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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.

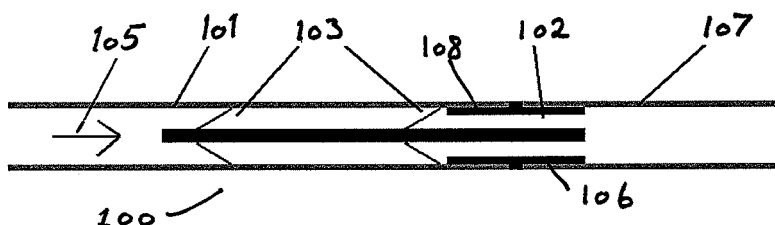


Fig. 1

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 infusionpumps.

[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] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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.

[0027] 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.

[0028] 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 repeatedly deforming the tube in several positions between sets of valve members. The tube may hereby be deformed in a peristaltic movement.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] A pump element according to the above is advantageous for the same reasons as apply to the tube pump given in the previous.

[0033] 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.

[0034] 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.

[0035] Further, because of the pump element con-

struction, 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.

[0036] 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 comprise 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.

[0037] 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.

[0038] 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.

[0039] In a further embodiment of the invention, the connecting rod is made of a bendable material such as a thermoplast (other material types?). 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.

[0040] 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.

[0041] 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 use 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.

[0042] 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 repeatedly 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.

[0043] 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

[0044] 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 view 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 con-

nection, and the coupling of two tube parts by means of a pump element, and

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

Detailed description of the drawings

[0045] 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).

[0046] 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.

[0047] 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.

[0048] 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 electroactive 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 one after the other in serial thereby generating a peristaltic pumping motion.

[0049] 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.

[0050] 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.

[0051] 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.

[0052] 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).

[0053] 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.

[0054] 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.

[0055] 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 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 claim 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 claims, 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. 5
4. A tube pump according to any of the preceding claims, where the tube is connected to a further tube via a connection part. 10
5. A tube pump according to any of the preceding claims comprising at least one actuator of an electroactive polymer material arranged for deforming said flexible tube portion when actuated. 15
6. A tube pump according to claim 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 claims comprising at least one actuator comprising a movable contact plate arranged for deforming said flexible tube portion by compressing the tube when actuated. 20
8. A tube pump according to any of the preceding claims comprising at least two pump elements placed serially. 25
9. A tube pump according to any of the preceding claims, 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. 30
10. A tube pump according to any of the preceding claims, where the valve members comprise valves placed in valve housings at least partly engaging with the inner wall of the tube. 35
11. A pump element for a tube pump according to any of claims 1-10, 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. 40
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12. A pump element according to claim 11, 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.
13. A pump element according to any of claims 11-12, where the pump element further comprises a pipe connection part configured for connecting the pump element to a further tube.
14. A pump element according to any of claims 11-13, 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.
15. A pump element according to any of claims 11-14, where the connecting rod is made of a bendable material such as a thermoplast.
16. A pump element according to any of claims 10-15, where the connecting rod is made of PE (polyethylene), PP (polypropylene), a rubber, or a metal alloy.
17. An infusion pump comprising a tube pump according to any of claims 1-10.
18. 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,
 - repeatedly 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.

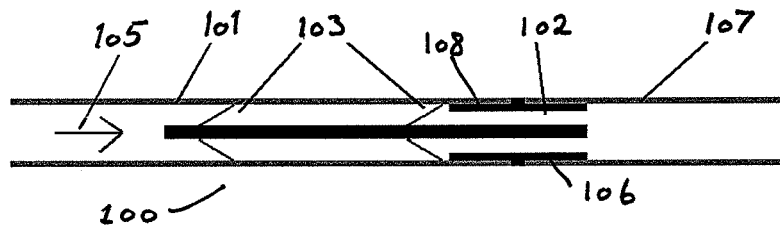


Fig. 1

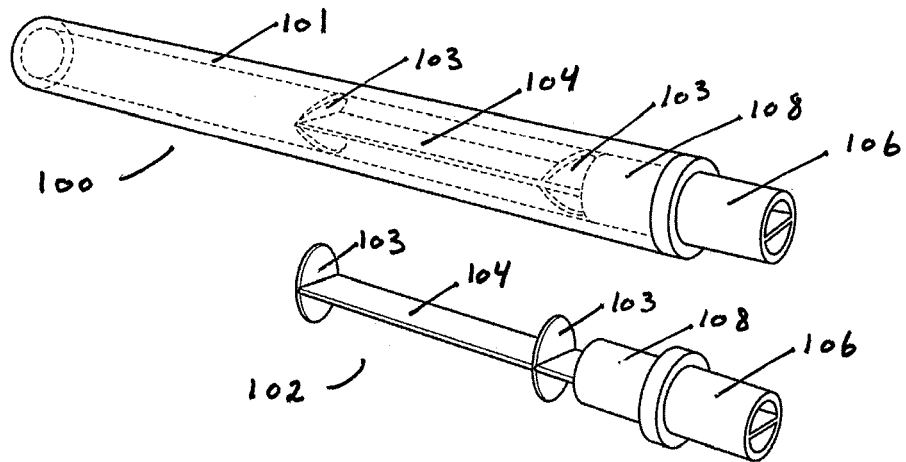


Fig. 2

Fig. 3A

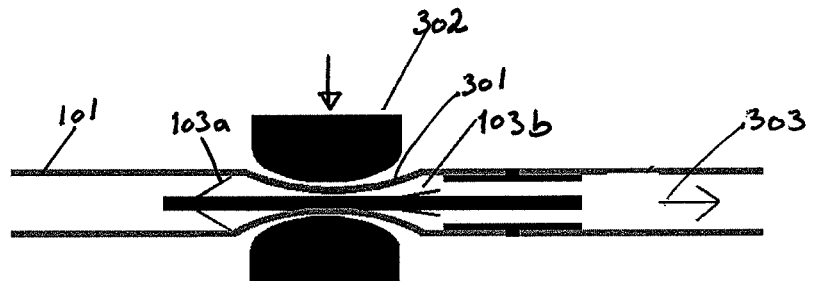


Fig. 3B

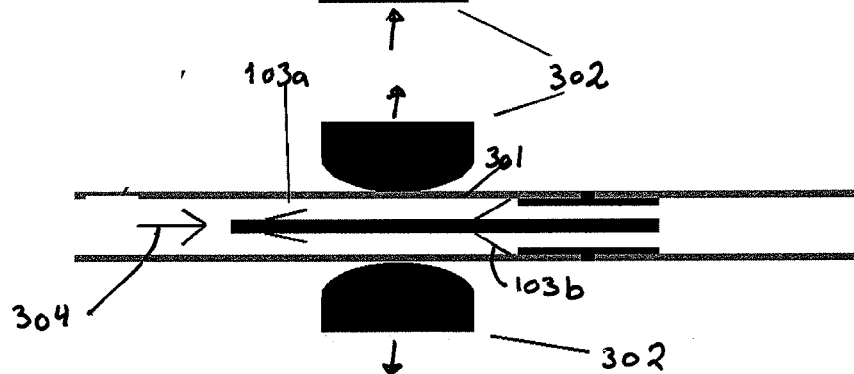


Fig. 4A

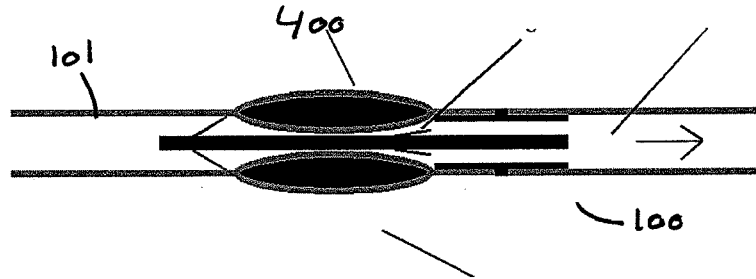


Fig. 4B

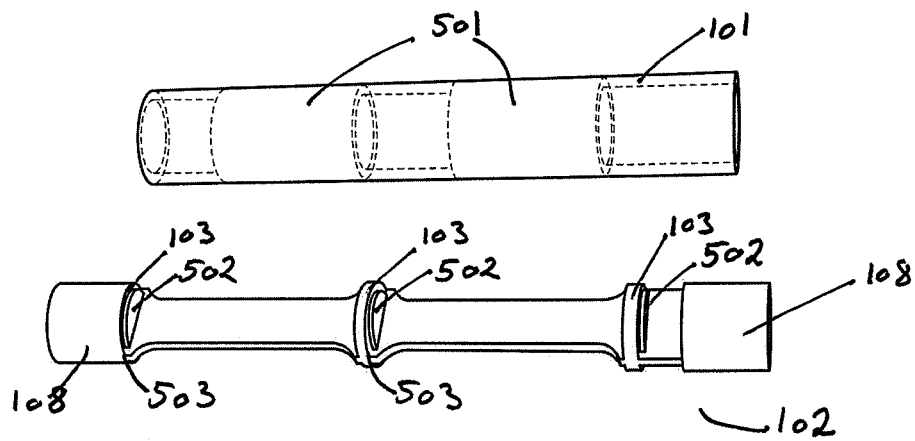
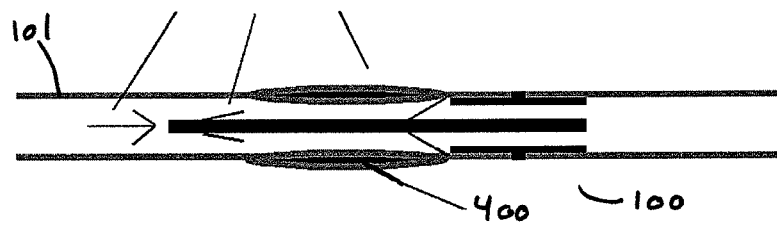


Fig. 5

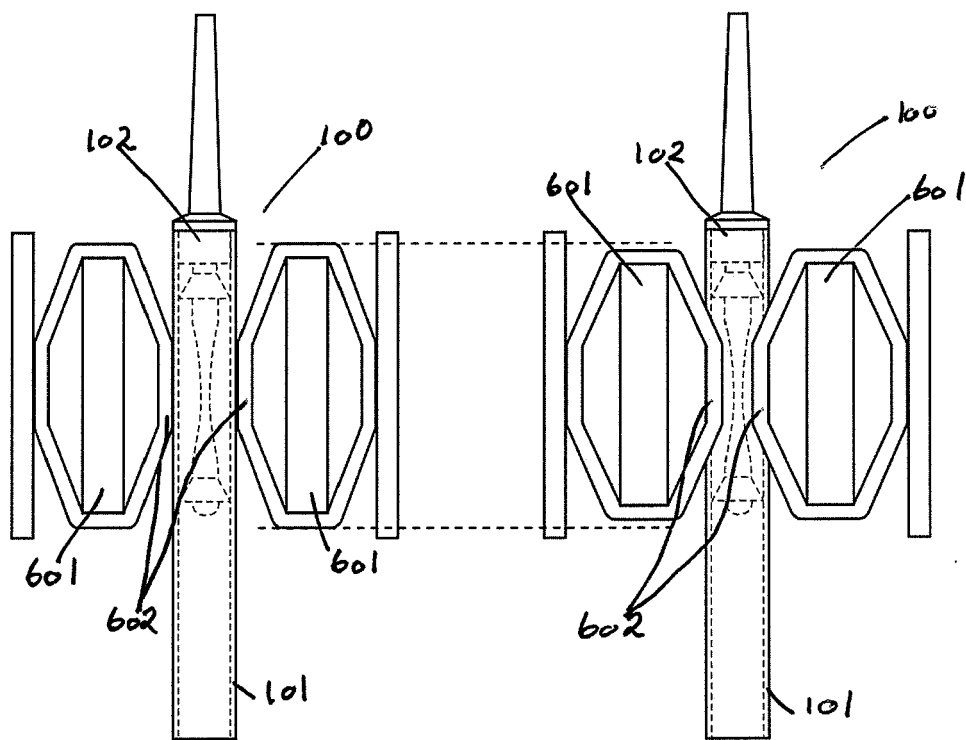


Fig. 6A

Fig. 6B

Fig. 7A

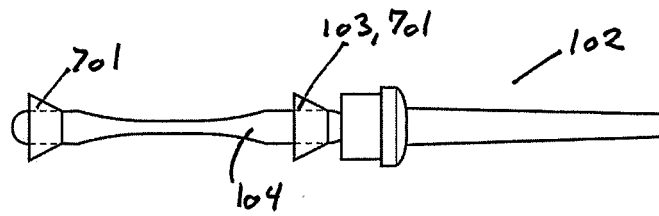


Fig. 7B

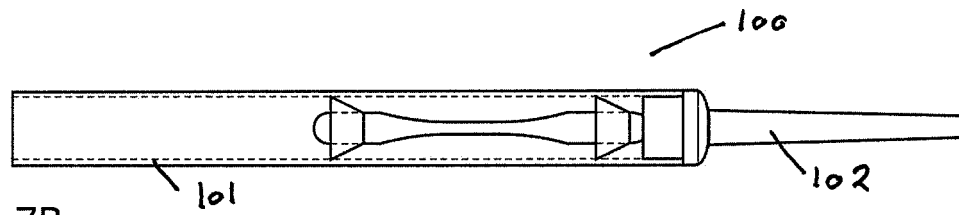
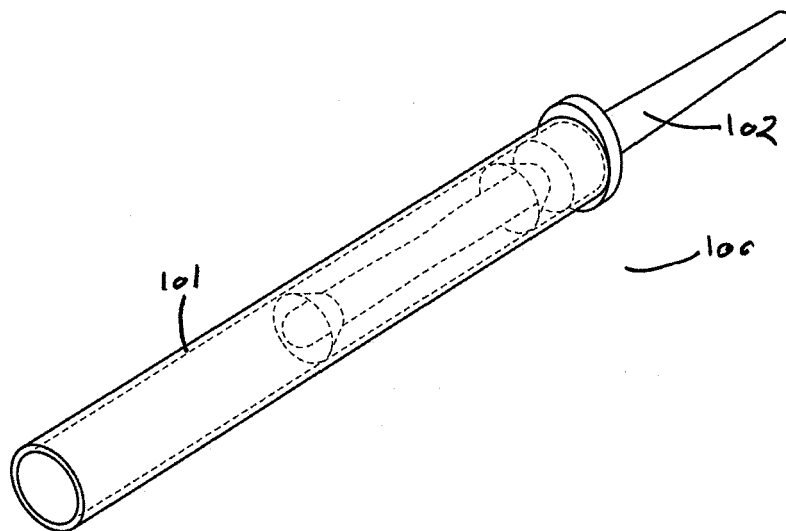


Fig. 7C



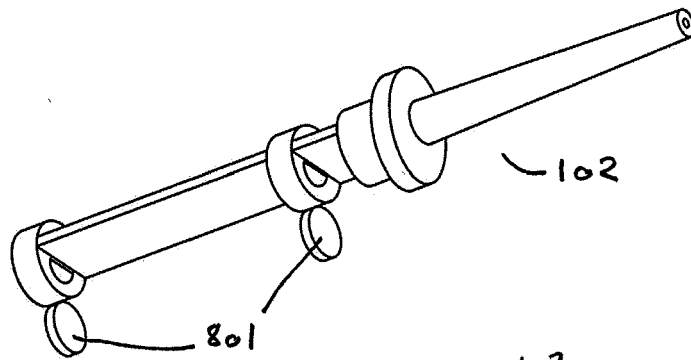


Fig. 8A

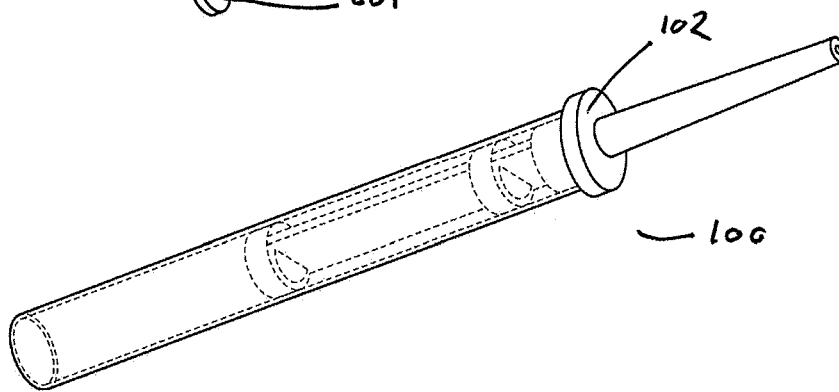


Fig. 8B

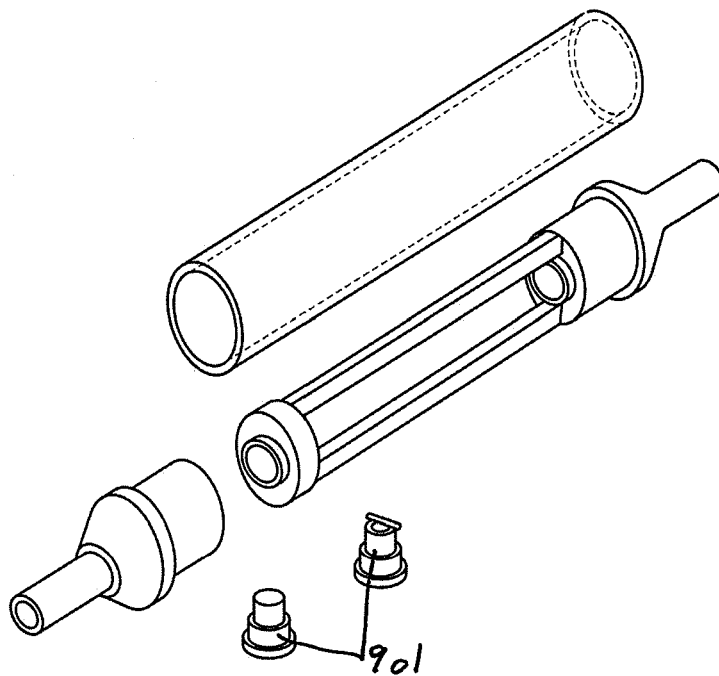


Fig. 9

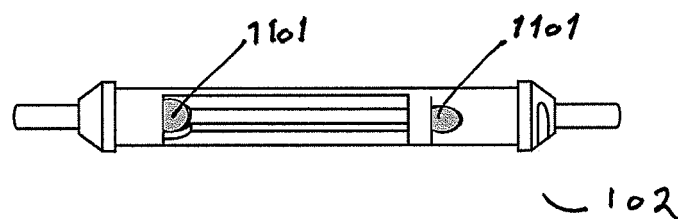
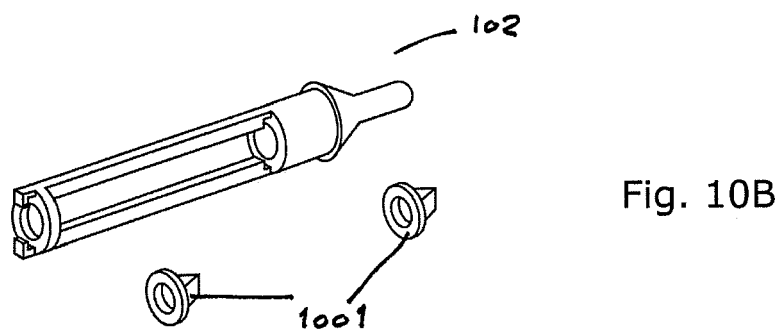
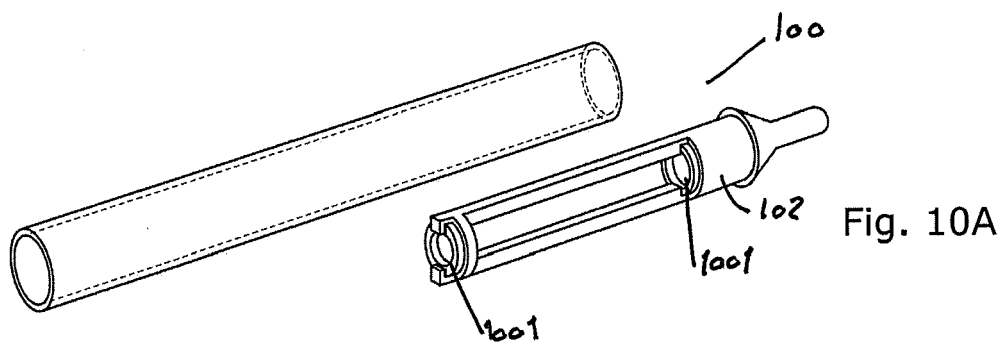


Fig. 11

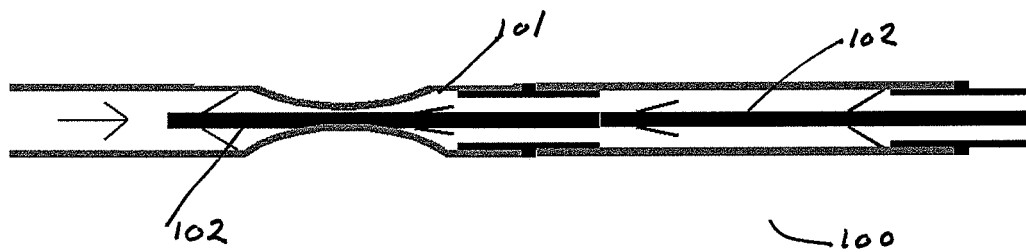


Fig. 12

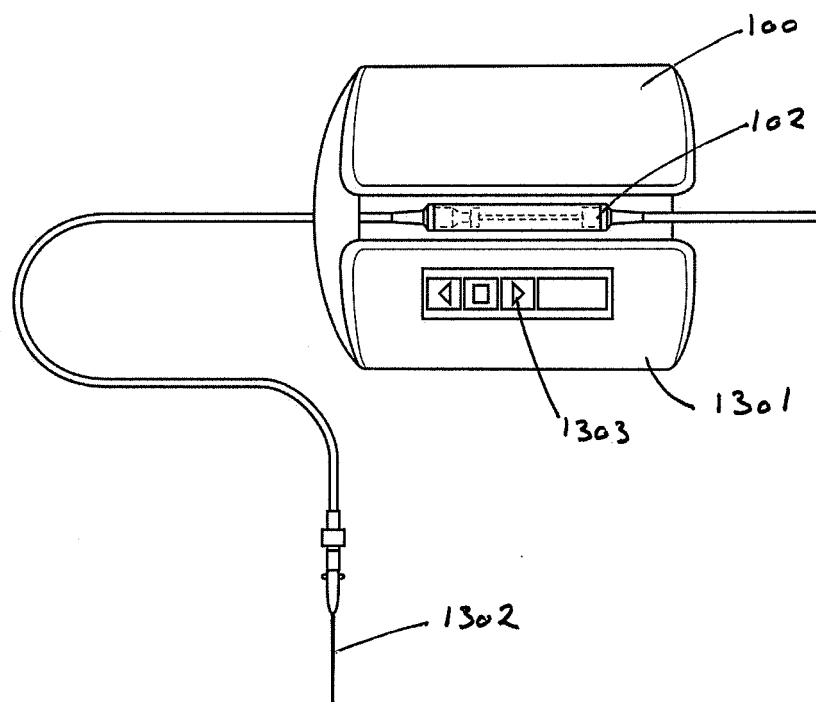


Fig. 13



EUROPEAN SEARCH REPORT

Application Number
EP 10 16 0177

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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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 * -----	1,4,7, 10,11, 14,17,18	
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Place of search Munich		Date of completion of the search 15 October 2010	Examiner 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			

2

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The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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