate a fluid, in this particular exemplary case blood.

The oxygenator device 1 comprises a container 2 having a side wall 3 and defining a first end 4 and an opposite second end 5.

20 The container 2 forms an oxygenation chamber 6 in the side wall 3, with a plurality 7 of hollow fibers 8 arranged therein, which are assembled in a winding that keeps them substantially parallel and have corresponding ends held by respective retention elements 9 and 10, preferably made of polyurethane-based material, and known as "pottings".

25 The ends of the container 2 are closed by respective lids 11 and 12 with apertures formed therein, namely: the lid 11 has an inlet 13 for blood coming from a patient "P", having a standard projecting mouth 13', an inlet 14 for an oxygenating fluid, namely oxygen or a mixture with a high oxygen content, having a standard mouth 14', whereas the lid 12 has an inlet 15 for
30 discharging gases removed from blood, having a standard mouth 15', and an outlet 16 for oxygenated blood, formed on the container body, which is connected by a return segment to the patient "P" of a circuit as better

described below and has a standardized mouth 16' like the others.

The term standard mouth is intended to designate a male mouth having a taper known as Luer taper, which progressively narrows outwards for female couplings to be fitted thereon or for connection with 3/16", 1/4" or
5 3/8" pipe fittings, as typically found in the medical devices used for extracorporeal circulation treatments.

The two lids 11 and 12 are also interiorly formed with a first end chamber 17 and a second end chamber 18, which receive the open ends of the hollow fibers 8.

10 The inner periphery 19 of the winding of hollow fibers 8 forms an internal seat 20 which is in fact a portion substantially concentric with the oxygenation chamber 6, with a blood flow deflecting diaphragm 21, preferably formed of one piece and with no apertures therethrough as described in detail below, precision fitted therein.

15 Referring to Figures 1 and 4, the diaphragm 21 has a central inlet duct 22 for the blood to be oxygenated which, as shown in Fig. 2, is connected with the mouth 13' of the inlet 13 by means of a connection segment 13" precision fitted on the concurrent end of the duct 22.

20 The latter has at least two longitudinally-extending spread openings 23 and 24 which, with the oxygenator device 1 assembled, are designed to face away from the outlet 16 and through which the blood that flows into the duct 22 is distributed into the oxygenation chamber 6 and fills it.

The diaphragm 21 also has two opposed wings 25 and 26 which are designed, in practice, to deflect the blood flows to be oxygenated, as better
25 explained below.

Each of these wings 25 and 26 that, as shown, have a substantially generally flat shape, has a first surface and a second surface opposite thereto, designated as S1 and S2 respectively, and respective distal end portions S3 for connecting them, namely with a substantially, but not
30 exclusively rounded profile.

As shown in Fig. 4, a succession of brackets 27 are formed at such rounded profile S3 and extend in a cantilever fashion from the surface S2

and preferably from the latter only, whereas the opposite surface S1 is substantially flat.

Parallel passages 28 are defined between brackets 27, for the blood flows to be oxygenated to flow therethrough and lap the hollow fibers 8.

5 A projecting rib 29 also extends from the surface S2 and, as shown in Fig. 1, faces away from the outlet 16 and is designed to contact the inner periphery 19 of the winding of hollow fibers 8.

The distal end portions S3 also contact the inner periphery 19 as well as the contour of the duct 22.

10 Therefore, two longitudinal and parallel passages 30 and 31 are defined between the diaphragm 21 which, as shown, is symmetrical with respect to a minor axis of symmetry "Y" of the container 2, and the inner periphery 19, on one side facing towards the outlet 16, i.e. between the surface S1 and the inner periphery 19, whereas four additional longitudinal
15 passages 32, 33, 34, 35 are defined between the opposite surface S2 and the inner periphery 19.

It shall be noted that two further projecting ribs facing towards the oxygenation chamber, and designated with numerals 36 and 37, are also formed in the central portion of the oxygenator device 1, and are used to hold
20 the winding of hollow fibers in its proper position within the oxygenation chamber 6.

The ends of the winding oriented along a further axis "X" of the container 2, which is considered as the major axis of the container 2 and is typically perpendicular to the minor axis "Y" of symmetry, delimit two further
25 opposite longitudinal passages 38 and 39 with the inner surface of the peripheral wall 3.

Referring to Figures 5 and 6, the container 2 also has two additional apertures, designated by numerals 40 and 41, formed in the proximity of one of the ends; these additional apertures are used for exhausting any air
30 accumulated in the device.

As generally shown in Figures 1 and 5, the cross sections of the container 2 show that the latter has a substantially flattened plan shape,

which is longer along the major axis "X" and narrower along the minor axis "Y", whereby two opposed faces F1 and F2 are defined, also flat and parallel, which are connected at their ends by connection segments F3 having a rounded profile following a circumferential arc or possibly an arc having a curvature other than that of a circumference.

Referring to Fig. 7, in a possible second embodiment of the oxygenator device 1, the latter is even larger along the major axis "X" than in the previously described version, so that the blood oxygenation path so obtained by has larger exchange surfaces.

In this case, each of the wings 25 and 26 has raised ribs 129 and 130 formed on both surfaces S1 and S2 and a greater number of longitudinal passages are defined between them and the inner periphery 19 of the winding of hollow fibers 9.

Referring to Figures 8, 9, 10, a patient "P" is connected to an oxygenator device 1 of the invention by a line of pipes having a first segment T1 that comes from the patient "P" and a second segment T2 that goes back to him/her.

Particularly referring to Figures 8 and 9, a pump, possibly of peristaltic type, designated by numeral 42 in Fig. 9, or of centrifugal type, designated by numeral 43 in Fig. 8, is provided upstream from the oxygenator device 1, whereas no pump is shown in Fig. 10, blood circulation from and to the patient "T" being obtained by a piezometric head differential, by placing the oxygenator device 1 lower than the patient "P" and by putting two vascular accesses thereof in mutual communication, in an arteriovenous model.

Referring to Figs. 11, 12 and 13, a third embodiment of the inventive oxygenator device is shown, here designated by numeral 100, which differs from the first embodiment as described above in that a blood thermostating element 121 is placed in the internal seat 20 and both has a blood thermostating function and acts as a diaphragm 121 having the same functions as the diaphragm 21 as described above.

Nevertheless, in this case, the diaphragm 121 is formed with a duct 122 for supplying blood to be oxygenated to the oxygenator 100 and two

additional ducts 123 and 124 parallel to the duct 122, with a thermostated fluid, for instance heated or cooled water, flowing therein.

Namely, one of the ducts, in this case the duct 124, is used for the supply of thermostated fluid, and the other duct 123 is used for the discharge thereof once it has released heat to the blood to be oxygenated.

A chamber 125 is located between these two ducts 123 and 124 and is connected to such ducts 124 and 123 by means of passages 127 and 128, a laminar element 126, preferably folded in a corrugated or pleated form, being arranged therein and having a surface 130 designed to be tangentially lapped by blood, as shown by the arrows "SN" in Figs. 12 and 13, and a surface 131, opposite thereto, designed to be lapped by the thermostated fluid, as shown in such Figs. 12 and 13 by the arrows "A": thus, the latter may release or extract heat to or from blood through contact with the laminar element 126.

The skilled person may obviously appreciate that a different embodiment of the element 126 may be provided, e.g. comprising a plurality of ducts, which may consist, for instance, of non porous and liquid impervious plastic capillaries, parallel to the hollow fibers 8 and the ducts 123 and 124 in which the blood thermostating fluid flows, which fluid would flow outside them.

The operation of the oxygenator device is as follows: the blood to be oxygenated that comes from the patient "P" through the section T1, enters the oxygenator device 1 through the aperture 13 and flows from the latter, through the connecting section 13", into the duct 22, which distributes it into the oxygenation chamber 6 through the spread openings 23 and 24, and thus fills the chamber.

At the same time an oxygen gas flow, or a gas mixture with a predetermined oxygen content, is caused to flow through the hollow fibers.

Such gas enters through the inlet 14, expands in the first end chamber 17 and penetrates the hollow fibers 8 whose ends are held by the two retaining elements 9 and 10.

Since the hollow fibers 8 are formed, as is typical, from a gas

permeable, liquid impervious membrane, oxygen exchange occurs as blood flows in contact with these hollow fibers 8.

At the same time, the red cells in blood release carbon dioxide and collect oxygen, due to differential concentrations of oxygen and carbon dioxide between the blood flowing outside the hollow fibers 8 and the oxygen gas that flows therein.

The carbon dioxide released by blood red cells is collected in the second end chamber 18 and expelled outwards therefrom through the discharge aperture 15.

10 Blood flows distributed from the spread openings 23 and 24 flow into the passages 33 and 34 and once the latter are completely filled, are deflected by the ribs 29 towards the winding of hollow fibers 8.

Blood flows pass through this winding, thereby becoming oxygenated and releasing carbon dioxide and are distributed into the oxygenation chamber 6.

Once the latter is filled, blood flows are deflected again towards the winding of hollow fibers 8 and pass through it again, following an undulating path, designated by arrows "S", which allows further blood oxygenation and further carbon dioxide release.

20 Once blood flows have passed through the winding of hollow fibers 8 again, they are deflected by the brackets 27 through the parallel passages 28 that deviate them once again towards the winding.

The flows pass through the latter one more time, with further oxygenation and carbon dioxide release and flow into the additional longitudinal passages 38 and 39.

Once the latter are also filled, blood flows are further deviated through the winding and, after passing through it and collecting further oxygen from the hollow fibers 8, they fill the longitudinal passages 30 and 31.

From the latter they are deflected one more time towards the winding and, once they have passed through it again, they flow out through the outlet 16 which is connected with the section T2 and brings them back to the patient "P" well oxygenated and purified from carbon dioxide.

Deflection of blood flows is caused by the profile of the surfaces S1 and S2 of the deflecting wings 25 and 26 of the diaphragm 21, which has the ribs 29 and the distal end portions S3 in tight contact with the inner periphery 19 of the winding of hollow fibers 8.

5 The ribs 29, the passages 28 and the inner surface of the side wall 3 have such transverse profiles as to impart a sinusoidal motion to blood flows, which causes them to repeatedly pass through the bundle 7, and thus improve gas exchange for blood oxygenation and carbon dioxide removal.

10 It should be noted that the shape of the container 2, substantially flattened according to the minor axis "Y" allows a general size reduction and easier handling by operators.

The operation of the further embodiment of the oxygenator device 100 equipped with the heating element, or diaphragm 121, is substantially as described above concerning the first embodiment.

15 The only difference is that, in addition to repeatedly deflecting blood flows towards the winding of hollow fibers 8 for the flows to repeatedly pass through it in a substantially perpendicular direction, the diaphragm 121 carries a thermostated fluid, typically water, especially heated water, in it, namely in the ducts 124 and 123 and through the passages 127 and 128 into
20 the chamber 125, which fluid releases (but also collects, if needed) heat to (from) blood by contact and hence by conduction, with the laminar element 126.

25 Thus, the blood that comes back to the patient "P" after being oxygenated and purified from carbon dioxide, is brought to a temperature substantially similar to the body temperature of the patient "P" to avoid thermal shocks.

 It shall be further understood that the oxygenator device 1 of the invention may be manufactured in a simpler manner than in prior art, because both the ends of the hollow fibers 8 and the ends of the element 126
30 may be embedded by a single application of glue material, during assembly, in the two corresponding retaining elements 9 and 10.

The invention has been found to fulfill the intended objects.

The invention so conceived is susceptible to changes and variants within the inventive concept.

Also, all the details may be replaced by equivalents.

In practical implementation, any shape and size may be used as
5 needed, without departure from the scope as defined by the following claims.

CLAIMS

1. An oxygenator device (1) comprising:

A container (2) having a first end (4) and an opposite second end (5) and a peripheral wall (3) which bound internally an oxygenation chamber (6) which can be passed through by a fluid to be oxygenated and inside which a winding (7) of a plurality of gas-permeable hollow fibres (8) is arranged, suitable to be lapped by said fluid to be oxygenated;

An internal seat (20) centrally defined inside said winding (7);

A diverting diaphragm (21) of flows of said fluid to be oxygenated, arranged inside said internal seat (20);

At least one exit (16) which connects said oxygenation chamber (6) to the outside, characterized in that said diaphragm (21) comprises:

At least one entry duct (22) of said fluid to be oxygenated and

Two flows diverting wings (25, 26) which extend from said duct (22) toward two opposite directions up to a substantial contact with said peripheral wall (3) and defining longitudinal passages (30-38) between said wings (25, 26) and said peripheral wall (3).
2. A device according to claim 1, wherein said hollow fibres (8) are arranged parallel to each other and to a longitudinal axis of said container (2).
3. A device according to anyone of claims 1 or 2, wherein said container (2) shapes transversally a flattened shape which defines:

A longer axis (X) and a shorter axis (Y) which are substantially perpendicular reciprocally;

A first surface (F1) and an opposite second surface (F2) of said peripheral wall (3) which are substantially parallel;

Two connecting ends (F3) between said first surface (F1) and second surface (F2).
4. A device according to claim 1, wherein said entry duct (22) comprises at least a spread opening (23, 24) longitudinally obtained for spreading said fluid to be oxygenated from said duct

(22) to said internal seat (20).

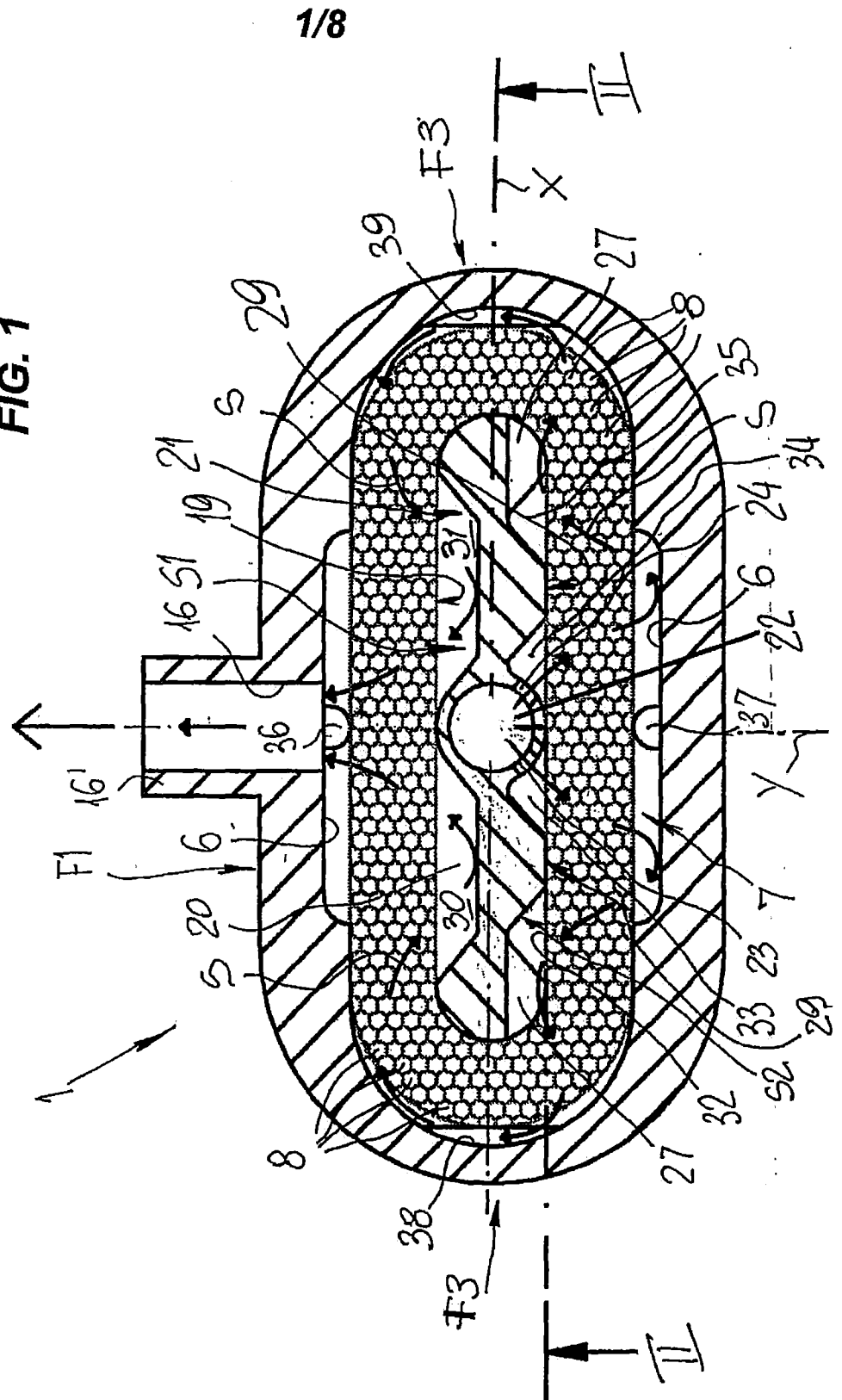
5. A device according to claim 3, wherein said shorter axis (Y) is an axis of symmetry.
- 5 6. A device according to anyone of claims from 1 to 5, wherein each of said flow diverting wings (25, 26) defines two opposite surfaces (S1, S2) and a distal end zone (S3) from said duct (22), to connect said surfaces (S1, S2) and to contact said peripheral wall (3).
- 10 7. A device according to anyone of claims 1 or 6, wherein at least one of said opposite surfaces (S1, S2) is planar and the other shapes at least a projecting rib (29) to contact said peripheral wall (3).
8. A device according to claim 6, wherein said distal end zone (S3) shapes a plurality of parallel projecting brackets (27) which define between them parallel flows passages (28) of said fluid to be oxygenated.
- 15 9. A device according to anyone of claims 1, 3, 4, wherein said at least an exit (16) is obtained in said first surface (F1) of said container (2) and said spread opening (23, 24) is turned toward said second surface (F2) of said container (2).
- 20 10. A device according to claim 1, wherein said first and second ends (4, 5) of said container (2) comprise closing lid means (11, 12) in which a first end chamber (17) and a second end chamber (18) are respectively obtained into which corresponding ends of said hollow fibres (8) flow.
- 25 11. A device according to claim 10 wherein said lid means (11, 12) have respectively an inlet opening (14) for the oxygenating gas and an outlet opening (15) for the elimination of said gas from the fluid to be oxygenated.
- 30 12. A device according to claim 1, wherein in at least one end zone of said container (2) further vent openings (40, 41) are obtained which communicate with said oxygenation chamber (6).
13. A device according to anyone of preceding claims, wherein said diaphragm (21) comprises at least two further thermostatic fluid

passages (127, 128) for thermal regulation of said fluid to be oxygenated.

5 14. A device according to claim 13, wherein between said at least two further passages (127, 128) at least an housing chamber (125) for at least an exchanger element (126) is provided, connected with said entry duct (22) of said fluid to be oxygenated and said two further passages (127, 128), said laminar exchanger element (126) defining two opposite exchanging surfaces (130, 131) suitable to be lapped by said fluid to be oxygenated and said thermostatic fluid
10 respectively.

15. A device according to claim 14, wherein said at least an exchanger element is chosen between a laminar element (126) or a plurality of capillary plastic elements (126') which are liquid impermeable.

FIG. 1



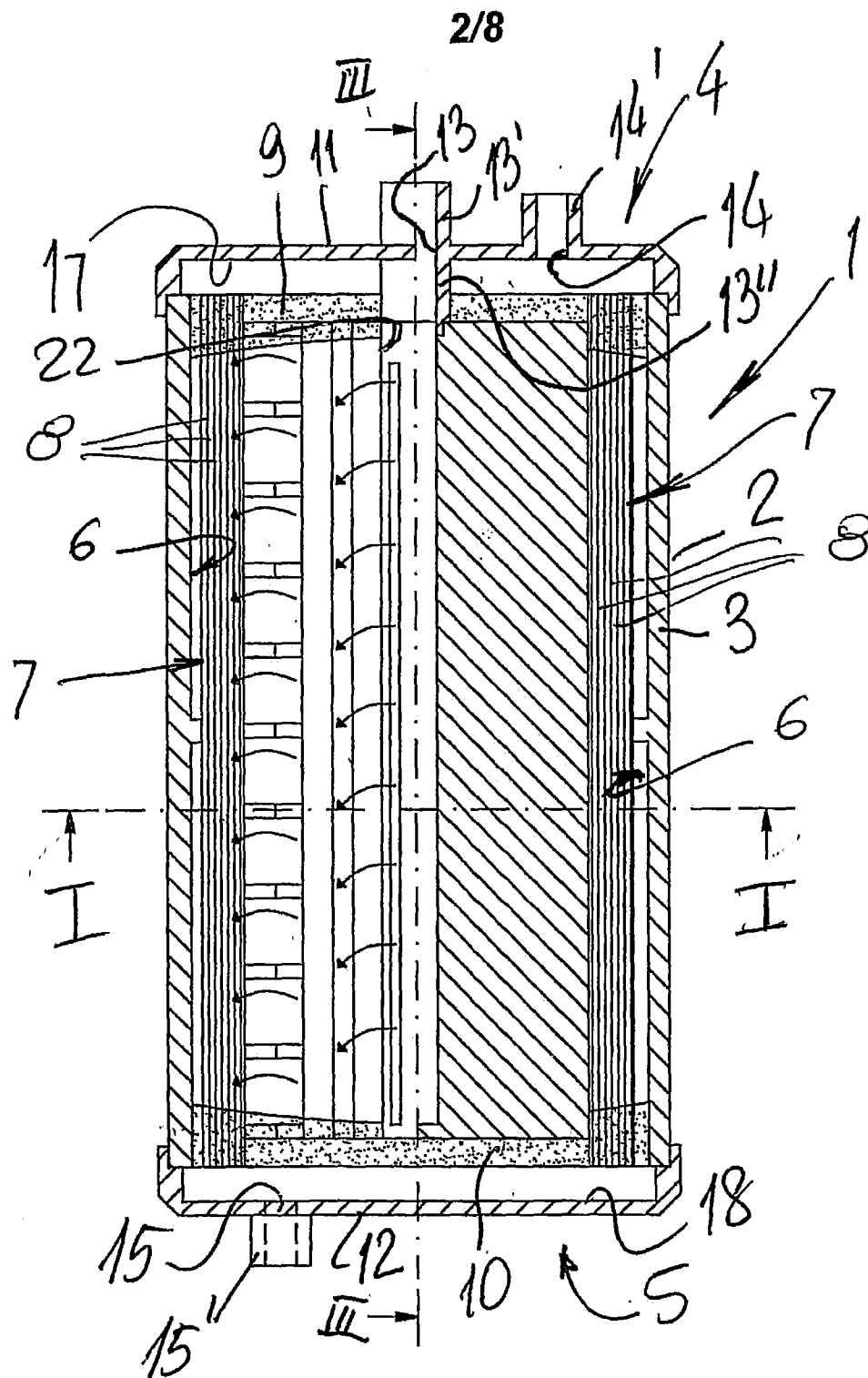


FIG. 2

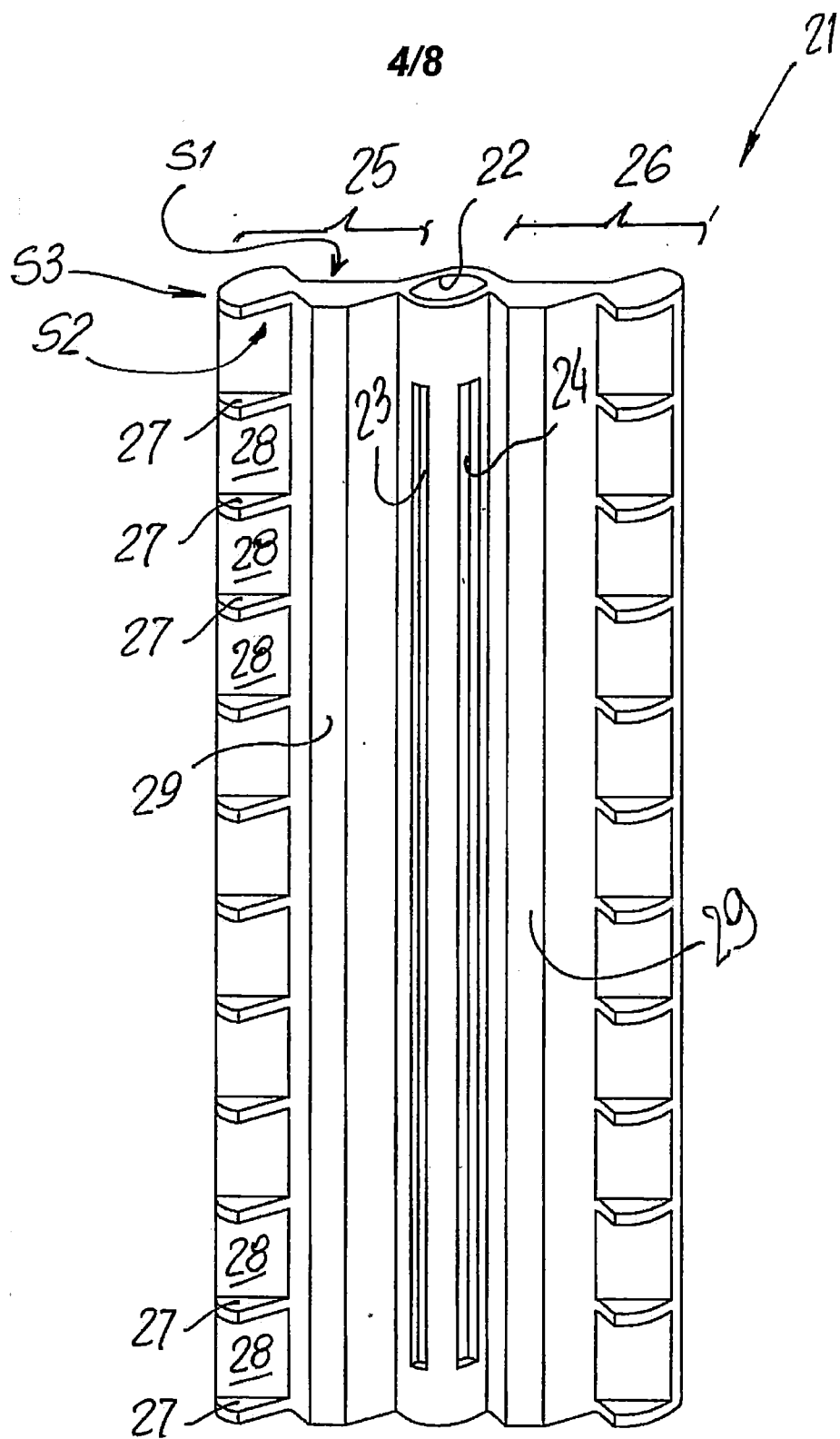


FIG. 4

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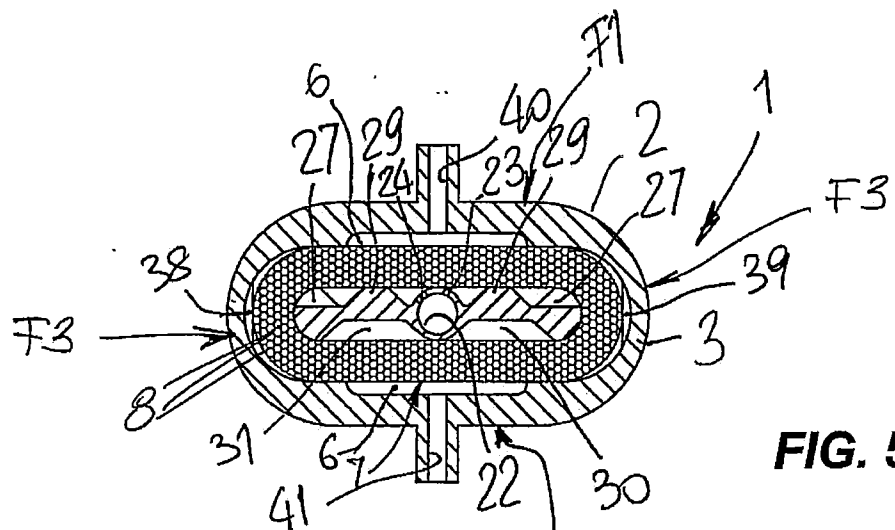


FIG. 5

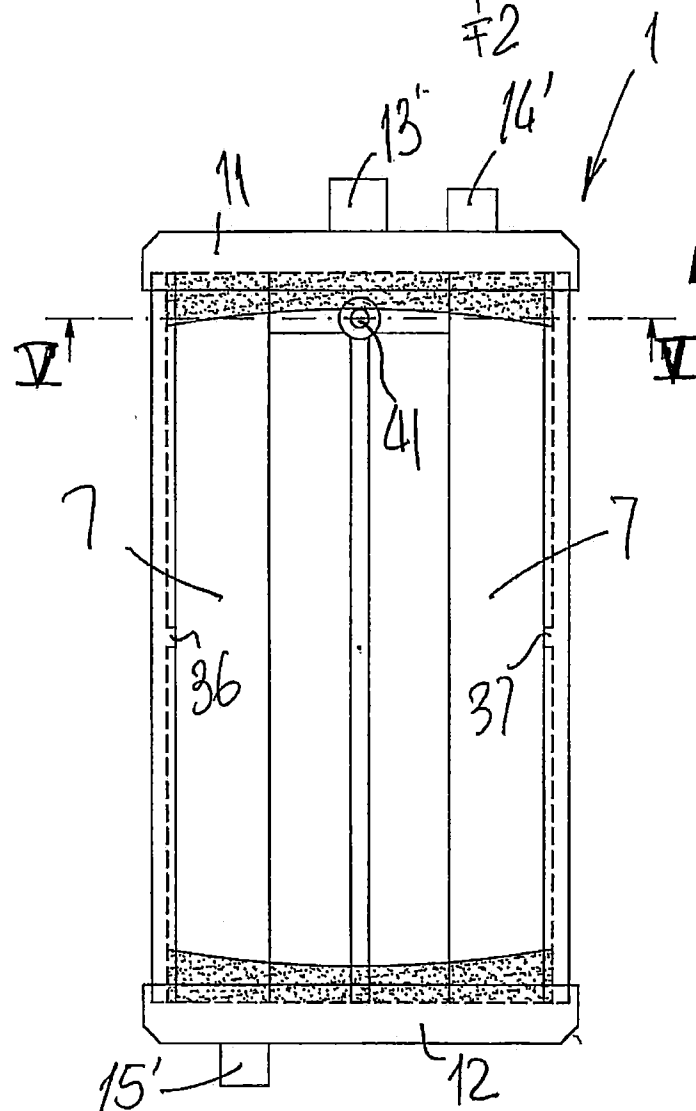
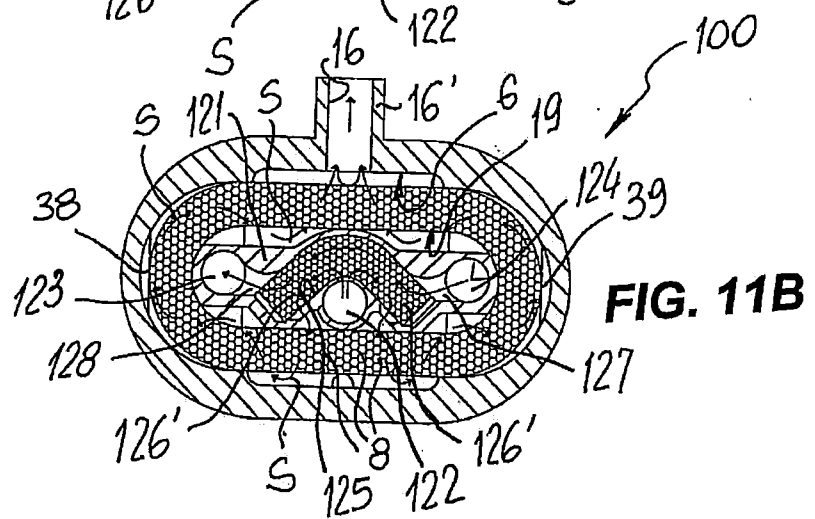
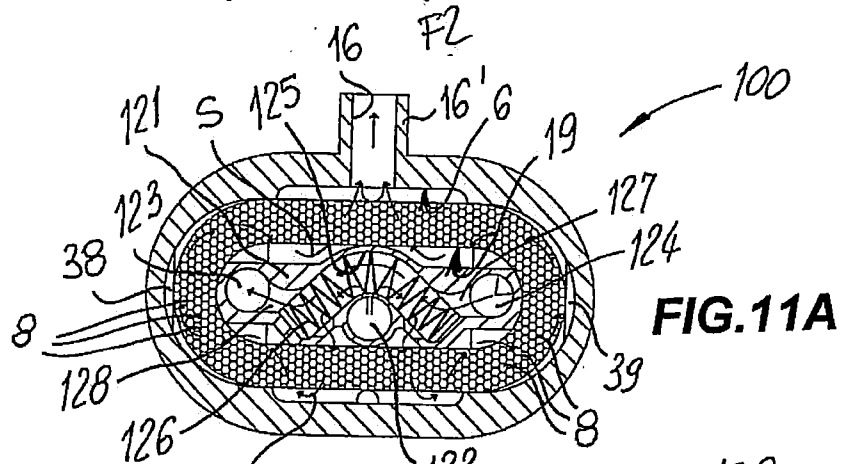
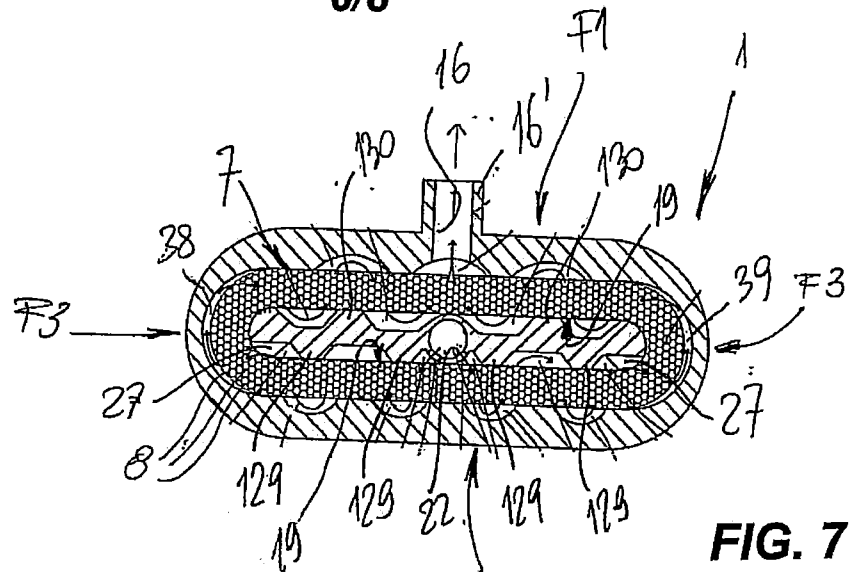
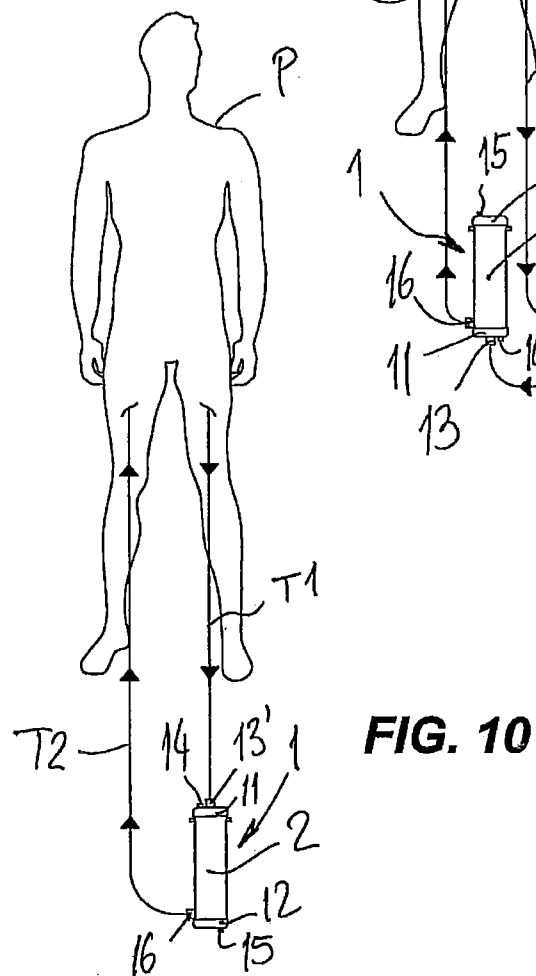
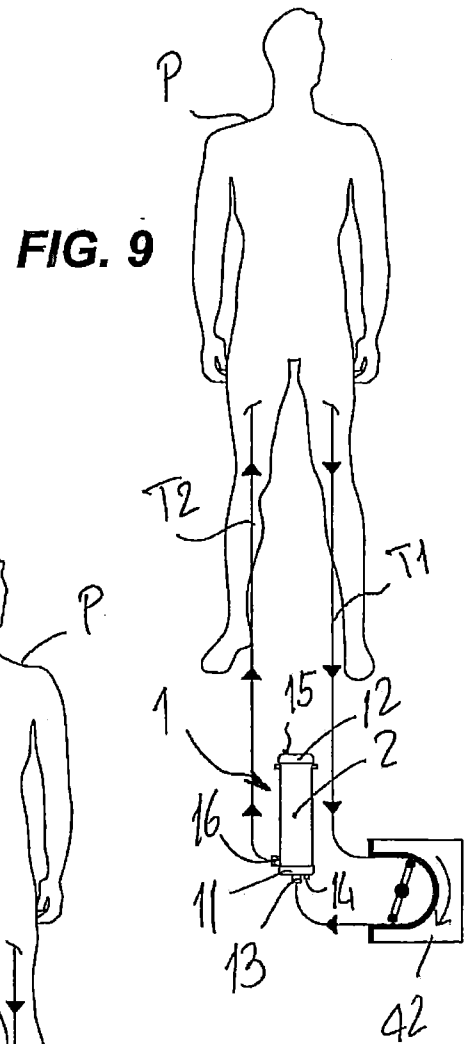
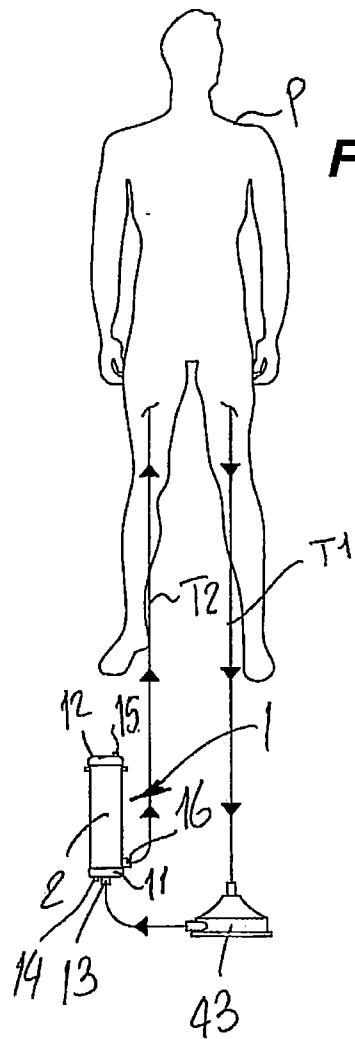


FIG. 6

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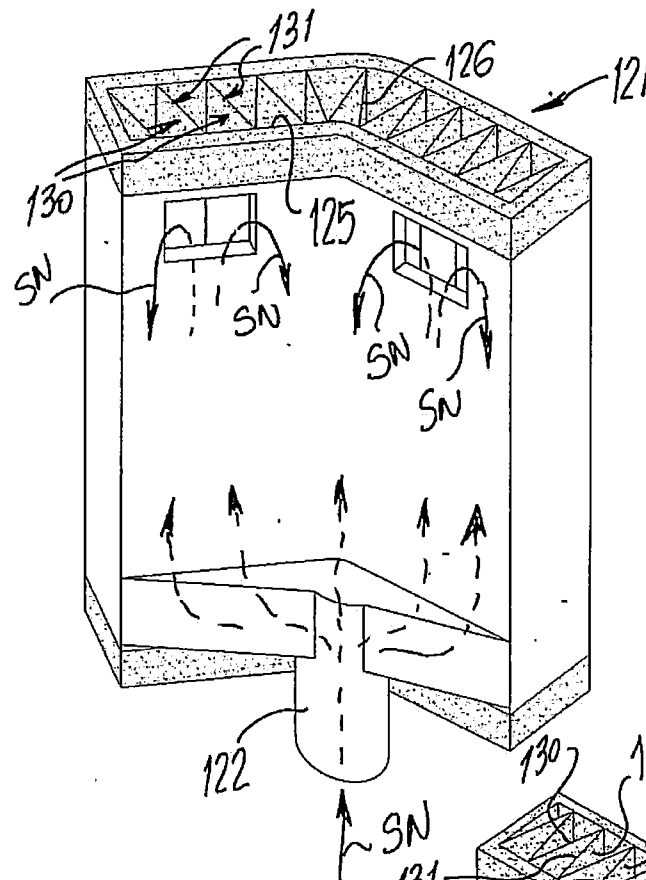
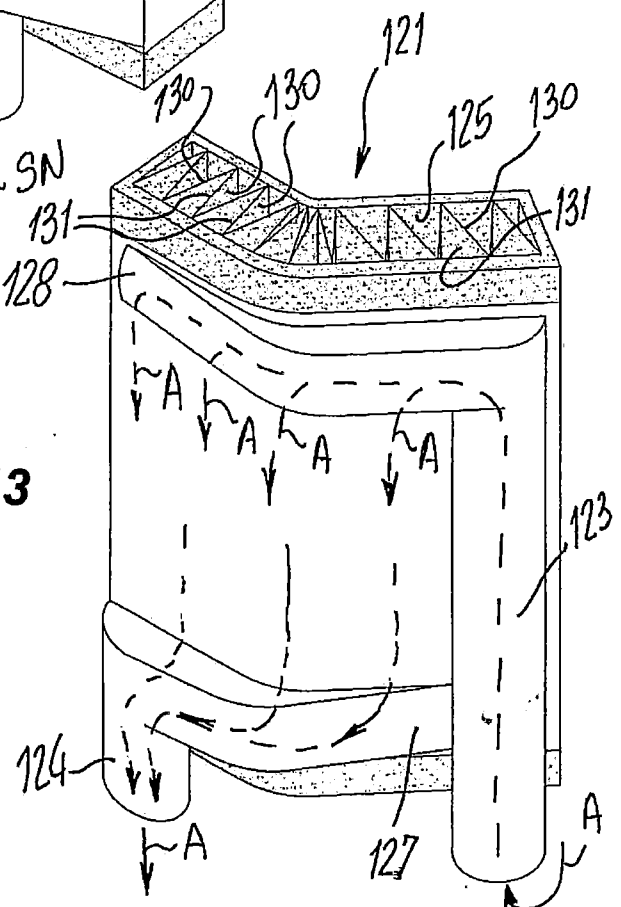


FIG. 12

FIG. 13



INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2010/053422

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61M1/16

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 557 185 A1 (RAND S R L [IT]) 27 July 2005 (2005-07-27) cited in the application paragraphs [0034] - [0055], [0057]; figures 1,2	1-15
A	US 4 639 353 A (TAKEMURA TOHRU [JP] ET AL) 27 January 1987 (1987-01-27) column 5, line 56 - column 6, line 33; figures 3,4	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

28 October 2010

Date of mailing of the international search report

05/11/2010

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2010/053422

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