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(54) PUMP ELEMENT FOR A TUBE PUMP

(57) The invention relates to a tube pump comprising a tube and a pump element inserted in the tube, where the pump element comprises a rod element and a first and a second non-return valve member positioned a distance apart on the rod element. The valve members are oriented in the same direction relative to the rod element so as to allow for a fluid flow in the tube through the first valve member, along the rod element, and through the second valve member. The tube comprises an at least partly flexible tube portion between the valve members such that a repeated deformation of the flexible tube portion acts to alternately close and open the valve members thereby generating a fluid flow through the tube.

The invention further relates to a pump element comprising at least two non-return valve members connected by a rod element, and for insertion in an at least partly flexible tube in such tube pump as mentioned above, thereby acting to generate a fluid flow through the tube upon repeated deformation of the tube between the two valve members.

The pump element may comprise a connecting part for coupling to another tube and may comprise a sealing part establishing a fluid tight connection to a part of the tube.

The invention further relates to a method for creating a flow of a fluid within an at least partly flexible tube by means of a pump element as mentioned above.

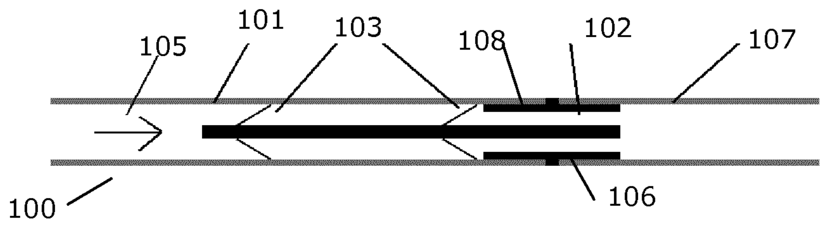

Fig. 1

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Description

Field of the invention

[0001] The present invention relates to a tube pump comprising a pump element inserted in a tube for the generation of a fluid flow within the tube. The invention furthermore relates to a pump element for such a tube pump and to a method of creating a flow of a fluid within an at least partly flexible tube.

Background

[0002] Different kinds of positive displacement tube pumps such as roller pumps or peristaltic pumps are known for pumping a fluid through a flexible tube or hose and are widely used in e.g. medical applications such as for instance in infusion pump systems, dialysis pumps, or bypass pumps for circulatory support.

[0003] A benefit of such pump types making them especially advantageous in medical applications is the absence of moving parts in contact with the fluid, whereby the pumps may be relatively easily sterilized. The peristaltic pumps, roller pumps and tube pumps however suffer from a number of drawbacks. Firstly, the pumping involves a complete or near complete compression or squeezing of the tube either by rollers, contact plates, or shoes to obtain the desired fluid flow within the tube. This inevitably leads to large wear on the part of the tube within the pump. The tube therefore regularly needs to be moved relative to the pump for the compression to be exerted on another part of the tube or exchanged completely thereby resulting in an excessive use of tube material and a need for longer tubes. The extra tube length or the moving of the pressure zones makes the known tube pumps more expensive and increases the time needed to setup and operate the pump. Further, the large wear increases the risk of damaging the hose considerably, leading to a loss of pumping fluid and contamination of the surroundings, and a reduction or loss of pumping effect which depending on the circumstances may be unacceptable and even fatal. Extra surveillance of the pump and tubes is therefore required to prevent such situations.

[0004] Further, the complete or near complete compression of the tube or hose may result in excessive large stresses and shear forces experienced by the fluid causing damages to the fluid molecules or separation of colloids and slurry fluids.

[0005] Another drawback of the known tube pumps is their often considerable size necessitating a large amount of space which in many medical situations is limited.

Description of the invention

[0006] It is therefore an object of embodiments of the present invention to overcome or at least reduce some or all of the above described disadvantages of the known tube and peristaltic pumps by providing a tube pump and a pump element with improved pumping efficiency and reduced wear of the tube material. It is a further object of embodiments of the invention to provide pump elements and tube pumps with minimized risk of leakages.

[0007] It is a further object of embodiments of the invention to provide pump elements for tube pumps which are simple and fast to apply and yet effective. It is a yet further object of embodiments of the invention to provide products of minimal number of parts and of low manufacturing costs.

[0008] In accordance with the invention this is obtained by a tube pump comprising a tube and a pump element inserted in the tube, the pump element comprising a rod element and at least a first and a second non-return valve member positioned a distance apart on the rod element and oriented in the same direction relative to the rod element so as to allow for a fluid flow in the tube through the first valve member, along the rod element, and through the second valve member. The tube comprises an at least partly flexible tube portion between the first and second valve members such that a repeated deformation of the flexible tube portion acts to alternately close and open the valve members thereby generating a fluid flow through the tube.

[0009] The non-return valve may be a so-called check valve, a clack valve, or one-way valve, and is a mechanical device, a valve, which normally will allow a fluid (liquid or gas) to flow through it in only one direction. The non-return valve may close the fluid passageway off partly or fully in its closed position. By orienting the non-return valve members in the same direction relative to the rod element is obtained that both valve members when in their open position will allow for a fluid flow in the tube in the same direction.

[0010] The whole tube may be flexible and may be made in a material such as a thermoplastic or a rubber, and may be reinforced. Alternatively or additionally, only a portion of the tube may be flexible, such as comprising a length of a flexible hose or comprising flexible tube wall portions.

[0011] By a tube pump according to the above may by very simple means be obtained an effective pump for and mechanism for pumping a fluid through the tube. The fluid flow is generated as the deformation of the tube between the at least two non-return valve members acts to squeeze the fluid out of the tube space between the valve members and out through one of the non-return valve members. When the deformation is relaxed, a negative pressure is created in the space, closing the one valve member and opening the other drawing in fluid from upstream the tube. A repeated deformation repeats the above described alternately opening and closing of the valve members thereby generating a fluid flow within the tube.

[0012] The deformation may in an embodiment of the invention involve a compression of the tube from one or more sides and/or may involve a decompression of the tube.

[0013] Unlike many conventional tube pumps such as roller pumps, the tube need not be completely compressed or squeezed to generate an efficient pumping motion of the fluid. Rather, even relatively small deformations of the tube may be enough to obtain a relatively high pumping efficiency due to the construction of the tube pump with the pump element comprising two or more non-return valve members. This is further advantageous in minimizing the wear on the tube caused by the repeating deformation and thereby minimizing the risk of leaking and loss of the fluid and contamination of the surroundings.

[0014] The smaller amount of deformation of the tube needed for obtaining an efficient pump further leads to lower stresses and shear forces experienced by fluid, which may prevent damaging of fluid molecules and help to keep colloids and slurry fluids from separating. This may be especially advantageous in pumping of specific types of fluid such as e.g. blood or other fluids comprising fragile or vulnerable components.

[0015] Due to the construction of the pump element of the valve members positioned on a rod element, a tube may fast and easily made ready for pumping by simply inserting a pump element into the tube. Similarly, the pump element may be extracted from the tube in an equally simple fashion, whereby the interior of the tube which then is the only part of the pump in contact with the fluid is left without obstacles and may be cleaned and sterilized easily and effectively. The extracted pump element is likewise simple to clean and sterilize effectively before reuse or may simply be disposed of. This makes the tube pump especially advantageous for medical applications and in the food industry.

[0016] The tube pump is further advantageous in that it may be operated to deliver a pulsed flow e.g. like the heart which may be advantageous in e.g. bypass pumps or in some infusion pumps.

[0017] The pump element may be pre-manufactured in one or more sizes dimensioned to tubes of different diameters and/or shapes.

[0018] The tube pump is advantageous in comprising only few parts and can be fast and easily assembled and made ready for pumping. Further, the tube pump is inexpensive to manufacture and inexpensive to maintain as the use of a hose or tube makes for a relatively low-cost maintenance item compared to other pump types.

[0019] A further advantage is that the tube pump may be constructed to yield a compact yet robust and efficient pump.

[0020] Because of rod element of the pump element, the valve members will be positioned in the tube at a predefined distance apart given by and fixed by the rod element whereby the amount of pumping may be equally well defined for each deformation of the tube and possible to determine on beforehand.

[0021] Furthermore, by the rod element being relatively stiff and inelastic compared to the flexible tube portion, the rod element aids the tube portion to relax and return to its undeformed shape after each deformation and each pumping movement. Hereby, the tube portion may be ready for a new deformation and pumping cycle faster.

[0022] Further, the rod element enable a fast and simple assembly of the pump element and the tube pump as all the parts of the pump element may by mounted one after another on the rod element. The assembly may advantageously be performed from only one side which enables a high-speed and automated mass production.

[0023] Also, the rod element enables a fast yet precise and well-controlled insertion of the pump element into the tube.

[0024] The rod element may further be provided with recesses for the different parts of the pump element to be placed in. This facilitates the mounting and positioning of the parts on the rod element. Furthermore, the distances between the parts and especially the distance between the valve members and thereby the pumping volume may hereby be determined and controlled accurately.

[0025] Also, the predetermined and fixed distance between the valve members eases the mounting or placing of the tube pump in a pumping apparatus such as an infusion pump.

[0026] The rod element may attain elongate shapes of different and/or varying cross sections such as e.g. a circular cylindrical shape, a rectangular cylindrical shape, a hollow cylindrical shape, or a helical shape. The rod element may further comprise two or more parallel or non-parallel bars.

[0027] According to an embodiment of the invention, the pump element extends into the tube from one end of the tube, and the pump element further comprises at least one sealing part engaging with the tube wall in a fluid tight fashion in one end of the tube. Hereby is obtained that the pumping element is easily inserted into a tube portion and that the pump element may also act as a coupling member for coupling the tube to another part such as e.g a further tube, an infusion bag, a syringe or the like without or with only minimal leaking. In this way the assembled tube pump may be made ready with only one connection or coupling.

[0028] The sealing part may engage with the tube wall by friction. The sealing part may comprise one or more gaskets e.g. in the shape of a ring or band of rubber or another deformable or flexible material.

[0029] In a further embodiment of the invention, the pump element extends through the entire length of the tube and comprises sealing parts engaging with the tube wall in a fluid tight fashion in both ends of the tube. Hereby a tube length of a predetermined length may be pre-manufactured and pre-assembled with the pump element already inserted and secured to the tube wall. Hereby the sealing parts may be brought to engage with the tube wall such as to be able to withstand a higher fluid pressure e.g. by involving heat sealing or shrinking.

[0030] In a further embodiment of the invention, the tube is connected to a further tube via a connection part. The connection part may be configured as a pipe connection part on the end of the pumping element. Hereby the tube pump may be easily fastened and secured to e. g. another tube, an infusion bag, syringe or the like for pumping the fluid to or from such other part. This further yields the possibility to use less expensive tubes or hoses leading to or from the tube pump without being constrained by any tube diameter or tube material applied in the tube pump.

[0031] In yet a further embodiment of the invention, the tube pump comprises at least one actuator of an electroactive polymer material arranged for deforming the flexible tube portion when actuated. The electroactive polymer material may be arranged on a wall portion of said flexible tube portion and may hereby act to compress or enlarge the tube diameter when actuated by the application of a current to the electroactive polymer material. The electroactive polymer material may for instance comprise a silicone and an electrically conductive layer.

[0032] In an embodiment of the invention the flexible tube portion may by squeezed or compressed e.g. by the application of vacuum to the tube, prior to the electroactive polymer material being wrapped or otherwise arranged on the wall portion. When the vacuum is released and the tube pump is ready for use, the electroactive polymer material is thereby prestressed by the tube portion. A pretension of the electroactive polymer material in the range of 10-50%, such as in the range of 20-30% may increase the efficiency of the electroactive polymer material. As the electroactive polymer material is subjected to a current, the length of the material film wrapped around the tube expands allowing for the tube diameter to increase creating a draw in the tube cavity. As the current on the electroactive polymer material is released, the tube portion is again compressed creating the pumping motion. More pump units may be placed parallel or in series to increase the overall efficiency of the pump.

[0033] The above described tube pump actuated by an electroactive polymer material may advantageously be driven by e.g. solar cells thereby obtaining a pump which may be manufactured at low costs and a reliable pump suitable for for example outdoor pumping of water for e.g. the watering of plants or animals, or for the oxidization of lakes or water holes by pumping water from the surface down to the bottom or vice versa. The disclosed tube pumps may work efficiently together with solar cells, in that the tube pumps may work in a discontinuous manner whenever power is available with no need for large capacitors, but may yield at least a single if not several pumping strokes with only minimal power.

[0034] In yet a further embodiment of the invention, the tube pump comprises at least one actuator comprising a movable contact plate arranged for deforming the flexible tube portion by compressing the tube when actuated. The actuator may be linear or non-linear and may comprise one or more contact plates placed to move towards each other and/or towards a base, so that the tube may be compressed from one or more sides.

[0035] According to a further embodiment, the tube pump may comprise at least two pump elements placed serially. By the use of a number of pumping elements placed after each other, the pumping effect may be increased equivalently by repeatingly deforming the tube in several positions between sets of valve members. The tube may hereby be deformed in a peristaltic movement.

[0036] In an embodiment, at least one of the valve members comprises a flexible diaphragm and/or membrane fitted onto the rod element and sized to at least partly engage in its closed position with the inner wall of the tube. The pump element and thereby the tube pump may hereby be constructed of very few parts in that the valve function is simply obtained by the flexible membrane moving relative to the inner tube wall. Further, the valve members may be easily positioned onto the rod element and may be easily exchanged if needed. The pump element and thereby the tube pump may hereby be manufactured at very low costs.

[0037] In a further embodiment of the tube pump according to any of the above described, the valve members comprise valves placed in valve housings which at least partly engage with the inner wall of the tube. Here, the valve opening is primarily established in the valve housings, whereby the valve opening is not dependent on the positioning within the tube and therefore may be determined precisely beforehand and independent of the tube properties. Further, such construction may be more robust.

[0038] In a further embodiment of the tube pump according to any of the above, at least one of the valve members comprises a flexible funnel shaped membrane and a perforated disk fitted onto the rod element, the disk being sized to engage with the interior of the tube in a fluid tight fashion. The membrane may be sized to cover the disk perforations if pressed against the disk.

[0039] Hereby is established a very compact yet efficient non-return valve which may be configured to completely or partly close off any flow effectively in the one direction while allowing for a full flow in the other direction caused by a pressure difference across the valve. The valve may be opened by only a small pressure in dependence of the material properties and stiffness of the funnel shaped membrane. The funnel shaped (i.e. conical, cup shaped, or trumpet shaped) membrane increases the efficiency of the valve and provides for a smooth continuous transition from its closed to its open position and vise versa without any 'flapping' or sudden changes of its shape. Hereby, a more even pumping motion without or with only minimal cudden changes in the flow speed may be obtained.

[0040] In both the open and closed position of the valve, the disk lies sealingly against the interior of the tube so that the only possible fluid flow is through the perforations or openings in the disk. The funnel shaped membrane is mounted on the rod element only allowing for any possible fluid flow around the membrane in the space between the membrane and the tube walls. The membrane is oriented so that the interior of funnel is oriented towards the disk. In the closed and relaxed position of the valve, the membrane lies against the disk. The membrane may lie completely or partly against the disk surface. Hereby the membrane covers at least some of the perforations in the disk preventing the fluid flow therethrough. In the open configuration of the valve, the membrane is deformed due to the increased pressure on the disk side of the valve so that a gap is established between the disk and the membrane allowing for a fluid flow through the perforations in the disk and around the membrane.

[0041] The perforations in the disk may be applied as openings or holes through the disk placed randomly or in a pattern. The perforations may be placed a distance from the rod element or next to the rod element. The perforations may e.g. be applied to the disk by the punching of a star shaped central hole in the disk both functioning as the hole for the disk to be mounted on the rod element and providing the perforations for the valve function.

[0042] The disk may be manufactured from e.g. a thermoplast, a metal, or a rubber material.

[0043] The funnel shaped membrane may be punched or cut out from a foil, a film or a cloth of e.g. a silicone material. The membrane may have a circular or oval shape with a central hole of a smaller diameter than the diameter of the rod element (optionally of the diameter of the recessed rod element) where the membrane is to be placed. As the membrane then is pushed or drawn onto the rod element, the initially flat membrane naturally attains a funnel shape and seals against the rod element. Alternatively, the membrane may be shaped e.g. by thermoshaping or thermoforming. In an embodiment of the invention the central part of the funnel shaped membrane attains an angle in the range of 10-40 degrees relative to the rod element. In a preferred embodiment the cone angle lies in the range of 20-35 degrees such as approximately 30 degrees.

[0044] Optionally, the funnel shaped membrane in the inlet valve may be manufactured from a material of a lower stiffness than the membrane in the outlet valve to ensure an easier an faster closing of the inlet valve therby increasing the efficiency of the tube pump.

[0045] According to a further embodiment, the tube pump may comprise a free flow prevention device mounted on the rod element between the first and second valve members, the free flow prevention device comprising a valve element which in the closed configuration of the device is sized to engage with the interior of the tube in a fluid tight fashion, and which is configured to be opened by the deformation of the flexible tube portion pressing on at least a part of the valve element. The valve element may simply comprise an element initially filling out the interior of the tube but deforming differently from the tube, so that openings between the element and the tube may occur when the tube is deformed e.g. as a part of the pumping, and such that the tube will again be closed when the deformation of the tube seizes. The free flow prevention device may advantageously completely prevent any fluid flow when the tube is not deformed and pumping is not intended. Hereby, a more reliable and automatic closing of the tube may be achieved without the need for any manual interaction such as the conventional manually placing of clamps on the tube. The free flow prevention device further acts to make the open and closed configurations of the pump, and the phases of the pumping more distinct. The free flow prevention device may further be used in a priming of the pump, i.e. in filling the pump cavity between the valve members with fluid prior to initiating the pumping. This may be achieved by pressing (automatically or manually) on the tube near the device opening the free flow prevention device.

[0046] The free flow prevention device according to embodiments of the invention is furthermore advantageous in preventing the free flow while still allowing the pumping with only small pressure forces on the tube. The stiffness of the free flow prevention device may be tailored to require a desired minimum deformation of the tube or minimum deformation force on the tube to enable any fluid flow.

[0047] The valve element of the free flow prevention device may comprise a funnel-shaped membrane of a larger diameter than the interior diameter of the tube, thereby sealing off the tube when not compressed. The funnel shaped membrane may be manufactured from a flat cloth in the same way as described in relation to the funnel shaped membranes of the valve members. Advantages of a funnel shaped membrane are as described in relation to the funnel shaped membranes of the valve members.

[0048] The valve element of the free flow prevention device may comprise a foam member preferably of a foam with closed cells and e.g. of a cubic shape. The foam member is easily deformed with minimal forces and may be manufactured and assembled efficiently and at low costs.

[0049] The prevention of any free flow in the tube pump is especially important in relation to applications of the tube pump in infusionpumps, where the unintended free flow of medicine is estimated to have added to or been the direct cause of death of about 500 persons in the USA.

[0050] According to another aspect, the invention relates to a pump element for a tube pump as described above, where the pump element is configured for insertion into a tube and to aid in generating a flow of a fluid within the tube. The pump element comprises a rod element with at least a first and a second non-return valve members positioned a distance apart on the rod element and oriented in the same direction relative to the rod element so as to allow for a fluid flow through the first valve member, along the rod element, and through the second valve member. Hereby the pump element when inserted in a flexible tube may act to generate a fluid flow through the tube upon repeated deformation of said tube between said first and second valve members. It should be understood that the invention in this aspect may relate to a pump element as an isolated product independent of the tube pump for which it is intended to be used.

[0051] A pump element according to the above is advantageous for the same reasons as apply to the tube pump given in the previous.

[0052] The pump element is advantageous in comprising only few parts and which may be easily assembled. Also the pump element is inexpensive to manufacture and therefore advantageous as a disposable product, which may be advantageous for medical applications or in the food industry where hygiene or sterile equipments are of outmost importance.

[0053] The pump element is further advantageous in being easy and fast to insert in a tube whereby a tube pump may be made ready for operation fast and easily.

[0054] Further, because of the pump element construction, the valve members will inevitably be inserted in a tube at the predefined distance apart as given by their position on the rod element, whereby the amount of pumping may be equally well defined for a given deformation of the tube.

[0055] In an embodiment of the invention, the pump element further comprises a sealing part positioned on one side of the first and second valve members and configured to establish a fluid tight connection to an end part of a tube when the pump element is inserted in the tube. Further, the pump element may comprises a pipe connection part configured for connecting the pump element to a further tube, syringe, infusion bag or the like. Hereby is obtained that a tube in which a pumping motion is generated is easily connected and coupled to another part via the pump element such that fluid may be pumped on to this other part. In this way a minimum of couplings are needed and the risk of leaks is minimized.

[0056] In a further embodiment, the first and second valve members comprise valves belonging to the group of ball valves, duckbill valves, diaphragm valves, wafer valves, check valves, swing check valves, disc check valves, split disc check valves, tilting disk check valves, cross slit valves, umbrella valves, and lift-check valves. Hereby may be obtained a set of effective valves and which may be pre-manufactured and positioned in the valve members in a simple yet effective manner.

[0057] In an embodiment of the invention, the valve members used in one pump element may of different types. For instance, the inlet valve may be relatively soft compared to the outlet valve whereby a larger pressure is needed to open the outlet valve thereby minimizing or avoiding any free flow in the tube. This may be especially advantageous for pumps involving dosing of medicine where it is important to know the exact flow through the pump to ensure the correct dosage.

[0058] In a further embodiment of the invention, the connecting rod is made of a bendable material such as a thermoplast. Hereby is obtained that the pump element may be easily inserted into bended tubes or hoses or that the tube may be bended without affecting the efficiency of the pumping. Further, a more compact tube pump may be obtained by allowing the tube to bend.

[0059] In a further embodiment of the invention, the connecting rod is made of a plastic material such as e. g. PE (polyethylene), PP (polypropylene), a rubber, or a metal alloy.

[0060] The invention further relates to an infusion pump comprising a tube pump according to any of the embodiments described in the preceding. The advantages hereof are as given in relation to the tube pump. Further, the infusion pump is advantageous in making the use of a drip counter and a flow regulator superfluous, as otherwise conventionally applied in infusion pumps, as the tube pump can be controlled and regulated to give a certain number of pulses per time whereby the flow may be accurately determined. Further, the infusion pump can maintain a constant flowrate throughout the entire emptying of the infusion bag and regardless of how the infusion bag is placed. In contrast hereto conventional infusion pumps uses the gravity for a continued and complete emptying of the infusion bag for which reason it may be essential that the infusion bag and the tube leading from the infusion bag must hang or be held correctly.

[0061] In a further aspect, the invention relates to a non-return valve member for use in a tube pump as described above, where the valve member is configured for insertion into a tube and to aid in controlling a flow of a fluid within the tube. The valve member comprises a flexible funnel shaped membrane, and a perforated disk sized to engage with the interior of the tube in a fluid tight fashion. The valve member further comprises a rod element onto which the disk and the membrane are mounted.

[0062] In an embodiment of the invention, the funnel shaped membrane in the closed configuration of the valve member is placed such as to cover the disk perforations.

[0063] In a further embodiment of the invention, the membrane is mounted on the rod element by sticking the rod element through a hole in the membrane, the hole being of a smaller diameter than the diameter of the rod.

[0064] The advantages of such non-return valve as described above are as given in relation to the tube pump comprising such valve member.

[0065] In a final aspect, the invention relates to a method for creating a flow of a fluid within an at least partly flexible tube, comprising the steps of connecting at least a first and a second non-return valve member to a connecting rod element a distance apart and such that said first and second valve members are oriented in the same direction relative to the rod element, and inserting the rod element with the valve members into the tube such that said valve members when closed at least partly engage with the tube wall. The method further comprises repeatingly deforming at least a part of the tube between the first and second valve members thereby alternately closing and opening the valve members and thereby generating a fluid flow through the tube.

[0066] The advantages hereof are as given in relation to the tube pump and the pump element in the previous paragraphs.

Brief description of the drawings

[0067] In the following different embodiments of the invention will be described with reference to the drawings, wherein:

Fig. 1 illustrates an embodiment of a tube pump with a pump element inserted in a tube as seen in a cross sectional views from the side,

Fig. 2 illustrates the tube pump as shown in figure 1 in a perspective view,

Figs. 3A and 3B illustrate the working principle of a tube pump according to the invention during and after deformation of the tube by an external compression force,

Fig. 4A and 4B illustrates the working principle of a tube pump according to the invention during and after deformation of the tube by an electroactive polymer material,

Figs. 5 and 6 illustrate different embodiments of a tube pump and a pump element with a electroactive polymer material,

Figs. 7-11 illustrate different embodiments of a tube pump and a pump element with different types of valve members,

Fig. 12 illustrates an embodiment of a tube pump with a number of pumping elements in a serial connection, and the coupling of two tube parts by means of a pump element,

Fig. 13 illustrates an infusion pump comprising a tube pump and a pump element according to embodiments of the invention,

Figs. 14 and 15 illustrates a further embodiment of a tube pump and a pump element with a free flow prevention device according to the invention,

Fig. 15 illustrates a further embodiment of a tube pump and a pump element with an electroactive polymer material,

Figs. 17A and B illustrate different embodiments of a tube wall in a cross sectional view suitable for considerable deformations, and

Figs. 18A, B, and C illustrate the working principle of a further embodiment of a tube pump and a pump element with a different type of a free flow prevention device.

Detailed description of the drawings

[0068] Figure 1 shows an embodiment of a tube pump, 100 according to the invention and as seen in a cross sectional view. The same tube pump is seen in a perspective view in figure 2. The tube pump 100 comprises a tube 101 (in grey) into which is inserted a pump element 102. The pump element 102 is also depicted in figure 2 below in a perspective view as seen before insertion into the tube. The pump element 102 comprises two or more non-return valve members 103 attached to a rod element 104 in a spaced apart manner. The two valve members are oriented in the same direction relative to the rod element 104, so that a fluid inside the tube portion 101 may only flow in one direction through the two valve members 103 as illustrated by the arrow 105. The valve members 103 here comprises split disc or duo check valves comprising a split disk which is dimensioned to have a larger surface area than the tube cross sectional area so that the disks only allow for a fluid flow in the one direction. The rod element 104 here is in the shape of a flat bar for optimally supporting the split disk valves but could also have other shapes such as circular. Other possible shapes are shown in some of the following figures. The pump element 102 further comprises a connecting part 106 at its end for connecting to another tube or hose 107. The connection part 106 could equally well be dimensioned and shaped to connect to tubes of smaller or larger diameters, to e.g. a syringe, or a infusion bag or the like. The pump element further comprises a sealing part 108 establishing a fluid tight connection between the pump element and the tube 101 when the pump element is inserted herein. The sealing part may optionally comprise one or more gaskets (not shown).

[0069] Figures 3A and 3B illustrate the working principle of the tube pump 101 in general. The tube 101 surrounding the pump element 102 comprises a flexible tube wall portion 301 positioned between the two valve members 103. The pumping is generated by deforming the tube between the valve members 103, which in this illustrated example is performed by an actuator compressing the tube 101 by means of two movable contact plates 302, the first valve member 103a will remain closed due to the increased pressure in the tube, whereas the second valve member 103b will be opened. Thereby the fluid is forced in the direction of the arrow 303. As the contact plates 302 retract (as shown in figure 3B) and the tube deformation is relaxed, an under pressure is created in the decompressed chamber between the valve members causing the second valve member 103b to close and the first valve member 103a to open and a flow in the direction of the arrow 304. A fluid flow in the tube is thereby obtained by a repeating deformation of the tube between the valve members 103.

[0070] Figures 4A and 4B illustrates the same pumping principle, but where the deformation of the tube 101 is effected by an electroactive polymer material 400 which changes its size considerably when subjected to a current. In this tube pump embodiment the electroactive polymer material 400 is placed in or on a part of the flexible tube wall thereby acting to compress the tube when actuated.

[0071] In figure 5 is shown another embodiment of a pump element 102 configured for insertion into a tube 101. The tube 101 in this case comprises two bands 501 of an electroactive polymer material which when activated may act to compress the tube 101 in two places. The pump element 102 in this embodiment comprises three valve members 103 which each comprises a disk check valve 502 in a valve housing 503. The valve housings 503 are dimensioned to fit inside the tube 101 on either side of each band 501 of electractive polymer material. Both sealing parts 108 in each end of the pump element 102 are hollow or perforated allowing the fluid to flow past the sealing parts inside the tube. The bands of electroactive polymer material may be activated on after the other in serial thereby generating a peristaltic pumping motion.

[0072] Figures 6A and 6B likewise illustrate the use of electroactive polymer material in the actuator deforming the tube 101 in a tube pump 100 according to the invention. Here, the electroactive polymer material is placed in broader ribbons or bands 601 in a hinged frame 502. Figure 6A shows the actuator bands 601 in their relaxed state where the frame parts 602 lay up against the tube wall. In figure 6B can be seen how the electroactive polymer bands 601 contract when electrically activated (as indicated by the hatched lines) thereby forcing the frame parts 602 to compress or squeeze the tube 101.

[0073] Different types of non-return valve members may be applied in the pump element 102 as illustrated in the figures 7-11. These figures also illustrate different possible shapes of the rod element 104 and of the pipe connection or coupling part 106.

[0074] The pump element 102 as shown in figure 7 comprises valve members 103 in the shape of flexible diaphragms or membranes 701 fitted onto the rod element and sized to at least partly engage in their closed position with the inner wall of the tube 100. The pump element alone is shown in figure 7A, as inserted in a tube and in a tube pump in figure 7B and 7C in a side view and perspective view, respectively.

[0075] The pump element 101 may additionally or alternatively comprise valves of the disk check type 801 (figure 8A and 8B), valves of a soft or elastic material such as a silicone, rubber or thermoplastic material and with a movable lid providing for the valve opening 901 (figure 9), duckbill valves 1001 (figure 10A and B), or ball valves 1101 (figure 11).

[0076] Figure 12 illustrates an embodiment of a tube pump 100 with a number of pump elements 102 placed in one or more tubes 101 in a serial. Hereby the pumping effect may be correspondingly increased, in that the tube or tubes 101 may be compressed in more than one place. This may advantageously be done one place after each other thereby establishing a peristaltic movement. The figure further illustrates how two or more tube parts 101 may be coupled to each other and brought in fluid connection by means of the one or more pump elements 102.

[0077] Fig. 13 illustrates an infusion pump 1301 comprising a tube pump 100 and a pump element 102 according to embodiments of the invention. Here, the pump element 101 is inserted in a tube, coupling the tube to a further tube or hose at each end of the pump element which may be coupled at one end to a syringe 1302 and at the other to an infusion bag of bottle (not shown). The infusion pump using a tube pump according to the invention is advantageous over conventional infusion pumps by being able to provide a well-controlled and steady flow irrespective of the orientation of the pump (independent of the gravity force) and irrespective of the amount of fluid left in the infusion container. Rather the infusion speed and amount can be precisely controlled and regulated by controlling the actuator force of the one or more actuators deforming the flexible tube, 1303.

[0078] The tube pump according to the various embodiments may likewise advantageously be applied in other types of pumps such as pumps driven by solar cells for instance in pumps for increased oxidisation of water where water from lower regions of for instance a lake or water basin is raised and pumped to higher regions thereby mixing the water. The disclosed tube pumps may work efficiently together with solar cells in that the tube pumps may work in a discontinuous manner whenever power is available, and may yield at least a single if not several pumping strokes with only minimal power.

[0079] Figure 14 discloses an embodiment of a pump element 102 inserted into a flexible tube thereby forming a tube pump 100. The figure shows the different parts of the pump elements as assembled and in an exploded view, respectively. In this embodiment the two non-return valve members 103 each comprise a funnel-shaped flexible membrane 1401 of a smaller diameter than the interior diameter of the tube 101. These membranes may initially be flat membranes of circular shape provided with a central hole of smaller dimension than the diameter of the rod element. The membranes may as an example be punched out or cut from films or foils of a flexible material such as silicone.

[0080] When pushed onto the rod element, the membrane deform into a funnel as illustrated in the figure. The funnel shaped membranes are each placed on the rod element 104 next to a disk 1402 of an outer dimension and shape so as to lie and seal against the interior of the tube. The disks 1402 comprise a number of openings 1403 which may be placed next to the rod element as illustrated on one of the valve members 1405 or as a pattern on the disk 1406. When the non-return valve member is closed as illustrated in the topmost configuration in figure 14, the funnel shaped membrane 1401 lies against at least the outer part of the neighbouring disk 1402. In case of a larger fluid pressure to the disk side of the valve (to the left in the figure) than to the membrane side (to the right in the figure), the membrane will be pushed away from the disk allowing for a fluid flow through the openings of the disk and around the membrane as sketched by the arrows 1407. An increased fluid pressure on the membrane side of the valve member, however, will cause the membrane to press more tightly against the disk preventing any fluid flow. The rod element 104 may optionally be provided with recesses for receiving and positioning the different parts of the pump element whereby the distance between the non-return valve members and thereby the pumping volume can be determined and controlled accurately.

[0081] The pump element illustrated in figure 14 further comprises a free flow prevention device 1410 which is a valve element configured such that it only opens and allows for passage of a fluid when affected by a pressure from the exterior on the tube. Hereby any unintentional fluid flow through the pump may be prevented which may otherwise be the problem e.g. for hanging infusion pumps where the gravity forces from a bags of infusion fluids may cause a small unnoticeable leak in the infusion pump. In the illustrated embodiment the free flow prevention device is simply made of a circular membrane placed on the rod element 104 somewhere between the two valve members 103 and of an outer diameter larger that the interior diameter of the tube 101. Like for the membranes 1401 in the valve members 103, the membrane of the free flow prevention device is given a funnel shape by being pushed on the rod element through a hole of a smaller dimension than the diameter of the rod element. As a pressure is applied to the tube, the tube deforms differently than the free flow prevention device making openings between the device and the tube wall for the fluid to flow through. When the pressure is released, the free flow prevention device attains its undeformed shape and closes off any flow through the tube again.

[0082] Further, the free flow prevention device may advantageously be used to prime the tube pump, i.e. fill the tube cavity between the non-return valve members with fluid prior to initiating any pumping. This may be performed by simply pressing manually or automatically on the tube near the free flow prevention device,

Figure 15 shows a tube pump 100 and a pump element 102 similar to the pump element described in relation to figure 14. Only here, the tube pump is configured to be attached to other tubes or hoses via the connection parts 106 in each end of the pump element and placed on each end of the rod element 104. Further, in this embodiment the first perforated disk 1501 (the openings in the disk not shown in the figure) sealing of the one end of the tube 101 and the connection part 106 is manufactured in one piece. The tube pump may in this way be manufactured from a minimal number of parts which furthermore may be effectively and fast assembled in a production line from optionally just one side.

[0083] Figure 16 depicts an embodiment of a tube pump suitable to be actuated by means of an electroactive polymer material 400. Here, an intermediate member 1600 is applied on a part of the rod element 104 between the fist and second non-return valve members 103. After assembling the different parts of the pump element and placing the pump element inside the tube 101, the tube may be shrinked or squeezed onto or close to the intermediate member 1600 by the application of vacuum to the pump element and the electroactive polymer material (not shown) is wrapped tightly around the compressed tube and the vacuum is released. As the electroactive polymer material is actuated, the material expands thereby allowing the tube of the tube pump wrapped by the material to expand likewise and vice versa. In the shown embodiment of the pump element, the non-return valve members comprise flexible membranes and perforated disks like in the embodiment described in relation to the figures 14 and 15. The type of the non-return valves used is however not of importance in relation to the described use of the electroactive polymer material, and other types of non-return valves may therefore likewise be applied in relation to the depicted tube pump of figure 16. In this embodiment, the connection parts 106 are configured to receive and connect to tubes or hoses through interior passageways.

[0084] In order to allow for the compression of the tube against the intermediate member 1600 the tube may for instance be made of a material comprising closed pores 1700 as illustrated in figure 17A. Alternatively, the tube may have a tube wall comprising grooves or channels 1701 as sketched in figure 17B whereby the tube diameter may be decreased considerably during the tube compression with minimal wear and fatigue on the tube.

[0085] Figure 18 shows sketches of another embodiment of a free flow prevention device 1410 according to the invention. Here, the free flow prevention device is shaped as a hatch-like member 1800 in connection to one of the non-return valve members 103 and likewise placed on the rod element (not shown). In the neutral position of the tube pump as shown in figure 18A, the flow is prevented in both directions of the tube. In the pumping phase illustrated in figure 18B, a compression and a deformation of the tube 101 causes the free flow prevention device to open as the tube wall presses against the hatch-like member 1800. The outlet valve 1802 is further opened and the inlet valve 1803 closed by the increased fluid pressure. As the external pressure is removed tube from thin the last phase (figure 18C) the outlet valve 1802 is closed and the inlet valve 1803 is opened by the lower pressure in the tube cavity between the valves. Furthermore, the free flow prevention device closes due to the relaxation of the tube. The described free flow device may likewise be applied in combination with other types of non-return valves than the ones illustrated here.

[0086] Further aspects of the invention are set forth in the following clauses:

1. A tube pump comprising a tube and a pump element inserted in said tube, the pump element comprising a rod element and at least a first and a second non-return valve member positioned a distance apart on said rod element and oriented in the same direction relative to the rod element so as to allow for a fluid flow in the tube through the first valve member, along the rod element, and through the second valve member, and the tube comprising an at least partly flexible tube portion between said first and second valve members such that a repeated deformation of said flexible tube portion acts to alternately close and open the valve members thereby generating a fluid flow through the tube.

2. A tube pump according to clause 1, where the pump element extends into the tube from one end of the tube, and where the pump element further comprises at least one sealing part engaging with the tube wall in a fluid tight fashion in one end of the tube.

3. A tube pump according to any of the preceding clauses, where the pump element extends through the entire length of the tube and comprises sealing parts engaging with the tube wall in a fluid tight fashion in both ends of the tube.

4. A tube pump according to any of the preceding clauses, where the tube is connected to a further tube via a connection part.

5. A tube pump according to any of the preceding clauses comprising at least one actuator of an electroactive polymer material arranged for deforming said flexible tube portion when actuated.

6. A tube pump according to the above clause 5, where said electroactive polymer material is arranged on a wall portion of said flexible tube portion.

7. A tube pump according to any of the preceding clauses comprising at least one actuator comprising a movable contact plate arranged for deforming said flexible tube portion by compressing the tube when actuated.

8. A tube pump according to any of the preceding clauses comprising at least two pump elements placed serially.

9. A tube pump according to any of the preceding clauses, where at least one of the valve members comprises a flexible membrane fitted onto the rod element and sized to at least partly engage in its closed position with the inner wall of the tube.

10. A tube pump according to any of the preceding clauses, where the valve members comprise valves placed in valve housings at least partly engaging with the inner wall of the tube.

11. A tube pump according to any of the preceding clauses, where at least one of the valve members comprises a flexible funnel shaped membrane and a perforated disk fitted onto the rod element, the disk being sized to engage with the interior of the tube in a fluid tight fashion.

12. A tube pump according to the above clause 11, where the membrane is sized to cover the disk perforations if pressed against the disk.

13. A tube pump according to any of the preceding clauses, further comprising a free flow prevention device mounted on said rod element between said first and second valve members, the free flow prevention device comprising a valve element which in the closed configuration of the device is sized to engage with the interior of the tube in a fluid tight fashion, and which is configured to be opened by said deformation of said flexible tube portion pressing on at least a part of said valve element.

14. A tube pump according to clause 13, where the valve element of the free flow prevention device comprises a funnel-shaped membrane.

15. A tube pump according to clause 13, where the valve element of the free flow prevention device comprises a foam member.

16. A pump element for a tube pump according to any of the previous clauses 1-15, where the pump element is configured for insertion into a tube and to aid in generating a flow of a fluid within the tube, the pump element comprising said rod element with at least said first and second non-return valve members positioned a distance apart on said rod element and oriented in the same direction relative to the rod element so as to allow for a fluid flow through the first valve member, along the rod element, and through said second valve member, whereby the pump element when inserted in a flexible tube may act to generate a fluid flow through said tube upon repeated deformation of said tube between said first and second valve members.

17. A pump element according to the above clause 16, where the pump element further comprises a sealing part positioned on one side of said first and second valve members and configured to establish a fluid tight connection to an end part of a tube when the pump element is inserted in said tube.

18. A pump element according to any of clauses 16-17, where the pump element further comprises a pipe connection part configured for connecting the pump element to a further tube.

19. A pump element according to any of clauses 16-18, where said first and second valve members comprise valves belonging to the group of ball valves, duckbill valves, diaphragm valves, wafer valves, check valves, swing check valves, disc check valves, split disc check valves, tilting disk check valves, cross slit valves, umbrella valves, and lift-check valves.

20. A pump element according to any of clauses 16-19, where the connecting rod is made of a bendable material such as a thermoplast.

21. A pump element according to any of clauses 16-20, where the connecting rod is made of PE (polyethylene), PP (polypropylene), a rubber, or a metal alloy.

22. An infusion pump comprising a tube pump according to any of clauses 1-15.

23. A method for creating a flow of a fluid within an at least partly flexible tube, comprising the steps of

- connecting at least a first and a second non-return valve member to a connecting rod element a distance apart and such that said first and second valve members are oriented in the same direction relative to the rod element,
- inserting said rod element with said valve members into said tube such that said valve members when closed at least partly engage with the tube wall,
- repeatingly deforming at least a part of the tube between said first and second valve members thereby alternately closing and opening said valve members and thereby generating a fluid flow through the tube.

24. A non-return valve member for use in a tube pump according to any of clauses 1-15, where the valve member is configured for insertion into a tube and to aid in controlling a flow of a fluid within the tube, the valve member comprising a flexible funnel shaped membrane and a perforated disk sized to engage with the interior of the tube in a fluid tight fashion, the valve member further comprising a rod element onto which the disk and the membrane are mounted.

25. A valve member according to clause 24 where the funnel shaped membrane in the closed configuration of the valve member is placed such as to cover the disk perforations.

26. A valve member according to any of clauses 24-25 where the membrane is mounted on the rod element by sticking the rod element through a hole in the membrane, the hole being of a smaller diameter than the diameter of the rod.

[0087] While preferred embodiments of the invention have been described, it should be understood that the invention is not so limited and modifications may be made without departing from the invention. The scope of the invention is defined by the appended claims, and all devices that come within the meaning of the claims, either literally or by equivalence, are intended to be embraced therein.

Claims

1. A non-return valve member configured for insertion into a tube and for aiding in controlling a flow of a fluid within the tube, the non-return valve member comprising a flexible funnel shaped membrane and a perforated disk sized to engage with the interior of the tube in a fluid tight fashion, the valve member further comprising a rod element onto which the disk and the membrane are mounted.

2. A valve member according to claim 1, where the funnel shaped membrane in the closed configuration of the valve member is placed such as to cover the disk perforations.

3. A valve member according to any of the preceding claims where the membrane is mounted on the rod element by sticking the rod element through a hole in the membrane, the hole being of a smaller diameter than a diameter of the rod element.

4. A non-return valve member according to any of the preceding claims wherein the rod element comprises recesses for receiving and positioning the funnel shaped membrane and the disk.

5. A valve member according to any of the preceding claims wherein the funnel shaped membrane is mounted on the rod element next to the disk so that an interior part of the funnel is oriented towards the disk.

6. A valve member according to any of the preceding claims wherein the funnel-shaped flexible membrane has a diameter smaller than an interior diameter of the tube.

7. A valve member according to any of the preceding claims wherein the disk comprises a number of openings placed next to the rod element and/or placed as a pattern on the disk.

8. A valve member according to any of the preceding claims further comprising a connection part placed on an end of the rod element where the connection part is configured to be attached to a tube or hose.

9. A valve member according to claim 8 wherein the connection part and the perforated disk is manufactured in one piece.

10. A valve member according to any of the preceding claims, where the rod element is made of a bendable material such as a thermoplast.

11. A valve member according to any of the preceding claims, where the rod element is made of a polyethylene, a polypropylene, a rubber, or a metal alloy.

12. A tube pump comprising a tube portion and a non-return valve member according to any of claims 1-11, wherein the non-return valve member is inserted into the tube from an end of the tube.

13. A method of manufacturing a non-return valve member comprising:

- providing a rod element,
- providing a membrane with a centrally placed hole of a diameter smaller than the rod diameter,
- mounting a perforated disk onto the rod element, and
- pushing or drawing the membrane onto the rod element such that the membrane deforms into a funnel-shaped membrane.

14. A method of manufacture according to claim 13 wherein the membrane is punched out or cut out from a foil, a film, or a cloth of a flexible material such as silicone material.

15. A method of manufacture according to any of claims 13-14 further comprising providing the rod element with recesses for receiving and positioning of the disk and/or the membrane.

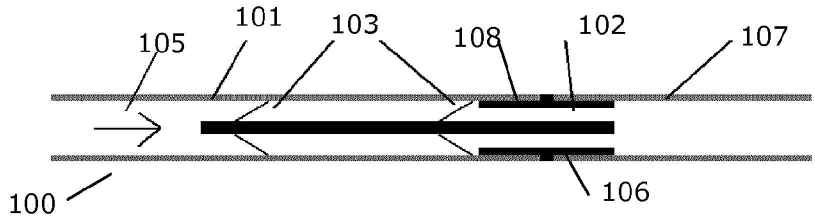


Fig. 1

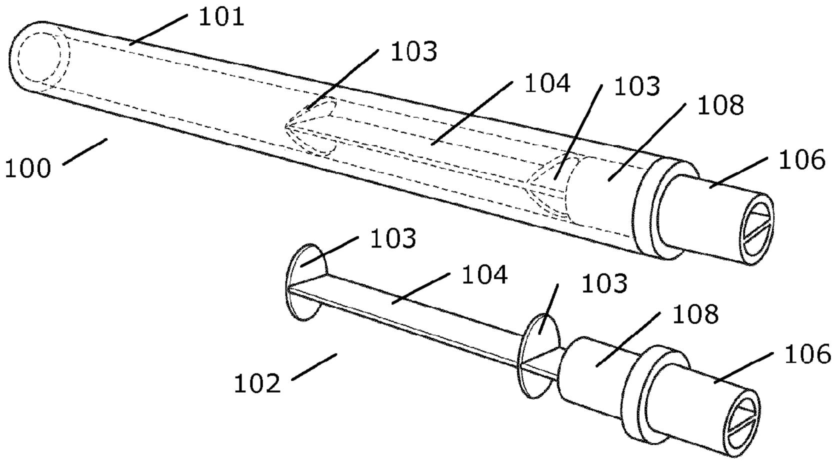


Fig. 2

Fig. 3A

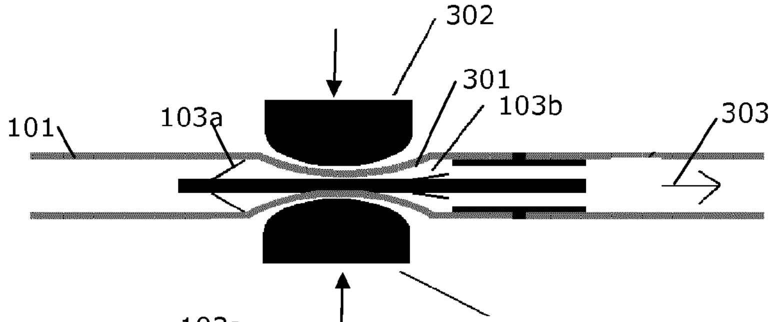


Fig. 3B

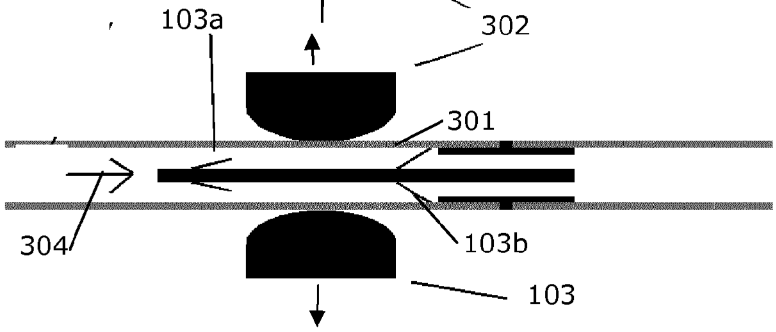


Fig. 4A

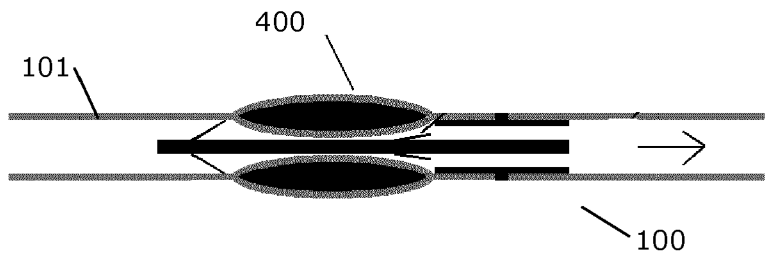
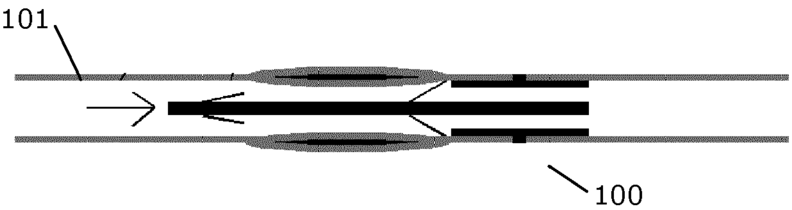


Fig. 4B



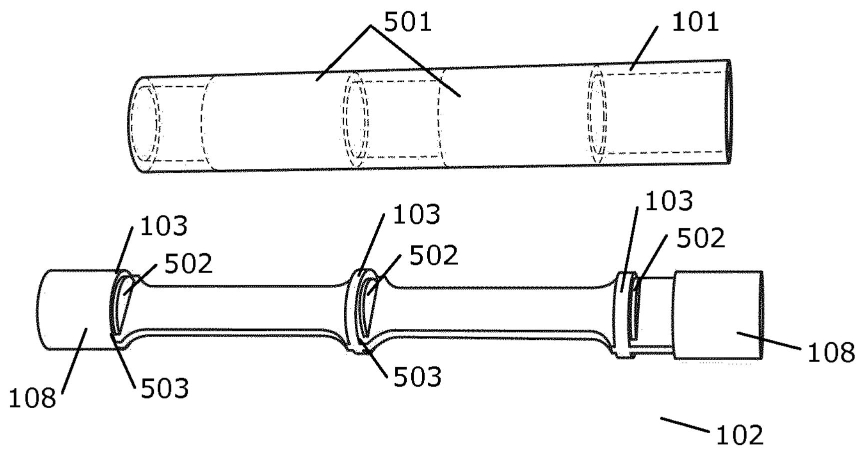


Fig. 5

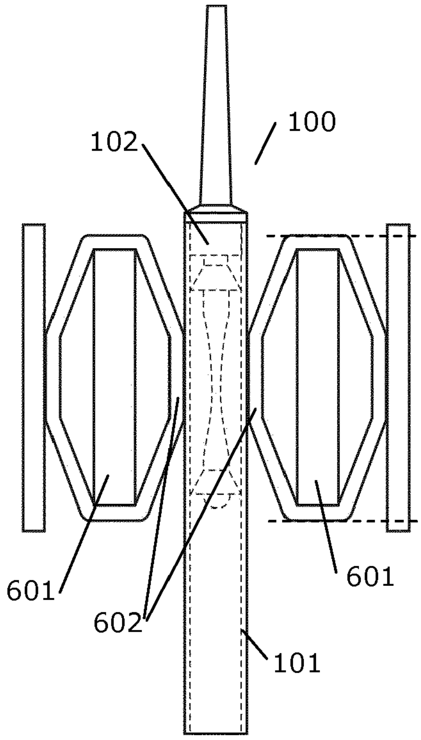


Fig. 6A

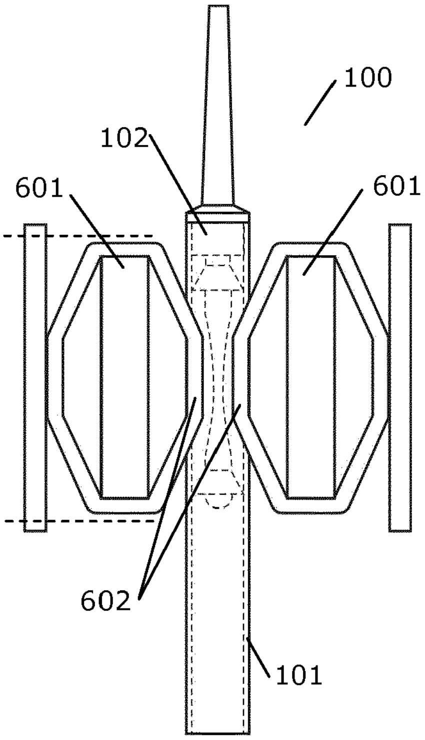
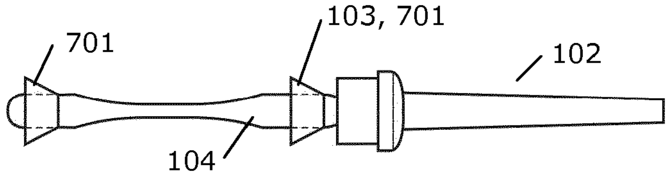


Fig. 6B

Fig. 7A



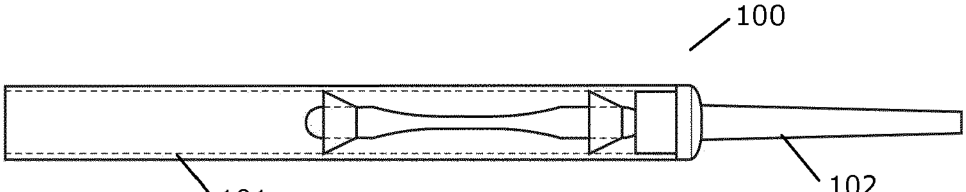


Fig. 7B

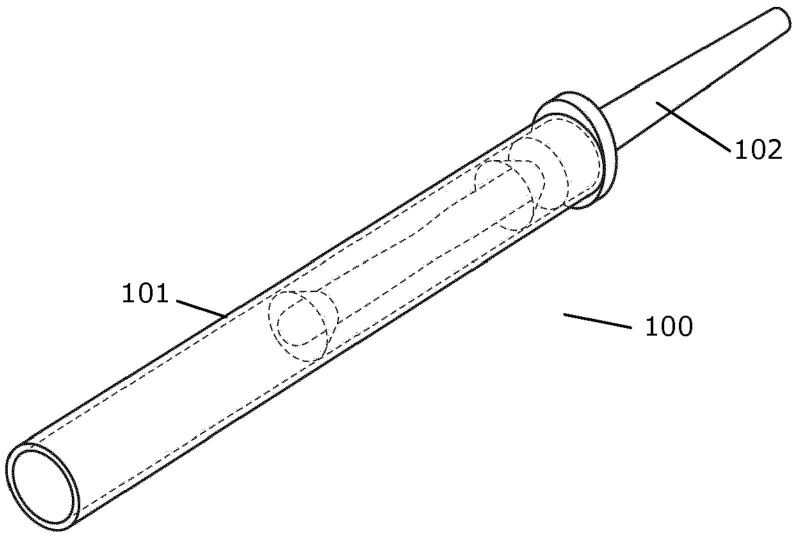


Fig. 7C

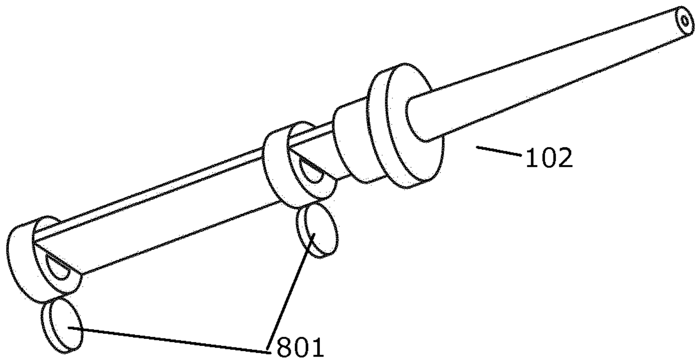


Fig. 8A

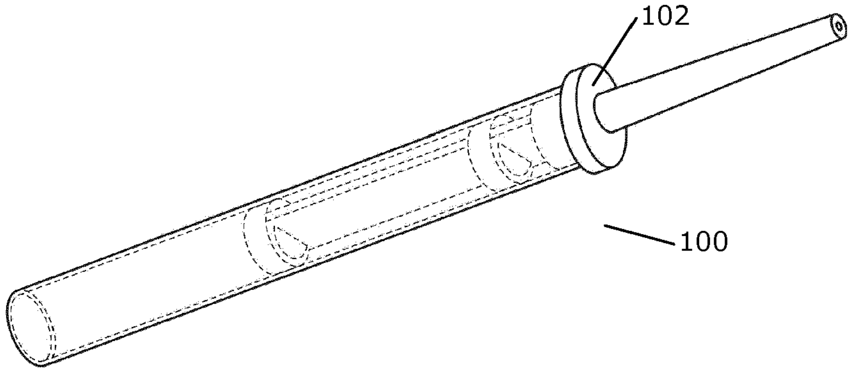


Fig. 8B

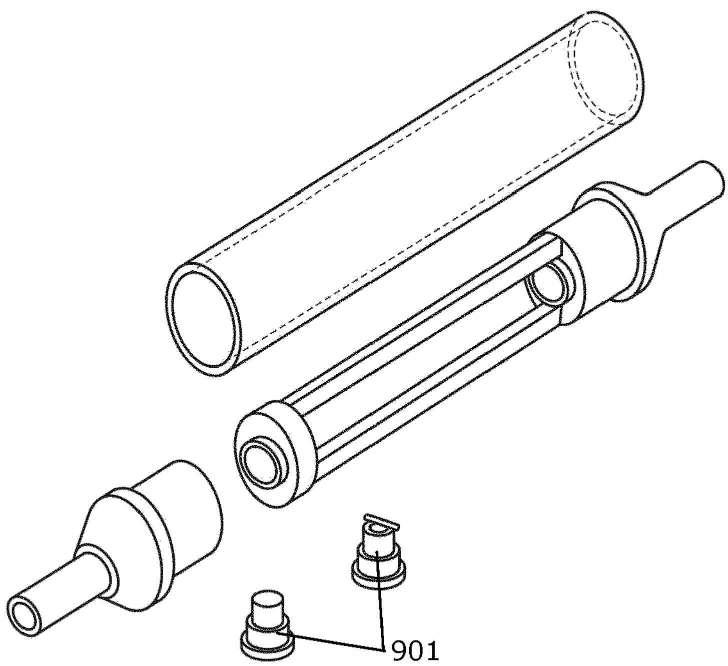


Fig. 9

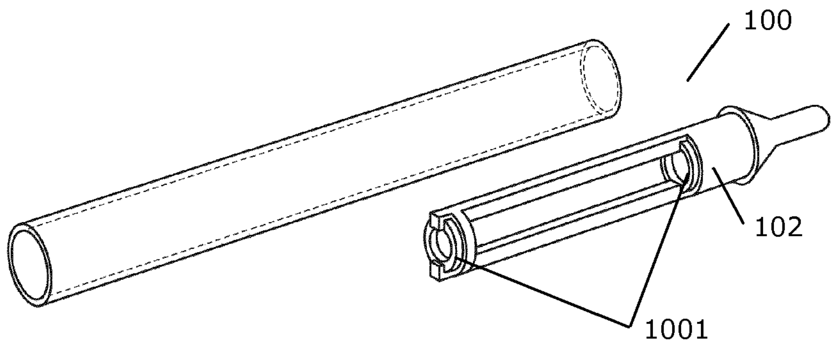


Fig. 10A

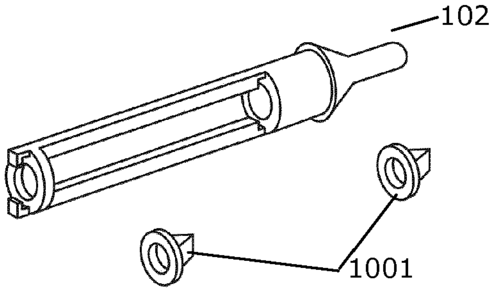


Fig. 10B

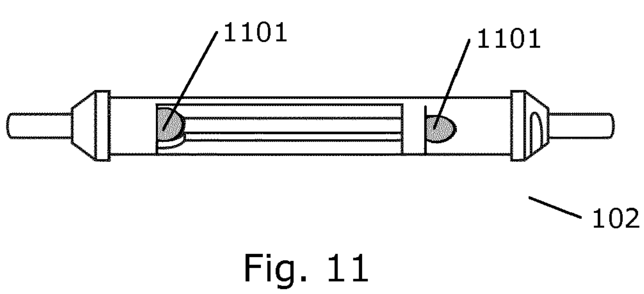


Fig. 11

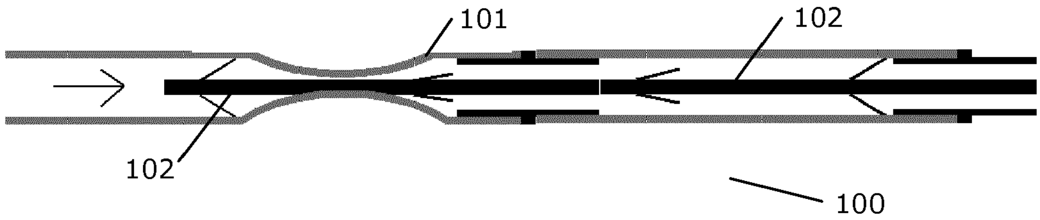


Fig. 12

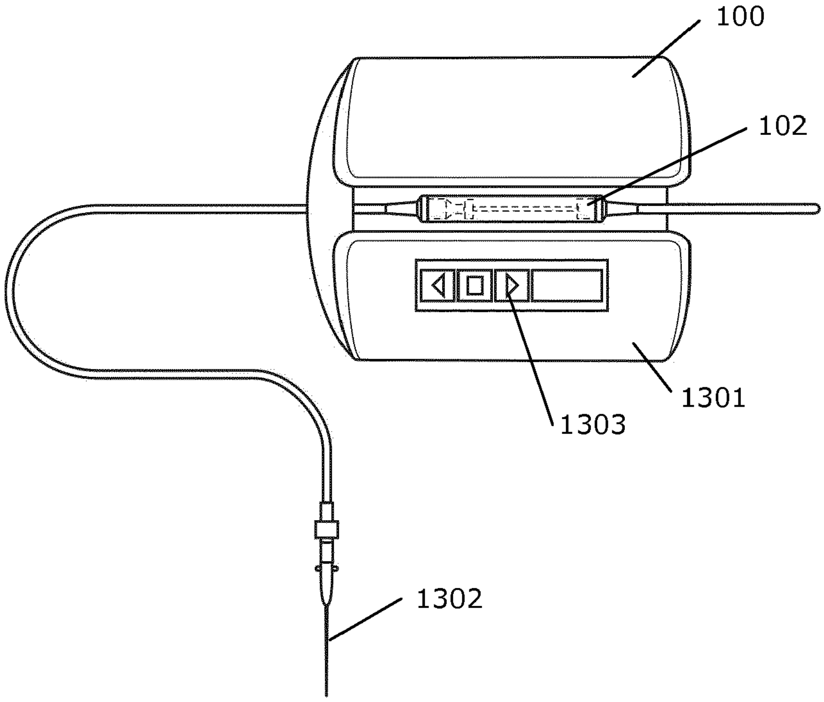


Fig. 13

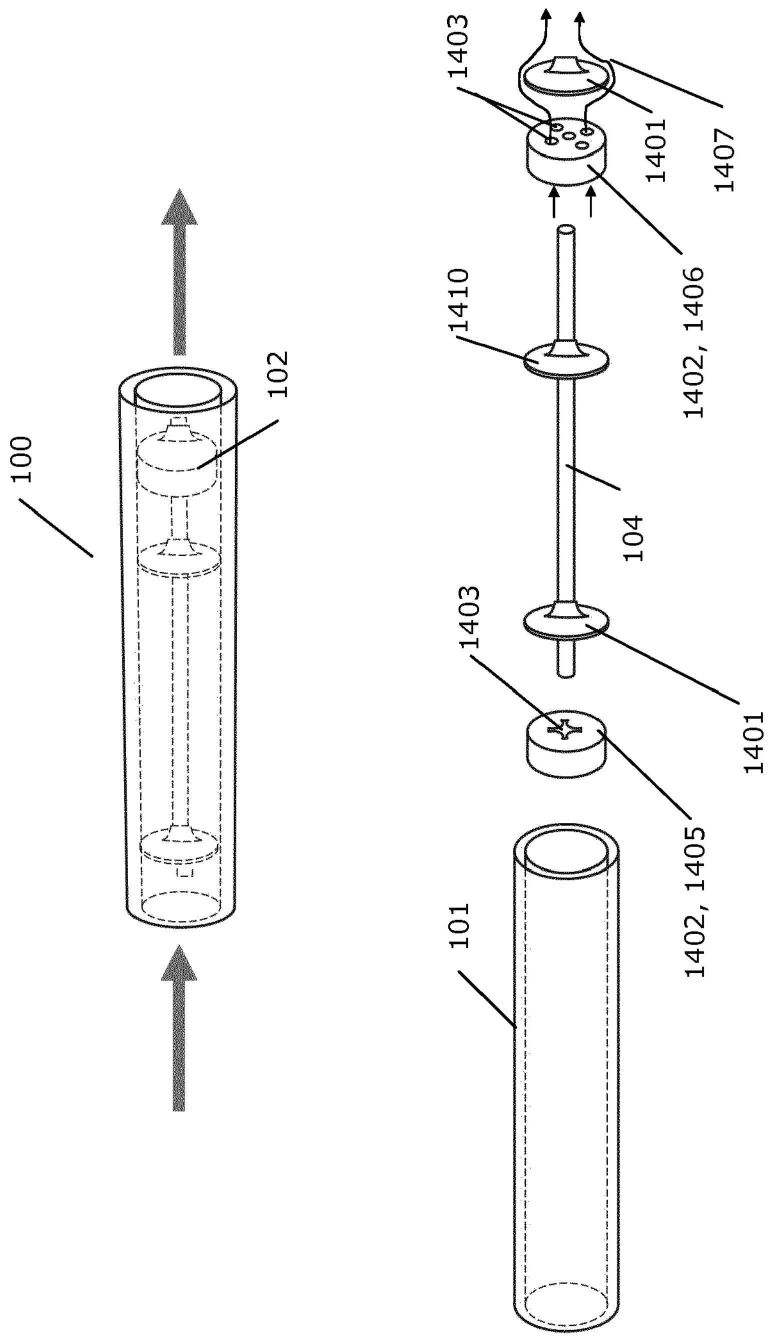
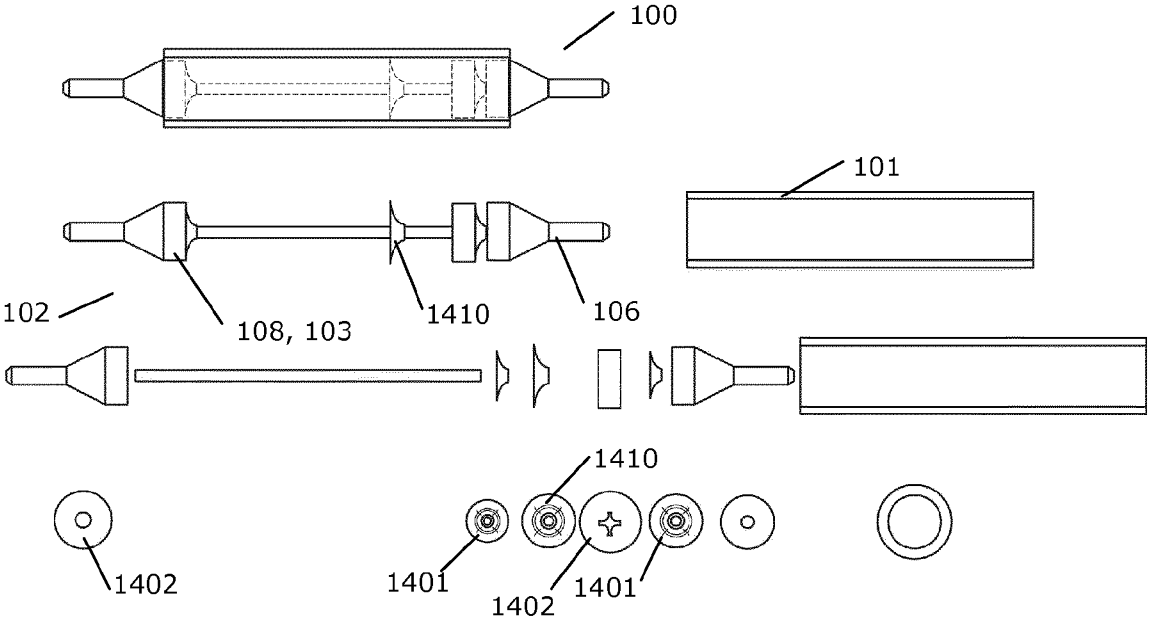

100
102
101
1402, 1405
1403
1401
104
1410
1402, 1406
1403
1401
1407

Fig. 14


100
101
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1410
106
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Fig. 15

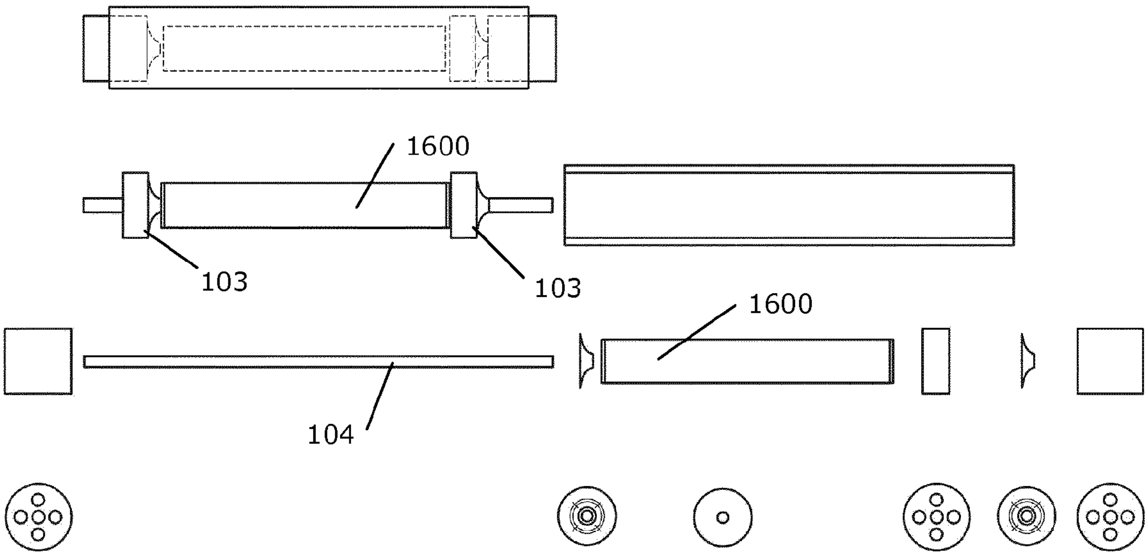
1600
103
103
1600
104

Fig. 16

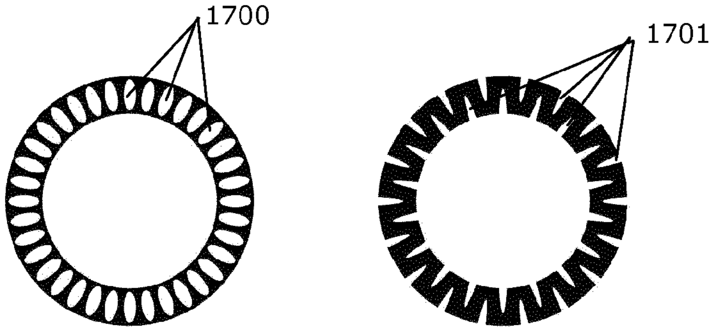

Fig. 17A

Fig. 17B

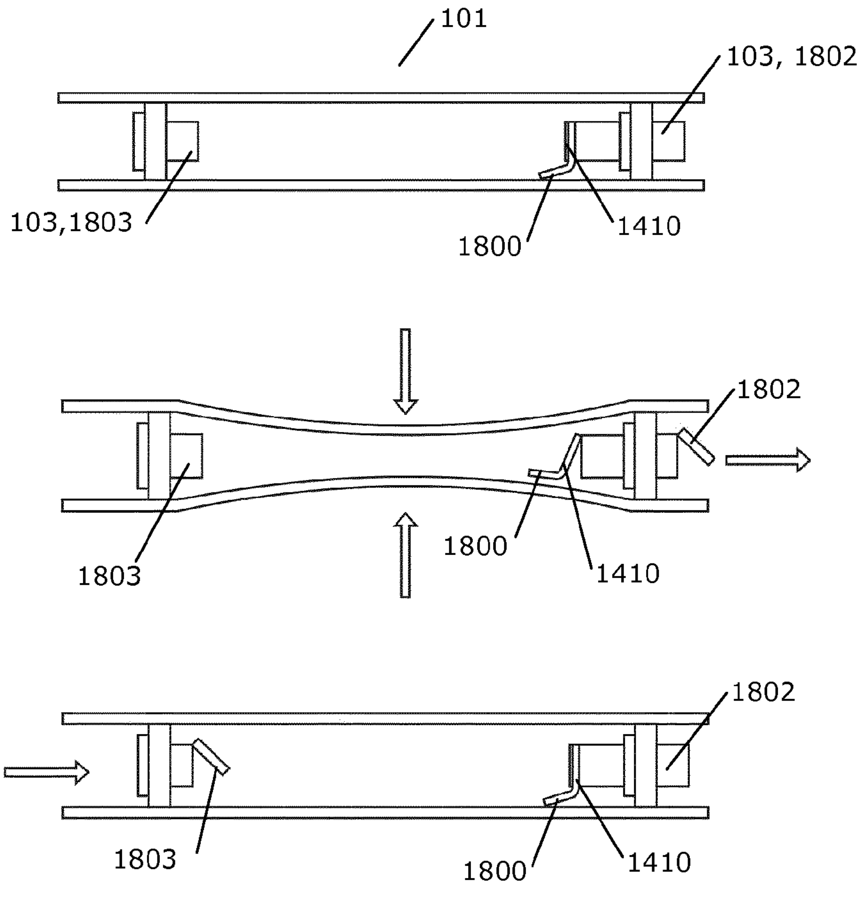

Fig. 18A

Fig. 18B

Fig. 18C

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 15 17 1185

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 5 947 167 A (BOGEN STEVEN A [US] ET AL) 7 September 1999 (1999-09-07) * figures 1,12,15 * * column 3, lines 26-37 * * column 4, line 19 - column 5, line 5 * -----	1-15	INV. F04B43/08 F04B53/10
A	US 6 092 695 A (LOEFFLER HERBERT H [US]) 25 July 2000 (2000-07-25) * figures 2a,2b * * column 5, line 33 - line 42 * * column 6, line 9 - line 28 * -----	1-15	
A	US 4 443 216 A (CHAPPELL ANTHONY G [AU]) 17 April 1984 (1984-04-17) * figures 2,3 * * column 5, line 58 - column 6, line 16 * -----	1-15	
A	US 2007/164641 A1 (PELRINE RONALD E [US] ET AL PELRINE RONALD E [US] ET AL) 19 July 2007 (2007-07-19) * paragraphs [0023], [0024], [0137]; figures 3a,3b * -----	1,13	TECHNICAL FIELDS SEARCHED (IPC)
A	US 3 289 232 A (BEACH JUSTICE H) 6 December 1966 (1966-12-06) * figures 9,10,11 * * column 1, lines 10-12 * * column 3, line 74 - column 4, line 17 * -----	1,13	F04B

The present search report has been drawn up for all claims

3

Place of search	Date of completion of the search	Examiner
Munich	30 July 2015	Richmond, Robin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 17 1185

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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30-07-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5947167 A	07-09-1999	NONE	
US 6092695 A	25-07-2000	AU 7979398 A	25-01-1999
		EP 1007974 A1	14-06-2000
		FR 2765686 A1	08-01-1999
		JP 4303795 B2	29-07-2009
		JP 2002510247 A	02-04-2002
		US 6092695 A	25-07-2000
		US 6244474 B1	12-06-2001
		WO 9901770 A1	14-01-1999
US 4443216 A	17-04-1984	AU 8227582 A	21-10-1982
		CA 1184278 A1	19-03-1985
		EP 0063727 A2	03-11-1982
		ES 8308002 A1	01-11-1983
		JP S5810185 A	20-01-1983
		NZ 200222 A	13-12-1985
		US 4443216 A	17-04-1984
		ZA 8202409 A	23-02-1983
US 2007164641 A1	19-07-2007	AT 521128 T	15-09-2011
		AU 2003225913 A1	08-10-2003
		DK 1512215 T3	05-12-2011
		EP 1512215 A1	09-03-2005
		EP 2317639 A1	04-05-2011
		JP 2005522162 A	21-07-2005
		JP 2011087460 A	28-04-2011
		JP 2011236916 A	24-11-2011
		US 7362032 B2	22-04-2008
		US 2004008853 A1	15-01-2004
		US 2006158065 A1	20-07-2006
		US 2007164641 A1	19-07-2007
		US 2010026143 A1	04-02-2010
		WO 03081762 A1	02-10-2003
US 3289232 A	06-12-1966	GB 1123438 A	14-08-1968
		US 3289232 A	06-12-1966

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82