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(54) **MOLECULAR EXCHANGE DEVICE**

MOLEKULARE AUSTAUSCHVORRICHTUNG

DISPOSITIF D'ÉCHANGE MOLÉCULAIRE

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Description

[0001] The present invention relates to a molecular exchange device.

[0002] Molecular exchange devices, such as dialysis probes, are known in the art. Such probes relate to use for insertion into a subject, such as in a blood vessel, for use in dialysis, detection of substances or levels of substances within the subject. Such probes generally include a porous membrane past which a perfusion fluid is supplied and removed. Molecules from the perfusion fluid can pass through the membrane into the subject and vice versa. In the latter case, analysis can be carried out using internal or external apparatus to ascertain the presence of certain molecules and their concentrations.

[0003] The membranes used for dialysis tubing such as that in the prior art probes typically have very thin walls to promote effective diffusion, which means that they provide very little structural support and, as such, the thin walls do not maintain their shape in use. In order to provide additional support to the membranes, the first probes had a thin wire placed within the centre of the tubing to provide support for the membranes during insertion into the subject, as well as to prevent the walls of the membrane from collapsing when the membrane is bent.

[0004] However, despite that addition of a thin wire, such probes are still prone to collapsing against the metal wire during insertion and, particularly, when bent. In an attempt to overcome this problem, the wire was replaced by a hollow tube within the membrane, typically positioned along the longitudinal axis of the probe. The hollow tube provides elongated support that also acts as a supply or a return line for the perfusion fluid.

[0005] One of the major disadvantages of using such forms of internal support for the membrane was damage to the membrane during the insertion of the internal support and during insertion into a subject.

[0006] In a further attempt to overcome the problem of providing sufficient support to the membrane, probes were formed having short lengths of membrane tubing glued on to a supporting structure such as a hollow stainless steel tube. The steel tube provides elongation and assists in the insertion of the device. The disadvantage with such probes is that, under physiological conditions, the glue used in the assembly of such probes weaken due to contact with fluids, resulting in fragmentation of the membrane tubing from the supporting structure within the subject. The membrane tubing of such hollow tubes could also fragment due to mechanical damage caused during insertion into the subject.

[0007] In view of the use of such probes within a subject (i.e. a human or animal body), it is clear that fragmentation of the membrane is not desired due to the potential damage that could be caused. When this occurs in tissue such as muscle it is unfortunate but, as the materials of the membrane are relatively bio-compatible, this is not disastrous. However, when this occurs in a system within a subject such as the circulatory system, lost fragments could be moved into areas (for example the heart) where they could be life threatening. Even if such fragments are spotted before serious damage can occur, the removal of such fragments causes further injury.

[0008] EP 0675695 discloses a dialysis probe wherein the dialysis membrane is attached at the proximal end of the probe to overcome the possibility of the probe becoming loose from its anchor, due to the fact that the anchoring area is not within the subject. Although reasonably effective, this is a relatively complicated and expensive probe to manufacture. Moreover, the tip is not protected in any way, which leaves it vulnerable to damage.

[0009] In an attempt to overcome the disadvantages described above, EP-A-1105045 and US 6,478,767 disclose an arrangement in which a tube formed of a dialysis membrane is mounted on a relatively stiff support member. In particular, the support member is elongate and a tubular dialysis membrane extends along one longitudinal side, folds back in a U shaped fashion, through an eye or a notch, at the distal end of the support member, and then passes back against the opposite longitudinal side. The support member provides support for the tubular membrane and as such, the probe is more robust and cost effective than its predecessors. US 6,478,767 further discloses an impermeable sheath to cover a portion of the probe.

[0010] However, the support member does not provide any protection to the external walls of the membrane. In particular, there are no means provided to maintain the walls of the membrane in position during use, to ensure that flow of fluid within the tubular membrane is not impeded. Furthermore, the folding of the membrane in the U shaped fashion may cause a kink and/or creases in the membrane at the tip of the probe, which can impede the flow of a fluid within the tubular membrane and, consequently, impedes the efficiency and accuracy of the probe. Moreover, this probe is still relatively complex and, due to the complexity of the manufacturing process, costly to manufacture. Without pre-treating the tubular membrane it is difficult to insert the membrane around the support member, thereby necessitating further complexity to the manufacturing process. Furthermore, maintaining the tubular membrane in position against the support has been found to be difficult.

[0011] WO 99/45982 discloses a catheter for insertion into a blood vessel for detecting substances. The catheter disclosed therein comprises an elongate body that includes two channels through which the microdialysis solution can flow. An opening is defined in the catheter body. A microdialysis membrane, which is attached to the outside of the catheter body, covers the opening across which membrane microdialysis may take place. The bonding of the dialysis membrane to the outside of the probe body, means that there is a high risk that the microdialysis membrane will fragment from the catheter body, which results in the disadvantages discussed above with regard to fragmentation.

[0012] US 7,008,398 discloses a micro-dialysis probe in which dialysis can occur along the entire length of the dialysis membrane. The only protection provided by the walls of the probe reduces the overall surface area of the dialysis membrane and thus the efficiency of the dialysis across the membrane.

[0013] US 2005/0251087 discloses a microdialysis probe that is supported by an elongated external frame to hold the tubular membrane in a desired configuration. However, the tubular membrane is not held securely by the frame and there is a great risk that the fragile construction could easily break during use. Furthermore, little protection is provided for the tubular membrane in this arrangement, which could lead to the disconfiguration of or damage to the tubular membrane when inserted into a subject. Moreover, a great deal of material is required to form a frame of sufficient strength and, as such, increases the size of the overall device with respect to the volume of fluid that can be passed through the device, which makes it both more invasive when inserted into the subject and more expensive to produce.

[0014] It is an object of the present invention to provide a molecular exchange device that overcomes or mitigates some or all of the above disadvantages.

[0015] For the avoidance of doubt, the following terms are intended to have the definitions as outlined below: Molecular exchange is the selective exchange of any suitable molecule or composition, including but not limited to dialysis, ultra filtration, drug delivery etc., from the device to the external environment and vice versa.

[0016] The casing is constructed from any suitable material, such that the substantial flow of fluid or molecules is prevented through its walls in the environment within which it is intended to be used. Hence, in biological applications where the molecular exchange device is intended to be inserted in a human or animal body, the casing is made of a material that is resistant to a biological biocompatible environment and prevents substances from penetrating through the casing. The material of the casing must also be rigid enough to ensure the device is not easily damaged during insertion, but flexible enough to allow a degree of bending of the device during use. Preferably, the casing is constructed from high density polyethylene (HDPE), polyamide, carbon fibre, stainless steel or similar material.

[0017] The distal end of the casing is the end of the device that is intended to be inserted into the environment in which molecular exchange is desired.

[0018] The proximal end of the casing is the end of the device that is not intended to be inserted into the environment in which molecular exchange is desired. The distal and proximal ends of the casing are adapted to allow the insertion/withdrawal of perfusion fluid to/from the fluid passageways.

[0019] The distal and proximal ends are also adapted to allow insertion/withdrawal of additional components, such as probes, sensors, connectors to monitoring/analysing systems etc.

[0020] The at least one exchange aperture is a portion of the casing that exposes the adjacent portion of the fluid passageway. The exchange aperture may be an opening in the external wall of the cavity. Alternatively, the exchange aperture may be a porous area that permits the exchange of selected molecules to/from the fluid passageways from/to the environment external to the device.

[0021] The porous portions are porous to the extent that they permit the selective exchange of molecules across the fluid passageway and/or casing. A skilled person would appreciate that different sized molecules will require different porosities to permit the selective exchange of molecules.

[0022] A flow chamber provides the passage of fluid from at least one fluid passageway to another at least one fluid cavity. For example, the flow chamber may provide passage of fluid from one fluid passage way to another fluid passageway through, for example, an open chamber.

[0023] The subject is any suitable environment in which the device may be applied. For example, the subject can be a human or animal body. Alternatively, the subject could be part of a industrial, chemical or fermentation process.

[0024] In a first aspect of the present invention there is provided a molecular exchange device comprising a casing, extending from a proximal end to a distal end, supporting at least two fluid passageways extending from the proximal end to the distal end; the casing comprising at least two exchange apertures between the distal end and the proximal end, wherein a portion of each of the at least two fluid passageways exposed by the exchange aperture is porous, the at least two fluid passageways are in fluid communication with one another; and the distal end of the casing is formed as a tip containing a flow chamber to allow flow from one end of one of the at least two fluid passageways into the end of the other of the at least two fluid passageways.

[0025] The main advantage provided by the molecular exchange device in accordance with the present invention is that the casing supports and protects the at least two fluid passageways. The casing further ensures that the porous portion of the passageway will not fragment in use, whilst ensuring that the passageway maintains its shape and maximises the flow of fluid therein.

[0026] In an advantageous embodiment of the present invention, a separator extends along the casing for at least the length of the exchange aperture, separating the at least two fluid passageways. In a further advantageous embodiment, the separator extends along substantially the entire length of the casing, from the distal end to the proximal end, separating the at least two fluid passageways. Preferably, the separator extends along the central axis of the casing. The separator provides the advantage of ensuring that there is no exchange of fluid between two or more fluid passageways, thereby improving dialysis efficiency. The separator also provides support to the two or more fluid passageways, particularly at the

porous portion of the passageways. The separator may or may not be integral with the casing.

[0027] Advantageously, the two fluid passageways may be arranged on aligning sides of the central separator. Advantageously, two or more fluid passageways may be arranged around the central separator. Preferably pairs of fluid passageways in fluid communication with one another may be arranged around the central separator to permit multiple sets of molecular exchange in one device. The molecular exchange may be for analysis, dialysis, delivery, recovery and extraction of substances etc. During use in a subject, for example, one set of fluid passageways may deliver a drug to the external environment of the device, whereas another set of fluid passageway may be used for recovery, extraction or analysis of a substance from the environment surrounding the device into the passageway to measure the overall drug content. It is envisaged that each set of fluid passageways will be selected for a particular function.

[0028] In an advantageous embodiment, the at least two fluid passageways are at least partially defined by the casing and/or separator. Alternatively, the at least two fluid passageways are not at least partially defined by the casing and/or separator. For example, the two fluid passageways are each at least one tube held within the casing. In one embodiment of the invention, the porous region of the fluid passage way is a porous membrane bonded within the casing at the proximal and distal ends of the exchange aperture. Preferably, the at least one tube is a porous membrane. More preferably, the porous membrane is a dialysis membrane.

[0029] In an embodiment of the invention, substantially the entire area of the tube is porous. In this embodiment, the tube can be made of a single type of material, which obviates the need for forming a separate porous portion in the conduit adjacent to the exchange aperture and makes the molecular exchange device even cheaper to manufacture. This embodiment also provides the advantage that the porous portion does not need to be carefully aligned with the at least one exchange aperture of the casing. As the hollow tube is only exposed to the external environment at the exchange aperture of the casing, molecular exchange will only occur at these desired points of the casing.

[0030] In a preferred example of the disclosure, the at least one tube extends from the proximal end to the distal end of the casing, folds back on itself at the distal end and extends from the distal end to the proximal end of the casing, providing two fluid passageways.

[0031] Advantageously, the at least one tube has a circular or non-circular shaped cross section. This enables the hollow tube to be positioned in the correct orientation within the casing. For example, the cross section may have one or more straight edges or be D-shaped or be profiled to orientate the hollow tube in such a way as to optimise its efficiency for exchange.

[0032] In preferred embodiments, the fluid may be supplied to one of the fluid passageways and drawn from other fluid passageway to ensure flow of fluid within the device.

[0033] Advantageously, the exchange aperture is an opening in the casing, preferably formed by removing, such as by cutting, an area of the casing. In an alternative embodiment, the exchange aperture is a porous area, preferably formed by treating the casing to render a portion of the casing porous.

[0034] In a preferred embodiment, more than one exchange aperture exposes the same fluid passageway.

[0035] In one embodiment, the porous portions of the more than one exchange aperture have different porosities. The porosity of each porous portion will depend upon the intended function of the specific porous portion.

[0036] In a preferred embodiment having two or more of fluid passageways or two or more porous portions on one fluid passageway, the porous portions have different porosities from one another. The use of porous portions and/or fluid passageways having different porosities enables different selections of molecular exchange at different exchange apertures along the casing.

[0037] For example, when the device is being used to deliver a drug into the bloodstream of a subject and monitor the concentration of the drug in the bloodstream, at least one porous portion will require a porosity that enables the drug to pass through the porous area into the bloodstream and at least one porous portion that has a porosity allowing the drug bound to a carrier, such as a plasma protein, for example albumin, to pass through the hollow area into the respective fluid passageway. The latter porous portion, located further downstream to other porous portion with respect to the flow of fluid within the at least two fluid passageways, will need to have a porosity that allows the passage of larger particles, i.e. the drug bound to a carrier as opposed to the drug alone. A skilled person will appreciate that the desired porosity of the porous portion of a fluid passageway will depend upon the size of the molecule that is intended to be exchanged across the porous portion adjacent to the exchange aperture. This arrangement will enable both the free (unbound to carrier) concentration and the total (unbound and bound to carrier) concentration of the drug to be determined.

[0038] In a preferred embodiment, the at least two fluid passageways have aligned exchange apertures. In use, an exchange aperture may rest against the internal walls of the vessel preventing access to the porous portion of the fluid passageway adjacent to the exchange aperture, as it is often the case that the device is not inserted into centre of the vessel. By providing aligned exchange apertures, it is more likely that at least one of the exchange apertures will be in contact with the flow of fluid within the vessel.

[0039] Alternatively, the exchange apertures may be positioned along the respective fluid passageway so that the apertures are not aligned. Such an arrangement is advantageous when the exchange apertures are intended to be used for different purposes.

[0040] In a preferred embodiment, the casing supports the at least two fluid passageways in the form of a tube, which are separated by the central separator along the length of the exchange aperture. The separator provides support to the tubing, whilst enabling a substantially large extent of exposure to the fluid passageway. In such an embodiment exchange of molecules may occur over substantially the entire circumference of the exposed tube, thereby providing a maximum surface area and increasing the efficiency of the exchange of molecules.

[0041] In a preferred embodiment of the invention, the at least two fluid passageways are held away from the separator in the porous section as a consequence of the hollow tubes being sealed where they enter and exit the porous section, thereby enabling substantially 100% of the circumference of the porous portion of the fluid passageway to be exposed. This provides the advantage of maximising the surface area of the porous region in contact with the environment external to the device. Preferably, the at least two fluid passageways are sealed by glue.

[0042] Advantageously, the distal end of the device comprises a plug in the end of the casing. More advantageously in this embodiment, the separator extends to the distal end of the casing and contains a fluid aperture to allow flow from one of the fluid passageway to another fluid passageway.

[0043] Alternatively, the distal end of the casing is formed as a tip containing a flow chamber to allow flow from the end of at least one of the fluid passageways into the end of another fluid passageway. Advantageously, the ends of the fluid passageways are within the flow chamber, such that any bond between the end of the fluid passageway and the distal end of the casing is remote from the exchange aperture to avoid fragmentation of the tube/porous membrane attached to the inside of the casing.

[0044] Preferably, the flow chamber has a sensor arrangement for detecting a substance. For example, the sensor arrangement is a fibre optic and a reflector, wherein the fibre optic and reflector are positioned at the distal end of the device to enable spectrological measurements, for example, spectrophotometric measurement. Alternatively the sensor is a wave guide, conductor, photoelectric, electro-active or electrochemical sensor.

[0045] Advantageously, the molecular exchange device further comprises a channel leading from the proximal end of the casing to the distal end of the casing to provide additional materials to the interior and/or exterior of the distal end of the casing. Preferably, the channel is integral with the separator. More preferably, the channel is formed within the central axis of the separator.

[0046] The channel may supply fluid through to the distal end of the casing, in particular, into the flow chamber. In such an embodiment, the fluid can then pass into one or more of the fluid passageways. Of course, the reverse is possible, with fluids being passed along the fluid passageways into the distal end of the casing and then drawn out through the channel to the proximal end of the casing.

[0047] In an advantageous embodiment, the channel delivers a composition to activate a particular drug being administered by the device.

[0048] The channel may also be used to receive an additional component. For example, a guide wire may be inserted for positioning the molecular exchange device into the desired position within a subject. Advantageously, a probe may be provided within the channel, such as electrical, sonic or optical probes, that may be used for detection and/or analysis. In a preferred embodiment, the channel may be exposed to the environment external to the device, to enable such a probe to have direct contact with the external environment. For example, a fibre optic or light source could be provided at the distal end of the molecular exchange device to allow guidance of the device during insertion into a subject.

[0049] Preferably, the proximal end of the casing is adapted for attachment to a catheter or cannular, to accommodate insertion of the molecular exchange device into the subject. Insertion of the device using a catheter or cannular is a minimally invasive procedure.

[0050] More preferably, the proximal end of the casing is a lockable-mating arrangement or anchoring member for connecting to an invasive port. In a medical application, it is possible that the subject will already have an existing invasive port inserted. Therefore, preferably, the proximal end is a lockable-mating arrangement or anchoring member for connecting to an existing invasive port, which reduces damage caused by insertion of the molecular exchange device into the subject.

[0051] More preferably, the proximal end of the casing is adapted for attachment to a pump. The pump allows fluid to be pumped into the fluid passageways and/or drawn from the fluid passageways, to ensure flow of the fluid through the device. Fluid may flow in both directions through the fluid passageways of the device. The intended use of the individual fluid passageway will determine whether the pump provides fluid flow through the fluid passageway in one direction or both directions. As will be appreciated, when the device has two or more of fluid passageways, the supply to and/or return of fluid from each of the fluid passageways will depend upon its required function.

[0052] Advantageously, the proximal end of the casing is adapted for attachment to an external device. More advantageously, the proximal end of the casing is adapted for attachment to two or more of external devices. The one or more external devices may be attached directly to the ends of the fluid passageways at the proximal ends of the device or indirectly attached to the fluid passageways via connecting tubing.

[0053] In a preferred embodiment, the external devices analyse the composition of the fluid drawn from one or more of the fluid passageways. Advantageously, the external device determines the presence of one or more molecules in the fluid from the fluid passageways and/or measures the amount/concentration of one or more mol-

ecules in the fluid. More advantageously, the external devices control delivery of a drug into the patient through the molecular exchange device.

[0054] In an advantageous embodiment, the device can provide a self-maintaining mechanism for drug delivery, to maintain the concentration of the drug at a predetermined level.

[0055] The present invention further provides a system for controlling the concentration of a first substance in a fluid passageway of the molecular exchange device. The system comprises a molecular exchange device described above in accordance with invention, a control device linked to the molecular exchange device, wherein the control device measures the concentration of a second substance in a fluid passageway and controls the supply of the first substance into a fluid passageway, preferably in response to the measured concentration. This will subsequently maintain the concentration of the composition in the environment external to the molecular exchange device. The first and second substances may be the same or different from one another.

[0056] In accordance with a further aspect of the present disclosure, there is provided a method of manufacturing a molecular exchange device, the method comprising the steps of:

i) forming of a casing
ii) providing at least two fluid passageways within the casing
iii) forming of at least one exchange aperture in the casing

[0057] Advantageously, steps i), ii) and/or iii) occur simultaneously. For example, the casing may be formed by an extrusion process that provides the at least two fluid passageways and/or the at least one exchange aperture during the forming of the casing.

[0058] Advantageously, the method further comprising the step of forming a separator to separate the at least two fluid passageways.

[0059] Preferably, the casing is formed by moulding. More preferably, at least one exchange aperture is formed by the moulding of the casing. Advantageously, the casing is formed through an extrusion process. More advantageously, the exchange aperture is formed by cutting away a portion of the casing. Alternatively, the exchange aperture is formed in the opening during the manufacture of the casing, for example during an extrusion process. In an alternative embodiment, the exchange aperture is a porous area, preferably formed by treating the casing to render a portion of the casing porous. The casing may be treated during and/or post formation of the casing. The treatment may be by laser, such as laser ablation, x-ray, spark erosion, etching, oxidation, use of salt treatment during an extrusion process, or other microfabrication processes to allow transfer of molecules from the inside of the fluid passageway to the environment external to the device and vice versa.

[0060] In a preferred embodiment of the disclosure, the at least two fluid passageways are inserted into the casing after the forming of the exchange apertures. More preferably, the fluid passageways are inserted into the casing after the sealing of the distal end of the casing. Advantageously, the fluid passageways have a shaped cross section to ensure insertion into the casing in the correct orientation. More advantageously, the fluid passageway has a circular or non-circular shaped cross section for orientation into the lumen. In a preferred embodiment the cross section of the fluid passageway has at least one straight edge. More preferably, the cross section of the fluid passageway is D-shaped.

[0061] In a preferred embodiment, the distal end of the casing is formed sealed as part of the moulding process. Alternatively, the method further comprises the step of sealing the distal end of the casing. Advantageously, the distal end of the casing is sealed by any method that causes the molecules of the distal end to flow together, such as heat sealing, cold sealing or crimping.

[0062] In order that the present invention may be more readily understood, non limiting embodiments thereof will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is an overall illustration of a first embodiment of a molecular exchange device in accordance with the present invention and an anchoring unit to hold the device in position during use;

Figure 2 is an enlarged view of a distal portion of the first embodiment of a molecular exchange device in accordance with the present invention;

Figure 3 is a cut away plan view of the first embodiment of a molecular exchange device in accordance with the present invention;

Figure 4 is a cross-sectional view of the first embodiment of a molecular exchange device sectioned through AA;

Figure 5 is a cross-sectional view of the first embodiment of a molecular exchange device sectional through BB;

Figure 6 is a cross-sectional view of the first embodiment of a molecular exchange device sectioned through CC;

Figure 7 is a cross-sectional view of a second embodiment of an molecular exchange device in accordance with the present invention;

Figure 8 is a cut-away view of an alternative embodiment of a molecular exchange device in accordance with the present invention;

Figure 9 is alternative embodiment of a molecular exchange device in accordance with the present disclosure;

Figure 10 is an alternative embodiment of a molecular exchange device in accordance with the present disclosure;

Figure 11 is an alternative embodiment of a molecular exchange device in accordance with the present disclosure;

Figure 12 is an alternative embodiment of a molecular exchange device in accordance with the present disclosure;

Figure 13 is a cross-sectional view of an alternative embodiment of a molecular exchange device in accordance with the present invention;

Figure 14 is a cross-sectional view of an alternative embodiment of a molecular exchange device in accordance with the present invention;

Figure 15 is an embodiment of an apparatus in accordance with the present invention.

[0063] As illustrated in figure 1, there is a first embodiment of a molecular exchange device (1) according to the present invention comprises a casing (2) made of HDPE, extending from a proximal end (3) to a distal end (4); and an anchoring unit (15) to hold the device (1) in position during use.

[0064] As shown in more detail, figure 2, the casing (2) supports two fluid passageways (7a, 7b) extending from the proximal end (3) to the distal end (4); a separator (6) extending along the length of the casing (2) separating the two fluid passageways; two aligned exchange apertures, between the proximal end (3) and the distal end (4) of the casing, exposing the fluid passageways (7a, 7b). The portion of the fluid passageways (7a, 7b) exposed by the opposed exchange apertures are porous.

[0065] In this embodiment, the casing (2) defines two internal lumens (5a, 5b) that extend within the casing from the proximal end (3) to the distal end (4). A separator (6), integral with the casing (2), extends along the central axis of the casing (2) defining the two lumens (5a, 5b) within the casing (2). It is also envisaged that the separator (6) is not integral with the casing (2), but firmly attached thereto.

[0066] In this embodiment, the lumens (5a, 5b) each hold a fluid passageway (7a, 7b) in the form of a tube. The tubes (7a, 7b) are suitable for fluid to travel within the passageway. The fluid may be supplied or drawn at the proximal end (3) of the tube (7a, 7b). The tubes are formed from a porous membrane that allows the selective exchange of molecules in one or both directions across the membrane. The level of porosity of the porous membrane will depend upon the intended use of the molecular exchange device (1). The tubes (7a, 7b) have a porosity that enables a specific molecule or composition to cross the membrane from the environment external to the tube (7a, 7b) into the tube (7a, 7b) and vice versa, for a particular use of the molecular exchange device (1).

[0067] As shown in figures 2 and 3, the casing (2) has aligning exchange apertures (9a, 9b) that each expose a tube (7a, 7b). It is also envisaged that the apertures (9a, 9b) are not aligned along the length of the casing (2). In this embodiment the entire circumference of the tube (7a, 7b) adjacent to the exchange aperture (9a, 9b) is exposed to the external environment, as shown in figure 5. The tube (7a, 7b) is sealed to the casing (2) by, for example, glue and this arrangement holds the tube away from the surface of the separator (6), such that 100% or substantially 100% of the circumference of the tube (7a, 7b), including that adjacent to the exchange aperture, is exposed to the external environment.

[0068] In this embodiment and as shown in figure 3, the distal end (4) of the casing (2) containing a flow chamber (10) that permits the passage of a fluid from one of the tubes (7a) to the other tube (7b). It is envisaged that fluid may flow in either direction in each tube (7a, 7b) and, as such, the flow chamber (10) permits the passage of fluid in both directions, i.e. from one tube (7a) to the other tube (7b) and vice versa. As illustrated in figure 2, the external configuration of the flow chamber (10) is tapered, to allow easy insertion of the molecular exchange device (1) into a subject.

[0069] As shown in more detail in figure 3, the tubes (7a, 7b) extend into and terminate within the flow chamber (10). The tubes (7a, 7b) are sealed into the casing by, for example, heat treatment or glue, such as UV curing glue, cyanoacrylate, two-part epoxy resin and any other appropriate method, including mechanical means. In this embodiment, the molecular exchange device (1), as shown in figure 7, is further provided with a channel (11), extending from the proximal end (3) to the distal end (4) of the casing (2), that runs internally through separator (6).

[0070] In this embodiment, as shown in figure 7, the tubes (7a, 7b) are profiled to accommodate the channel (11). The profile of the tubes (7a, 7b) allow the correct orientation of the tubes (7a, 7b) in the lumens (5a, 5b).

[0071] The channel (11) provides a means to transport materials, such as a drug, into and out of the flow chamber, once the molecular exchange device (1) has been placed in the desired position within a subject.

[0072] In this embodiment, a sensor may be positioned on one or both of the ends of the tubes (7a, 7b), the sensor measuring, for example, a drug within the flow chamber (10). The rate of delivery of the drug into the device (1) can be altered in accordance with the concentration of the drug across the membrane. The rate of delivery of the drug can be controlled by changing the quantity of a drug introduced into the device. The higher the quantity of a drug passed into the device (1), the greater

the delivery of the drug to the environment external to the device (1) when a concentration gradient that has been set up across the dialysis membrane.

[0073] As illustrated in figure 3, in use, fluid may be passed into one of the tubes (7a, 7b) of the molecular exchange device (1). The fluid may be passed along the tube (7a), into the flow chamber, into the second tube (7b), along the second tube (7b) to the opening of the passageway at the proximal end (3) of the device (1). Due to the nature of the material of the casing (1), the fluid and any compositions in it will be maintained within the tube (7), except at the exchange apertures. At each of the exchange apertures in the respective lumens (5a, 5b) of the casing (2), the fluid carried in the respective tube (7a, 7b) will be exposed to the environment surrounding the molecular exchange device (1). Depending on various factors, such as the relative internal and external concentration of molecules/compositions, the specific porosity of the porous area of the tube (7a, 7b) and the intended use of the molecular exchange device (1), molecules/compositions present in the tube (7a, 7b) may be supplied across the porous membrane into the environment external to the device (1) or molecules/compositions present in the external environment may be drawn across the porous membrane are into the tube (7a, 7b).

[0074] The first tube (7a) may have the same properties (for example porosity) as the other tube (7b) and used for the same function. Alternatively, the first tube (7a) could be used to supply and/or absorb different molecules/compositions and, as such, have different properties.

[0075] As illustrated in figure 8, the distal end (4) of the casing (2) may alternatively comprise a plug (12). To permit flow between the tubes (7a, 7b), the separator (6) has a flow aperture (13) to allow flow from one tube (7a) to the other tube (7b) and vice versa.

[0076] As illustrated in figure 9, a further example of the present disclosure comprises a casing (2) having an integral separator (6), extending from the proximal end (3) to the distal end (4) of the casing (2). A fluid passageway in the form of a tube extends within one of the lumens (5a) from the proximal end (3) to the distal end (4) of the casing, extending beyond the distal end of the casing, bends back on itself, and extends back into the second lumen (5b) from the distal end (4) to the proximal end (3) of the casing (2), providing a single uninterrupted tube (7a, 7b), anchored, at least, at the proximal end (3) of the casing (2). Therefore, fragmentation of the tubes (7a, 7b), in use, is prevented. The tube may also be bonded along the length of the casing (2) but only to retain its orientation rather than provide additional bonding.

[0077] A further example of the disclosure (not shown), is the same as that described with reference to figure 9 above, except that the tube at the distal end (4) of the casing is fully contained within the casing (2); the casing being in a similar confirmation as shown in figures 2 and 3.

[0078] In use, the fluid may be passed along the first passageway (7a), through the distal end and along the second passageway (7b) to the opening of the passageway at the proximal end of the device (1). Again the fluid is exposed to the external environment at each exchange apertures along the casing, permitting selective exchange of molecules/compositions across the porous portion of the tubes (7a, 7b).

[0079] As shown in figure 10, as an example of the disclosure, the two tubes (7a, 7b) are arranged in two distinct lumens (5a, 5b). Each of the tubes (7a, 7b) has a concentric arrangement within the tube, such that fluid may flow along a internal tube and back along the external tube and vice versa. There is no fluid connection between the two fluid passagewayss (7a, 7b). Such an arrangement is suitable, for example, for use when one of the tubes (7a) provides a dialysis membrane and the other tube (7b) monitors the concentration levels of molecules/compositions in the external environment. With regard to the latter, molecule/compositions cross the porous portion of the tube (7b) from the external environment into the tube (7b) of the device (1), and travel along the tube (7b) to the proximal end (3) of the casing (2) and carried to an external device (14) for analysis, as shown in figure 15.

[0080] Alternatively, as shown in figure 11 as an example of the disclosure, one tube provides two fluid passageways (7a, 7b).

[0081] A further example of the disclosure, as shown in figure 12, comprises a device (1) in which the external walls of the casing (2) are arranged at the exchange aperture (9) to form a concave aperture (9a).

[0082] As shown in figures 13 and 14, it is envisaged that a molecular exchange device (1) according to the present invention can be provided with a casing (2) having two or more of fluid passageways (7a, 7b, 7c, 7d), separated by a separator (6). This permits multiple molecular exchange to be carrying out using one device. For example, the molecular exchange may be for analysis, dialysis, delivery etc. As shown in figure 13, the device (1) has four fluid passageways (7a, 7b, 7c, 7d). Alternatively, as shown in figure 14, the device (1) has twelve fluid passageways (7a, 7b, 7c, 7d etc.).

[0083] Figure 15 illustrates schematically an apparatus embodying the present invention. A molecular exchange device (1) is connected with an anchoring unit (15), such as a luer lock, and is in fluid communication, by means of tubing (16), with an external device (14). The external device (14) may analyse fluid received from the device (1), for instance to detect certain molecules/compositions or concentrations of molecule/compositions, or may supply molecule/compositions in a fluid for supply to the device (1), for instance maintaining concentrations of those compositions in the fluid passageways.

[0084] A molecular exchange device (1) according to the present invention is preferably manufactured by injection moulding the casing (2) having a central separator (6) and plurality of exchange apertures (9) and then heat-sealing or crimping the distal end (4), either before or after insertion of the hollow tubes (7). However, other

methods of manufacture known to those of skill in the art are also possible. For instance, the casing (2) could be formed as an extrusion process, with the walls of the casing (2) being removed to form the exchange apertures (9). Alternatively, the exchange apertures could be formed by treating the material of the casing (2) appropriately, as would be appreciated by those of skill in the art, to render the wall of the casing porous.

[0085] The molecular exchange device of the present invention and one or more external devices can be used to analyse, measure or deliver industrial, chemical, fermentation and animal or plant compositions. The molecular exchange device may be used in industrial, chemical or fermentation processes and the human or animal body.

[0086] The molecular exchange advice according to the present invention is intended to be used in the human or animal bodies including but not restricted to the circulatory system, insertion into blood vessels, lymphatic system, muscles, ear, mouth, tissue fat and internal organs.

[0087] When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

[0088] The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Claims

1. A molecular exchange device (1) comprising;

a casing (2), extending from a proximal end to a distal end, supporting at least two fluid passageways (7a, 7b) extending from the proximal end (3) to the distal end (4); the casing comprising at least two exchange apertures (9a, 9b) between the distal end and the proximal end,
wherein a portion of each of the at least two fluid passageways (7a, 7b) exposed by the exchange aperture (9a, 9b) is porous, the at least two fluid passageways (7a, 7b) are in fluid communication with one another; and the distal end of the casing is formed as a tip containing a flow chamber (10) to allow flow from one end of one of the at least two fluid passageways into the end of the other of the at least two fluid passageways.

2. A molecular exchange device according claim 1, wherein a separator (6) extends along the casing for at least a length of the exchange aperture, separating the at least two fluid passageways.

3. A molecular exchange device according to any one of claims 1 to 2, wherein the separator extends along substantially the entire length of the casing, from the distal end to the proximal end, separating the at least two fluid passageways.

4. A molecular exchange device according to any one of claims 2 to 3, wherein the separator extends along a central axis of the casing; preferably two fluid passageways are arranged on aligning sides of the central separator, or two or more of fluid passageways are arranged around the central separator.

5. A molecular exchange device according to any one of the preceding claims, wherein the at least two fluid passageways are defined by the casing and/or separator, or the at least two fluid passageways are not defined by the casing and/or separator; preferably each of the at least two fluid passageways is at least one tube held within the casing; more preferably the at least one tube is a porous membrane.

6. A molecular exchange device according to any one of claims 1 to 5, wherein the porous region of the fluid passageway is a porous membrane bonded with the casing at the proximal and distal ends of the exchange aperture; preferably wherein the porous membrane is a dialysis membrane.

7. The molecular exchange device according to claim 5, wherein the at least one conduit has a circular or non-circular shaped cross section, preferably, the cross section has one straight edge and, more preferably, the cross section is D-shaped.

8. A molecular exchange device according to any one of the preceding claims, wherein the exchange aperture is an opening, preferably formed by cutting away a portion of the casing; or the exchange aperture is an opening, preferably formed by treating the casing to render a portion of the casing porous.

9. A molecular exchange device according to any one of the preceding claims, wherein the at least two fluid passageways (7a, 7b) have aligned or non-aligned exchange apertures (9a, 9b), and/or wherein more than one exchange aperture exposes the same fluid passageway; and/or wherein the porous portions of the more than one exchange aperture have different porosities; and/or wherein the distal end of the device comprises a plug (12) in the end of the casing; and/or wherein the separator extends to the distal end of the casing and contains a fluid aperture to allow flow from one fluid passageway to another fluid passageway; and/or to any one of the preceding claims, and preferably the ends of the at least two fluid passage-

ways extend into the flow chamber.

10. The molecular exchange device according to claim 9, wherein the flow chamber has a sensor arrangement to, preferably, enable spectrologic measurement; more preferably the spectrologic measurement is spectrophotometric measurement; or the sensor arrangement is a reflector, wave guide, conductor, photoelectric, electro-active or electrochemical sensor.

11. The molecular exchange device according to any one of the preceding claims, further comprising a channel (11) leading from the proximal end of the casing to the distal end of the casing to provide additional materials to the interior and/or exterior of the distal end of the casing; preferably the channel is integral with the separator; more preferably the channel is formed within the central axis of the separator.

12. The molecular exchange device according to claim 11, wherein the channel provides access to/for an optical, sonic and/or electrical probe.

13. The molecular exchange device according to any one of the preceding claims, wherein the proximal end of the casing is adapted for attachment to a catheter and/or cannular; and/or the proximal end of the casing is a lockable-mating arrangement and or anchoring member for connecting to an invasive port; and/or the proximal end of the casing is adapted for attachment to a pump; and/or the proximal end of the casing is adapted for attachment to an external device (14).

14. A system for controlling the concentration of a first substance in a fluid passageway of the molecular exchange device, the system comprising a molecular exchange device according to claims 1 to 13, a control device linked to the molecular exchange device, wherein the control device measures the concentration of a second substance in a fluid passageway and controls the supply of the first substance into a fluid passageway, preferably in response to the measured concentration; and more preferably the first and second substances may be the same or different from one another.

Patentansprüche

1. Molekulare Austauschvorrichtung (1), umfassend;

ein Gehäuse (2), das sich von einem proximalen Ende zu einem distalen Ende erstreckt, das mindestens zwei Fluiddurchgänge (7a, 7b) trägt, die sich von dem proximalen Ende (3) zu dem distalen Ende (4) erstrecken; wobei das Gehäuse mindestens zwei Austauschaperturen (9a, 9b) zwischen dem distalen Ende und dem proximalen Ende umfasst,
worin ein Abschnitt jedes der mindestens zwei Fluiddurchgänge (7a, 7b), der von der Austauschapertur (9a, 9b) bloßgelegt ist, porös ist, worin die mindestens zwei Fluiddurchgänge (7a, 7b) in Fluidkommunikation miteinander sind; und das distale Ende des Gehäuses als eine Spitze ausgebildet ist, die eine Durchflusskammer (10) enthält, um Durchfluss von einem Ende eines der mindestens zwei Fluiddurchgänge in das Ende des anderen der mindestens zwei Fluiddurchgänge zu gestatten.

2. Molekulare Austauschvorrichtung nach Anspruch 1, worin sich ein Abscheider (6) entlang des Gehäuses für mindestens eine Länge der Austauschapertur erstreckt, wodurch die mindestens zwei Fluiddurchgänge getrennt werden.

3. Molekulare Austauschvorrichtung nach einem der Ansprüche 1 bis 2, worin sich der Abscheider entlang im Wesentlichen der gesamten Länge des Gehäuses, von dem distalen Ende zu dem proximalen Ende, erstreckt, wodurch die mindestens zwei Fluiddurchgänge getrennt werden.

4. Molekulare Austauschvorrichtung nach einem der Ansprüche 2 bis 3, worin sich der Abscheider entlang einer zentralen Achse des Gehäuses erstreckt; vorzugsweise zwei Fluiddurchgänge auf fluchtenden Seiten des zentralen Abscheiders angeordnet sind oder zwei oder mehr Fluiddurchgänge um den zentralen Abscheider angeordnet sind.

5. Molekulare Austauschvorrichtung nach einem der vorhergehenden Ansprüche, worin die mindestens zwei Fluiddurchgänge von dem Gehäuse und/oder Abscheider definiert sind oder die mindestens zwei Fluiddurchgänge nicht von dem Gehäuse und/oder Abscheider definiert sind; vorzugsweise jeder der mindestens zwei Fluiddurchgänge mindestens ein innerhalb des Gehäuses gehaltener Schlauch ist; bevorzugter der mindestens eine Schlauch eine poröse Membran ist.

6. Molekulare Austauschvorrichtung nach einem der Ansprüche 1 bis 5, worin die poröse Region des Fluiddurchgangs eine poröse Membran ist, die mit dem Gehäuse an dem proximalen und distalen Ende der Austauschapertur verbunden ist; vorzugsweise, worin die poröse Membran eine Dialysemembran ist.

7. Molekulare Austauschvorrichtung nach Anspruch 5, worin die mindestens eine Leitung einen kreisförmigen oder nicht kreisförmigen Querschnitt aufweist, vorzugsweise, der Querschnitt eine gerade Kante

aufweist und, bevorzugter, der Querschnitt D-förmig ist.

8. Molekulare Austauschvorrichtung nach einem der vorhergehenden Ansprüche, worin die Austauschapertur eine Öffnung ist, die vorzugsweise durch Wegschneiden eines Abschnitts des Gehäuses gebildet ist; oder die Austauschapertur eine Öffnung ist, die vorzugsweise durch Behandeln des Gehäuses, um einen Abschnitt des Gehäuses porös zu machen, gebildet ist.

9. Molekulare Austauschvorrichtung nach einem der vorhergehenden Ansprüche, worin die mindestens zwei Fluiddurchgänge (7a, 7b) ausgerichtete oder nicht ausgerichtete Austauschaperturen (9a, 9b) aufweisen, und/oder worin mehr als eine Austauschapertur den gleichen Fluiddurchgang bloßlegt; und/oder worin die porösen Abschnitte der mehr als einen Austauschapertur verschiedene Porositäten aufweisen; und/oder worin das distale Ende der Vorrichtung einen Stopfen (12) in dem Ende des Gehäuses umfasst; und/oder worin sich der Abscheider zu dem distalen Ende des Gehäuses erstreckt und eine Fluidapertur enthält, um Durchfluss von einem Fluiddurchgang zu einem anderen Fluiddurchgang zu gestatten; und/oder nach einem der vorhergehenden Ansprüche, und vorzugsweise sich die Enden der mindestens zwei Fluiddurchgänge in die Durchflusskammer erstrecken.

10. Molekulare Austauschvorrichtung nach Anspruch 9, worin die Durchflusskammer eine Sensoranordnung aufweist, um, vorzugsweise, eine spektrologische Messung zu ermöglichen; bevorzugter die spektrologische Messung eine spektrophotometrische Messung ist; oder die Sensoranordnung ein Reflektor, Wellenleiter, Leiter, photoelektrischer, elektroaktiver oder elektrochemischer Sensor ist.

11. Molekulare Austauschvorrichtung nach einem der vorhergehenden Ansprüche, ferner umfassend einen Kanal (11), der von dem proximalen Ende des Gehäuses zu dem distalen Ende des Gehäuses führt, um dem Inneren und/oder Äußeren des distalen Endes des Gehäuses zusätzliche Materialien bereitzustellen; vorzugsweise der Kanal integral mit dem Abscheider ist; bevorzugter der Kanal innerhalb der zentralen Achse des Abscheiders gebildet ist.

12. Molekulare Austauschvorrichtung nach Anspruch 11, worin der Kanal Zugang zu/für eine optische, Schall- und/oder elektrische Sonde bietet.

13. Molekulare Austauschvorrichtung nach einem der vorhergehenden Ansprüche, worin das proximale Ende des Gehäuses für die Befestigung an einem Katheter und/oder einer Kanüle ausgelegt ist; und/oder das proximale Ende des Gehäuses eine arretierbare Verbindungsanordnung und/oder ein Verankerungselement für den Anschluss an einen invasiven Port ist; und/oder das proximale Ende des Gehäuses für die Befestigung an einer Pumpe ausgelegt ist; und/oder das proximale Ende des Gehäuses für die Befestigung an einer externen Vorrichtung (14) ausgelegt ist.

14. System zur Kontrolle der Konzentration einer ersten Substanz in einem Fluiddurchgang der molekularen Austauschvorrichtung, wobei das System umfasst: eine molekulare Austauschvorrichtung nach Anspruch 1 bis 13, eine mit der molekularen Austauschvorrichtung verbundene Steuervorrichtung, worin die Steuervorrichtung die Konzentration einer zweiten Substanz in einem Fluiddurchgang misst und die Zufuhr der ersten Substanz in einen Fluiddurchgang steuert, vorzugsweise als Reaktion auf die gemessene Konzentration; und bevorzugter die erste und die zweite Substanz gleich oder voneinander verschieden sein können.

Revendications

1. Dispositif d'échange moléculaire (1) comprenant :

un boîtier (2), s'étendant d'une extrémité proximale à une extrémité distale, supportant deux ou plus de deux passages de fluide (7a, 7b) s'étendant de l'extrémité proximale (3) à l'extrémité distale (4) ; le boîtier comprenant deux ou plus de deux orifices d'échange (9a, 9b) entre l'extrémité distale et l'extrémité proximale,
dans lequel une partie de chacun des deux ou plus de deux passages de fluide (7a, 7b) exposée par l'orifice d'échange (9a, 9b) est poreuse, les deux ou plus de deux passages de fluide (7a, 7b) sont en communication fluidique l'un avec l'autre ; et l'extrémité distale du boîtier a la forme d'une pointe contenant une chambre d'écoulement (10) pour permettre l'écoulement d'une extrémité d'un des deux ou plus de deux passages de fluide dans l'extrémité de l'autre des deux ou plus de deux passages de fluide.

2. Dispositif d'échange moléculaire selon la revendication 1, dans lequel un séparateur (6) s'étend le long du boîtier sur au moins une longueur de l'orifice d'échange, séparant les deux ou plus de deux passages de fluide.

3. Dispositif d'échange moléculaire selon l'une quelconque des revendications 1 à 2, dans lequel le séparateur s'étend sensiblement le long de la longueur totale du boîtier, de l'extrémité distale à l'extrémité proximale, séparant les deux ou plus de deux pas-

sages de fluide.

4. Dispositif d'échange moléculaire selon l'une quelconque des revendications 2 à 3, dans lequel le séparateur s'étend le long d'un axe central du boîtier ; de préférence deux passages de fluide sont agencés sur des côtés alignés du séparateur central, ou deux ou plus de deux passages de fluide sont agencés autour du séparateur central.

5. Dispositif d'échange moléculaire selon l'une quelconque des revendications précédentes, dans lequel les deux ou plus de deux passages de fluide sont définis par le boîtier et/ou le séparateur, ou les deux ou plus de deux passages de fluide ne sont pas définis par le boîtier et/ou le séparateur ; de préférence chacun des deux ou plus de deux passages de fluide est un ou plusieurs tubes tenus dans le boîtier ; plus préférablement le ou les tubes sont une membrane poreuse.

6. Dispositif d'échange moléculaire selon l'une quelconque des revendications 1 à 5, dans lequel la région poreuse du passage de fluide est une membrane poreuse liée avec le boîtier aux extrémités distale et proximale de l'orifice d'échange ; de préférence dans lequel la membrane poreuse est une membrane de dialyse.

7. Dispositif d'échange moléculaire selon la revendication 5, dans lequel le ou les conduits ont une section transversale de forme circulaire ou non circulaire, de préférence, la section transversale a un côté droit et, plus préférablement, la section transversale est en forme de D.

8. Dispositif d'échange moléculaire selon l'une quelconque des revendications précédentes, dans lequel l'orifice d'échange est une ouverture, de préférence formée en découpant une partie du boîtier ; ou l'orifice d'échange est une ouverture, de préférence formée en traitant le boîtier pour qu'une partie du boîtier soit poreuse.

9. Dispositif d'échange moléculaire selon l'une quelconque des revendications précédentes, dans lequel les deux ou plus de deux passages de fluide (7a, 7b) ont des orifices d'échange alignés ou non alignés (9a, 9b), et/ou dans lequel plusieurs orifices d'échange exposent le même passage de fluide ; et/ou dans lequel les parties poreuses des orifices d'échange ont des porosités différentes ; et/ou dans lequel l'extrémité distale du dispositif comprend un bouchon (12) dans l'extrémité du boîtier ; et/ou dans lequel le séparateur s'étend jusqu'à l'extrémité distale du boîtier et contient un orifice de fluide pour permettre l'écoulement d'un passage de fluide à un autre passage de fluide ; et/ou selon l'une quelconque des revendications précédentes, et de préférence les extrémités des deux ou plus de deux passages de fluide s'étendent dans la chambre d'écoulement.

10. Dispositif d'échange moléculaire selon la revendication 9, dans lequel la chambre d'écoulement a un agencement de capteurs afin, de préférence, de permettre une mesure spectrologique ; plus préférablement la mesure spectrologique est une mesure spectrophotométrique ; ou l'ensemble capteur est un réflecteur, un guide d'ondes, un conducteur, un capteur photoélectrique, électro-actif ou électrochimique.

11. Dispositif d'échange moléculaire selon l'une quelconque des revendications précédentes, comprenant en outre un canal (11) allant de l'extrémité proximale du boîtier à l'extrémité distale du boîtier pour fournir des matériaux additionnels à l'intérieur et/ou à l'intérieur de l'extrémité distale du boîtier ; de préférence le canal fait partie intégrante du séparateur ; plus préférablement le canal est formé dans l'axe central du séparateur.

12. Dispositif d'échange moléculaire selon la revendication 11, dans lequel le canal fournit un accès à/pour une sonde optique, sonique et/ou électrique.

13. Dispositif d'échange moléculaire selon l'une quelconque des revendications précédentes, dans lequel l'extrémité proximale du boîtier est adaptée pour se fixer à un cathéter et/ou une canule ; et/ou l'extrémité proximale du boîtier est un agencement d'accouplement verrouillable et/ou un élément d'ancrage destiné à se connecter à un orifice invasif ; et/ou l'extrémité proximale du boîtier est adaptée pour se fixer à une pompe ; et/ou l'extrémité proximale du boîtier est adaptée pour se fixer à un dispositif externe (14).

14. Système destiné à réguler la concentration d'une première substance dans un passage de fluide du dispositif d'échange moléculaire, le système comprenant le dispositif d'échange moléculaire selon l'une quelconque des revendications 1 à 13, un dispositif de régulation relié au dispositif d'échange moléculaire, dans lequel le dispositif de régulation mesure la concentration d'une deuxième substance dans un passage de fluide et régule l'alimentation de la première substance dans un passage de fluide, de préférence en réponse à la concentration mesurée ; et plus préférablement les première et deuxième substances peuvent être les mêmes ou différentes l'une de l'autre.

Fig. 1.

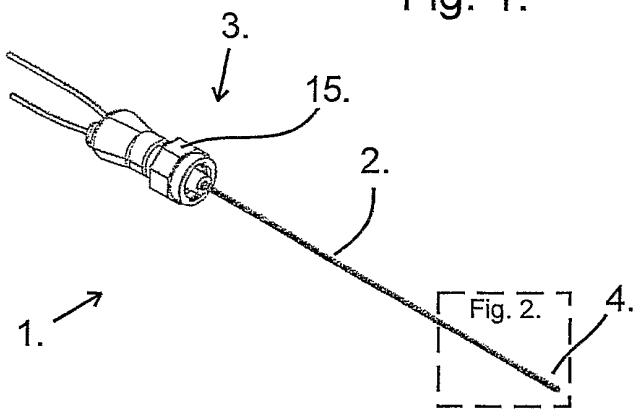


Fig. 2.

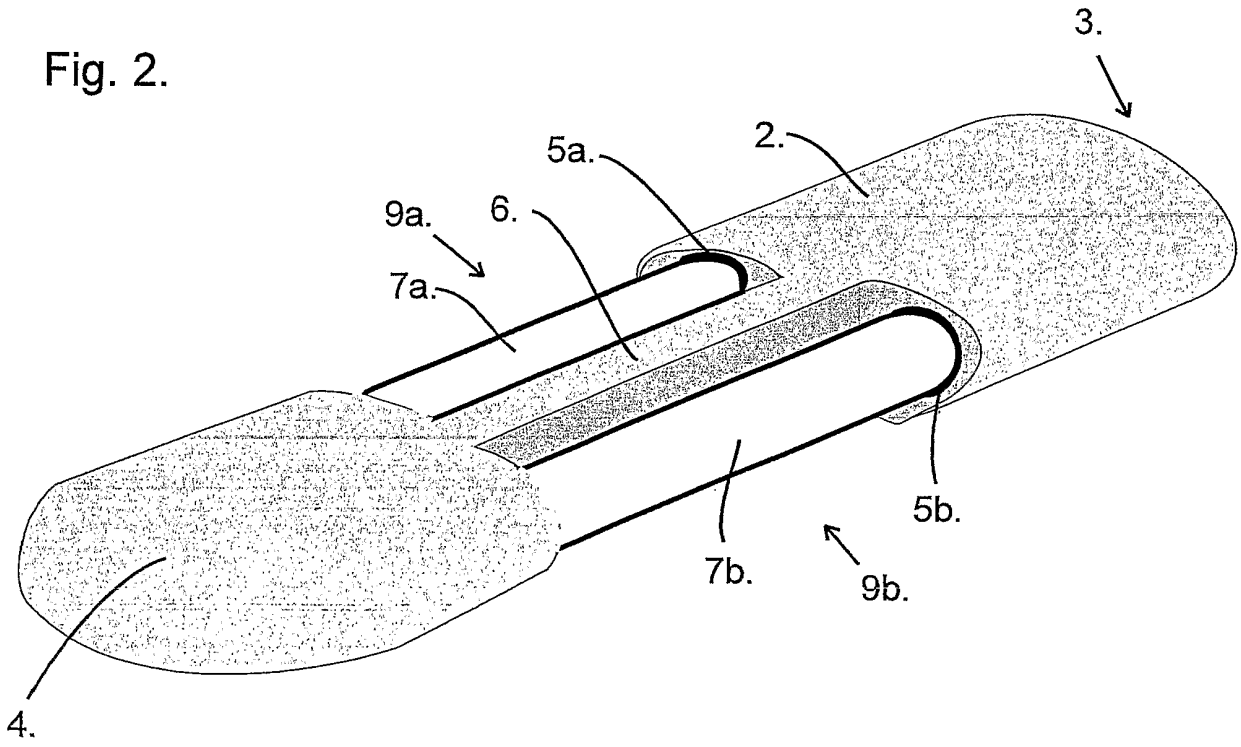
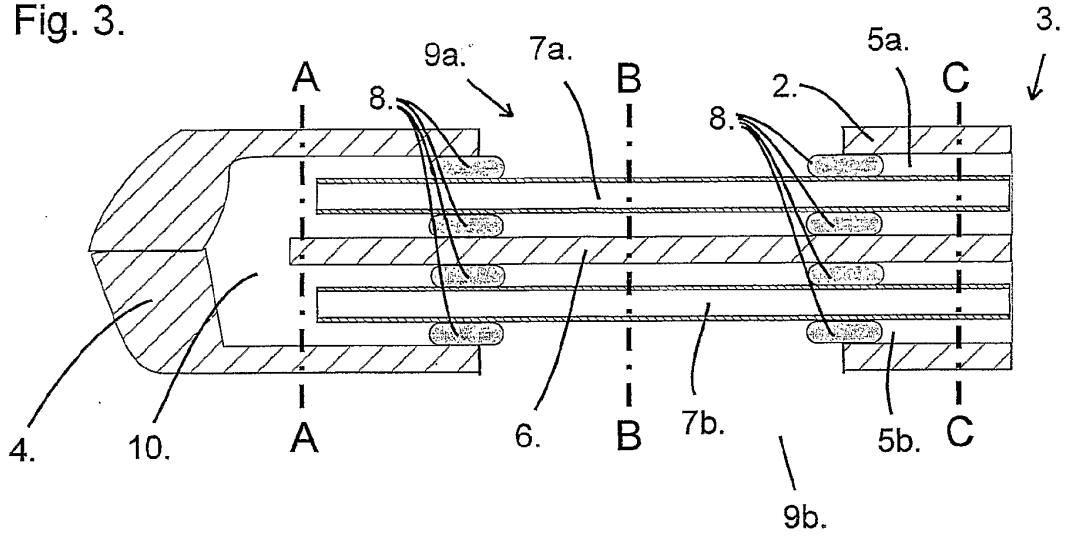


Fig. 3.



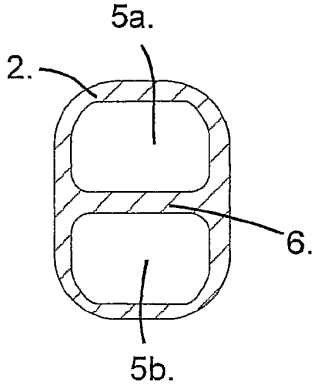


Fig. 4.

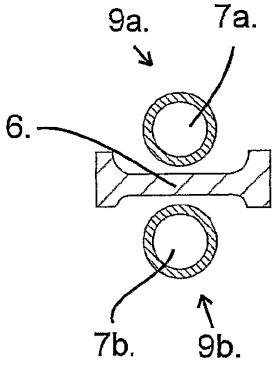


Fig. 5.

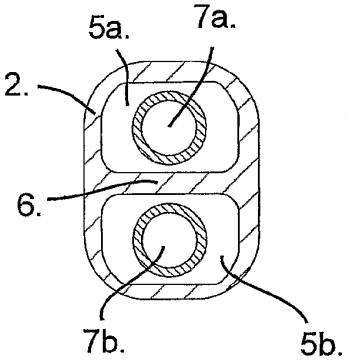


Fig. 6.

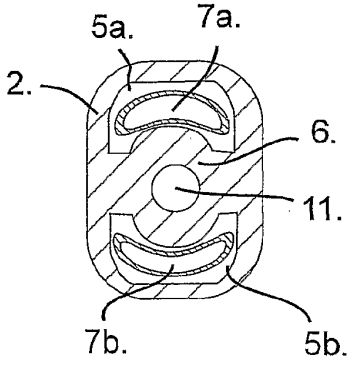
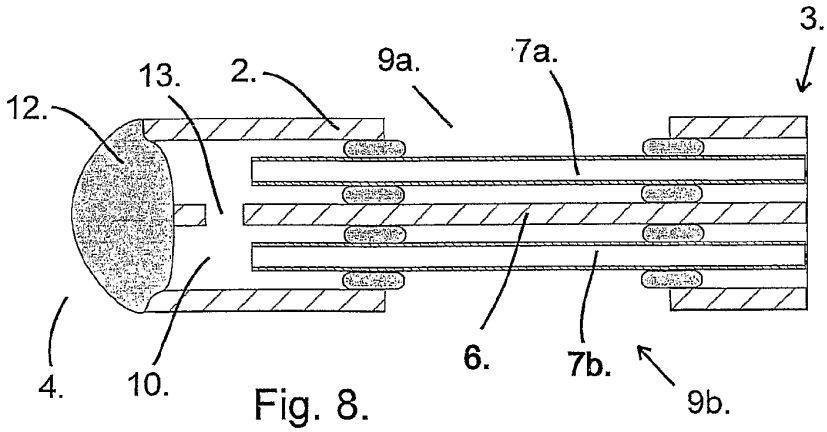


Fig. 7.



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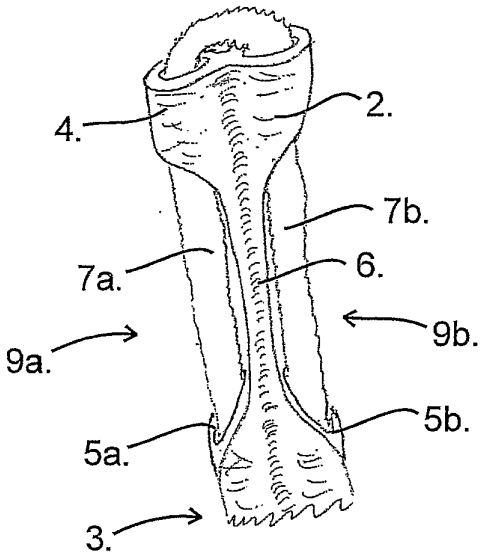

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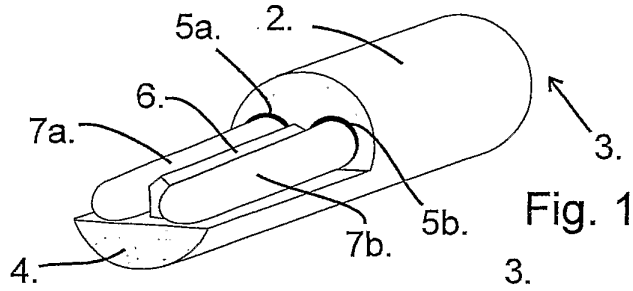

Fig. 10.

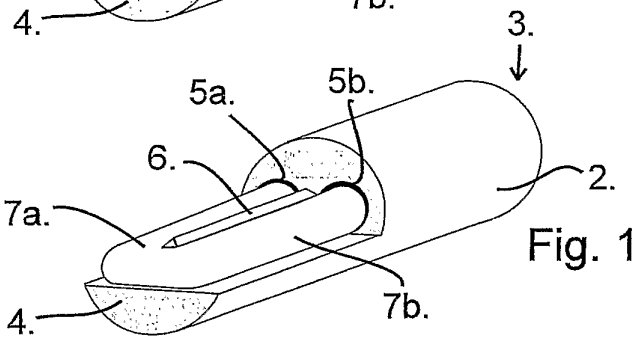

Fig. 11.

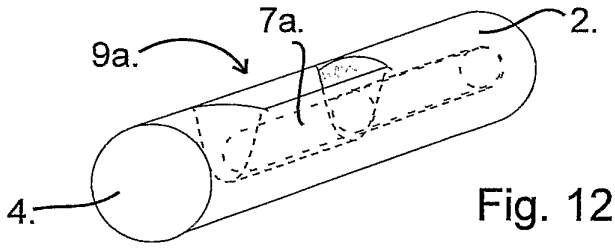

Fig. 12.

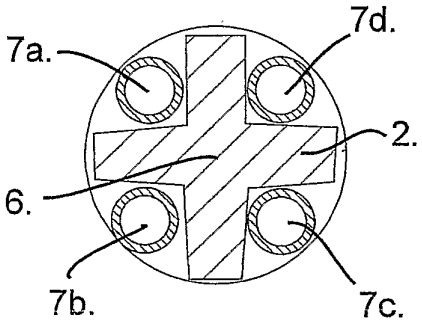

Fig. 13.

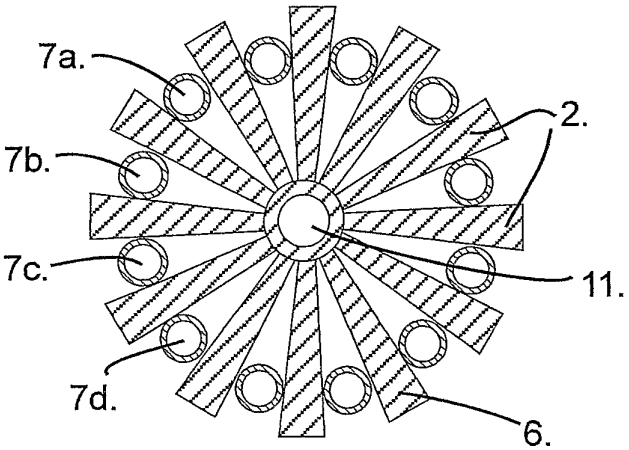

Fig. 14.

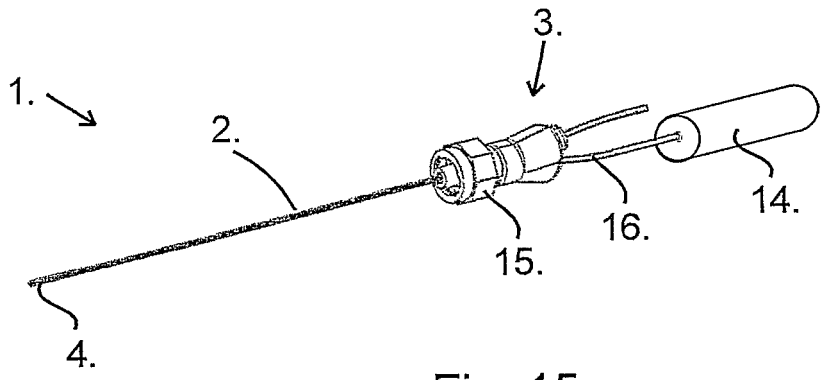

Fig. 15.

REFERENCES CITED IN THE DESCRIPTION

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- EP 0675695 A **[0008]**
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专利名称(译)	分子交换装置		
公开(公告)号	EP2079369B1	公开(公告)日	2019-09-25
申请号	EP2007823956	申请日	2007-09-28
[标]申请(专利权)人(译)	探测器科学有限公司		
申请(专利权)人(译)	PROBE科技有限公司		
当前申请(专利权)人(译)	PROBE科技有限公司		
[标]发明人	OCONNELL MARK THOMAS BLOCK STEWART JEFFREY		
发明人	O'CONNELL, MARK THOMAS BLOCK, STEWART JEFFREY		
IPC分类号	A61B10/00 A61B5/00		
CPC分类号	A61B5/14503 A61B5/14507 A61B5/14528 A61B5/14552 A61M1/16 A61M1/1652 A61B5/0075 A61B5/0084 A61B5/1473 A61B5/418 A61B10/0045 B01D61/243 G01N1/40 Y10T29/49826 A61B5/145 G01N1/4005		
优先权	2006019157 2006-09-28 GB		
其他公开文献	EP2079369A2		
外部链接	Espacenet		

摘要(译)

本申请涉及一种与分析和控制设备一起使用的分子交换装置（1）以及一种制造分子交换装置的方法。该分子交换装置包括壳体（2），该壳体（2）从近端（3）延伸到远端（4），并支撑至少两个从近端延伸到远端的流体通道（7a，7b）；所述壳体包括在所述远端和所述近端之间的至少一个交换孔（9a，9b），其中由所述交换孔暴露的所述流体通道的一部分是多孔的

Fig. 1.

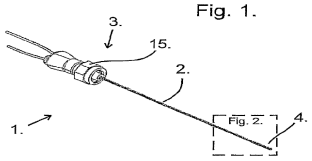

Fig. 2.