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(54) **POSITIVE GRIP FINGERS IN A  
PERISTALTIC PUMP**

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(76) **Inventor: Jeff LY, Vista, CA (US)**

(57)

**ABSTRACT**

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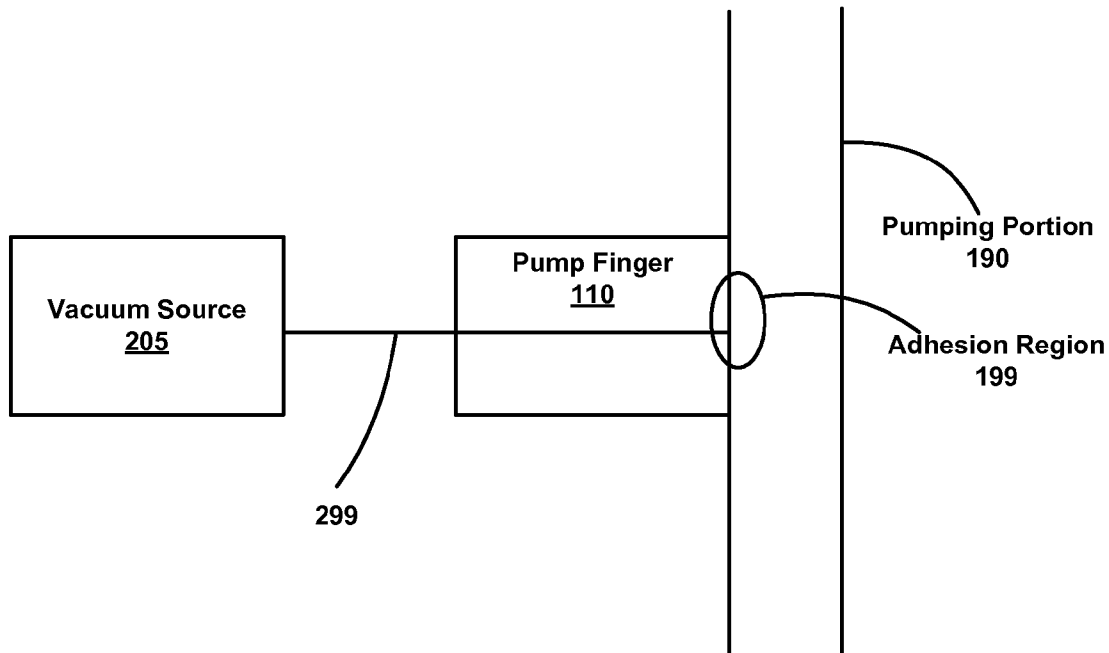
A method for enhancing peristaltic pumping in a tube type infusion pump is provided. The method includes providing an adhesion region on a pumping finger of an infusion pump for creating an adhesion between the pumping finger and a pumping segment of the infusion pump such that when the pumping finger is moved from an occluded position to an initial position the adhesion forcibly restores the pumping segment from an occluded state to a non occluded state.

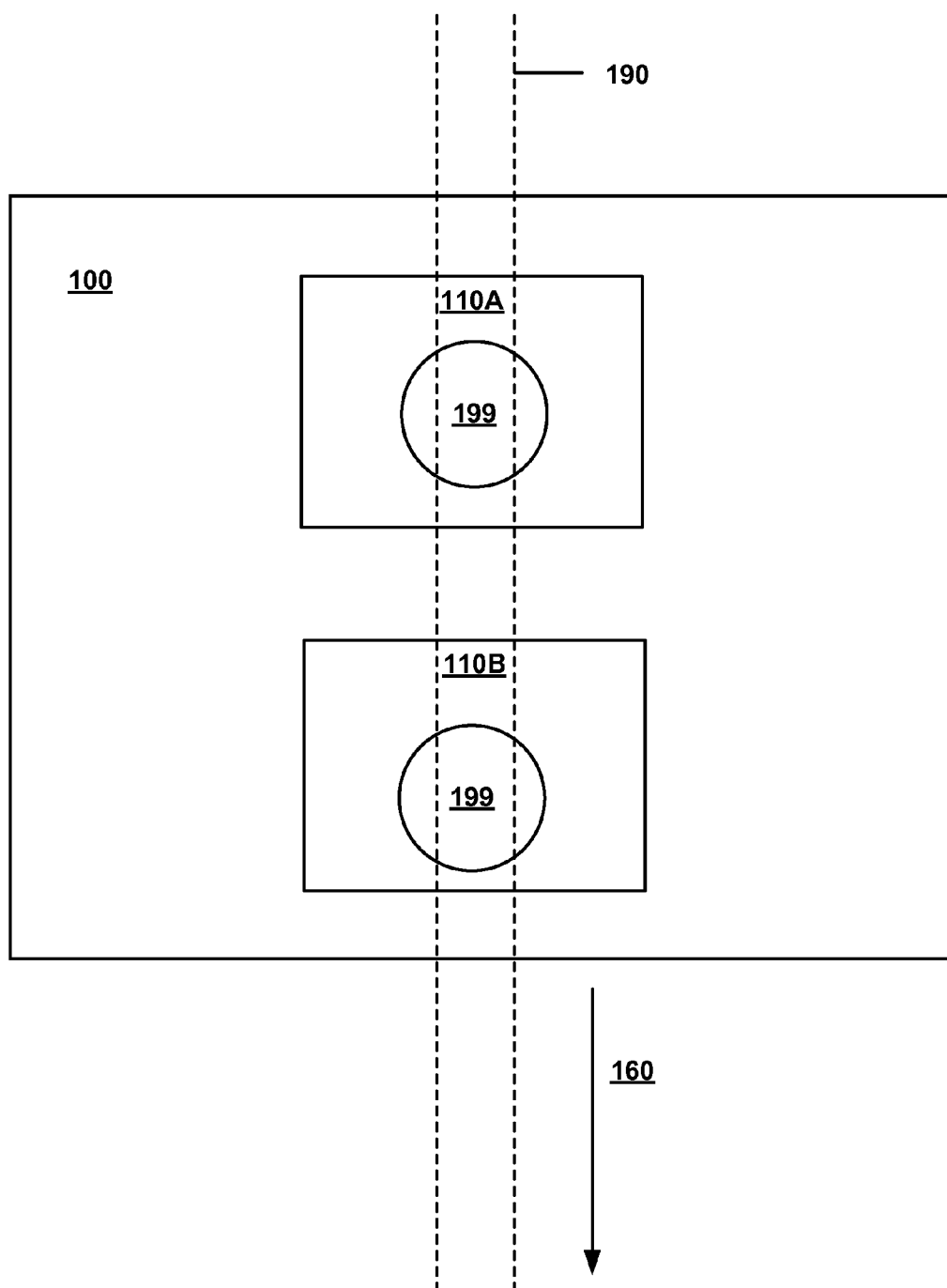
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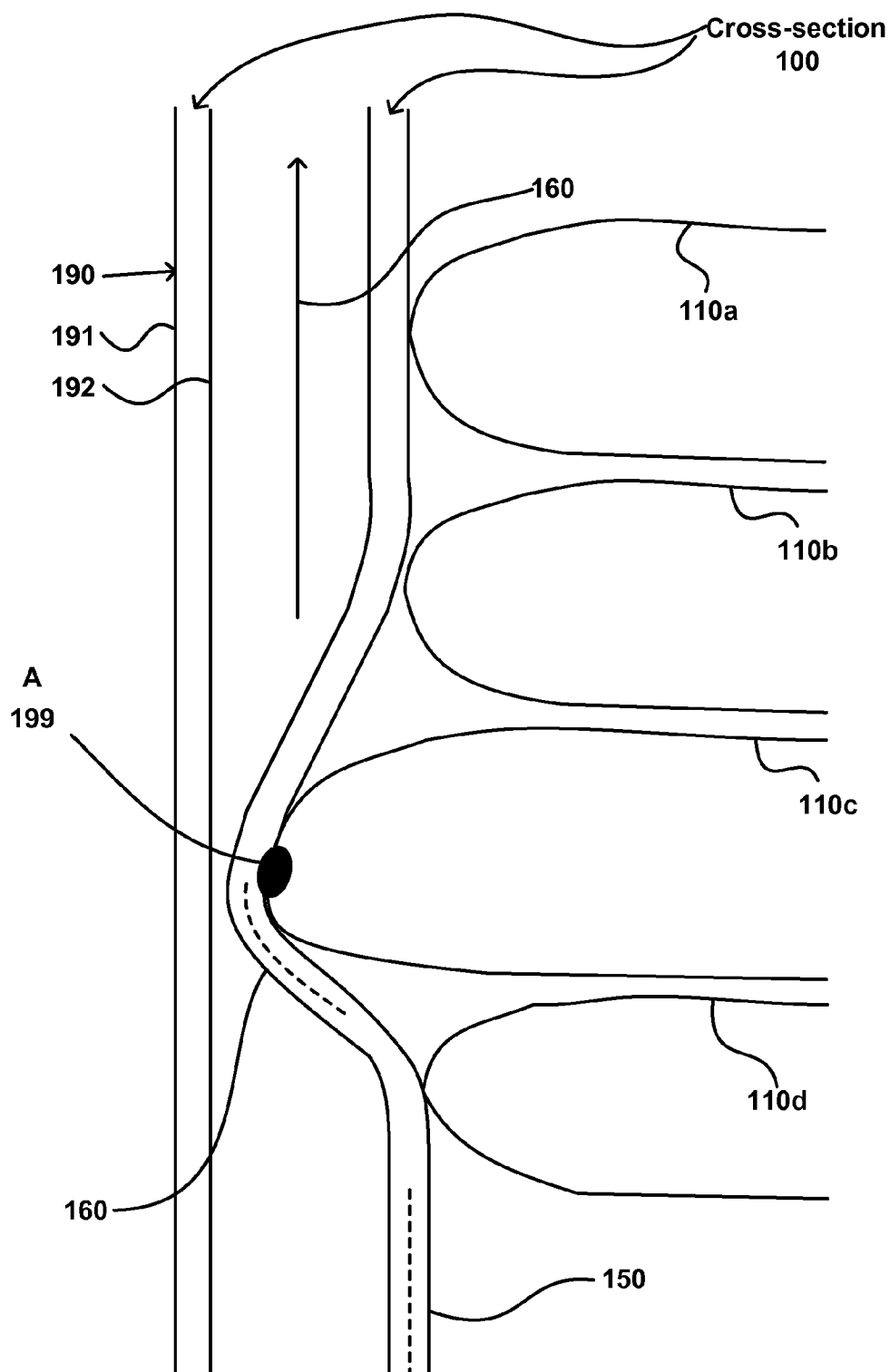
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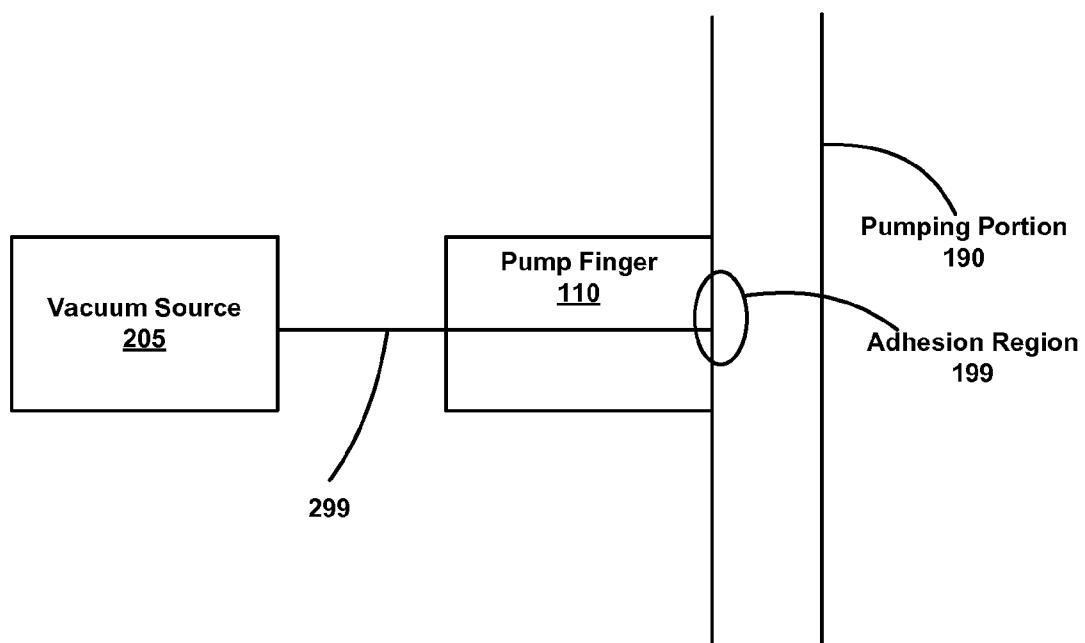




**FIG. 1A**

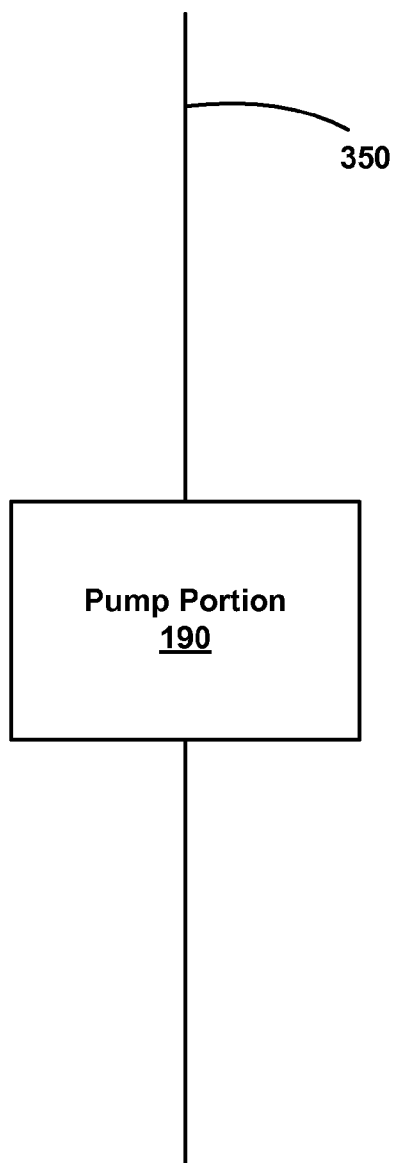


**FIG. 1B**



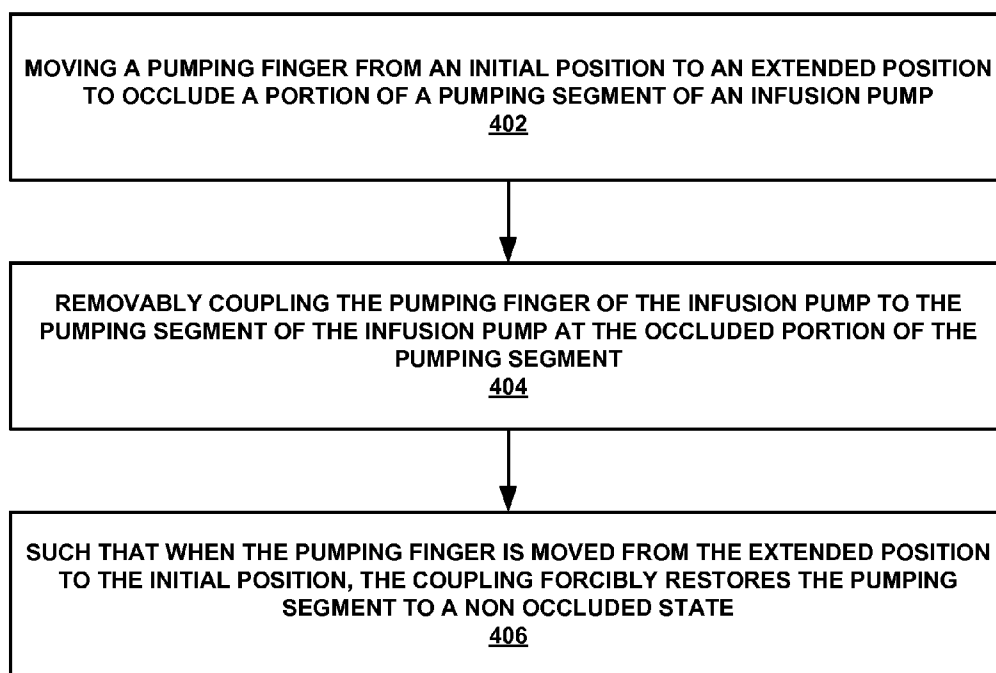
**FIG. 2**

300



**FIG. 3**

**400**



**FIG. 4**

## POSITIVE GRIP FINGERS IN A PERISTALTIC PUMP

### FIELD OF THE INVENTION

[0001] The invention relates generally to medical equipment. More particularly, the invention relates to medical pumps.

### BACKGROUND OF THE INVENTION

[0002] Peristaltic pumps are positive displacement pumps whereby a mechanical force is applied to a flexible pumping portion to move fluid in a linear direction. As the force is applied, the pumping portion closes or occludes forcing fluid to be pumped through. As the force is removed, the pumping portion opens and fluid re-enters the pumping portion.

[0003] Many times, the inner walls of the pumping portion become stuck together and the opening remains partially or fully occluded after the force is removed. The occluded line restricts or stops flow of fluids to the patient and reduces the functionality of the pump.

### SUMMARY OF THE INVENTION

[0004] Embodiments of the present invention include a method for enhancing peristaltic pumping in a tube type infusion pump. The method includes providing an adhesion region on a pumping finger of an infusion pump for creating an adhesion between the pumping finger and a pumping segment of the infusion pump such that when the pumping finger is moved from an occluded position to an initial position the adhesion forcibly restores the pumping segment from an occluded state to a non occluded state.

[0005] Embodiments of the present invention also include a peristaltic pump comprising a plurality of pumping fingers for pumping fluid in a linear direction through a pumping segment of a line set, an adhesion region on one of the plurality of pumping fingers for creating an adhesion between the pumping finger and the pumping segment such that when the pumping finger is moved from an occluded position to an initial position the adhesion forcibly restores the pumping segment from an occluded state to a non occluded state.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The features, objects and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like references identify correspondingly throughout, and wherein:

[0007] FIG. 1A shows a portion of a peristaltic pump with a positive grip pumping finger in accordance with embodiments of the present invention.

[0008] FIG. 1B shows a cross section of a portion of a peristaltic pump with a positive grip pumping finger in accordance with embodiments of the present invention.

[0009] FIG. 2 shows a vacuum source coupled with a pumping finger of a peristaltic pump in accordance with embodiments of the present invention.

[0010] FIG. 3 shows an exemplary line set with an exemplary pumping portion for use in a positive grip peristaltic pump in accordance with embodiments of the present invention.

[0011] FIG. 4 is a flow diagram of an exemplary method for positive grip peristaltic pumping in accordance with embodiments of the present invention.

### DETAILED DESCRIPTION OF EMBODIMENTS

[0012] Certain embodiments of the invention will now be described in detail with reference to the figures.

[0013] FIG. 1A shows a portion of a peristaltic pump 100 with pumping fingers 110A and 1108. It is appreciated that FIG. 1A shows in inside view of pump 100 and that a front cover portion of pump 100 is omitted from the figure. The front cover includes mating surfaces for pumping fingers 110A and 1108 such that when pumping finger 110A is moved from an initial position to an initiated position, pumping portion 190 becomes occluded by the finger and the opposing mating surface. When pumping finger 1108 is moved from an initial position to an initiated position, pumping portion 190 becomes occluded by the finger and the opposing mating surface. activating the fingers 110A and 1108 in a predetermined sequence pumps fluid in direction 160.

[0014] In one embodiment, pumping fingers 110A and 1108 comprise adhesion region 199 that provides a positive grip between the pumping fingers 110A and 1108 and the pumping portion 190 of the lumen. The adhesion region 199 pulls the lumen from an occluded state back to an initial restored state. In one embodiment, the adhesion region 199 comprises a vacuum source (not shown) that provides suction between the pumping region 190 and the pumping fingers 110A and 1108.

[0015] FIG. 1B shows a cross section of peristaltic pump 100 with a positive grip pumping finger (finger 110C) in accordance with embodiments of the present invention. Embodiments of the present invention include pump fingers 110A-110D that can provide an adhesion between the fingers 110A-110D and the pumping portion 190. In one embodiment, pumping portion 190 is part of a disposable line set. In one embodiment, any portion of a lumen can be used as a pumping portion of a peristaltic pump with the positive gripping fingers of the present invention.

[0016] The pumping portion 190 has an inner surface 192 and an outer surface 191 of the tubing. Fluid flows in direction 160 through the pumping portion 190. In conventional peristaltic pumps, the inner surface 192 of the pumping segment can stick together and occlude the pumping portion 190 after the finger 110C is retracted to initial position 150 from occluded or extended position 160.

[0017] Embodiments of the present invention prevent line occlusion and line sticking of conventional peristaltic pumps by providing an adhesion region 199 that adheres the outer surface 191 of the pumping segment 190 to the pumping finger 110C such that when the pumping finger 110C is moved from the extended position 160 to the initial position 150, the adhesion of the outer surface 191 of the pumping portion 190 with the pumping finger 110C creates a pulling force that restores the pumping segment to a non occluded state.

[0018] In one embodiment, the adhesion region 199 is created by a vacuum source (not shown) that can be disposed at the tip of pump finger 110C. In one embodiment, a vacuum line passes through the pumping finger and is disposed in a location to create adhesion between the pumping finger and the pumping portion 190.

[0019] In another embodiment, an adhesive material (disposed at region 199) is used to provide adhesion of pump finger 110C to pumping portion 190.

[0020] In one embodiment, each of fingers 110A-110D comprises an adhesion region 199. However, it is appreciated that any number of configurations can be used in accordance with the present invention where one or more adhesion regions can be used at any one finger. It is also appreciated that in one embodiment, one or more fingers may not have an adhesion region 199.

[0021] In one embodiment, the pumping segment 190 maintains contact with the pumping fingers throughout the entire pumping cycle. For example, the pump segment 190 contacts finger 110C from the occluded state 160 to the initial or non-occluded state 150. In one embodiment, the fill cycle of the pump can be controlled by changing how quickly the tube is restored from the occluded state to the non-occluded state. In one embodiment, the rate of occlusion of the line portion is determined by the position of the pump finger 110C.

[0022] FIG. 2 shows a vacuum source 205 coupled with a pumping finger 110 of a peristaltic pump in accordance with embodiments of the present invention. A vacuum line 299 couples vacuum source 205 to the adhesion region 199 that adheres the pumping finger 110 to the pumping segment 190 of the peristaltic pump. In one embodiment, the vacuum source 205 applies a constant vacuum force at adhesion region 199. However, it is also appreciated that vacuum source 205 can be configured to selectively provide vacuum at location 199, such as only when the pumping finger moves from an occluded state to an initial state, for example.

[0023] In one embodiment, vacuum line 299 includes a separate portion that passes through pump finger 110. In this embodiment, this portion of the line is permanent and can be made of a non-disposable material, such as stainless steel.

[0024] In one embodiment, the pumping portion 190 is part of a disposable line set that can be installed into the peristaltic pump.

[0025] FIG. 3 shows an exemplary line set 300 comprising lumen 350 and pumping portion 190. In one embodiment, the line set 190 is configured for use in the positive grip peristaltic pump of the present invention. In one embodiment, the pumping portion 190 of line set 300 is configured to adhere to a pumping finger of the positive grip peristaltic pump of the present invention. In one embodiment, line set 300 is disposable. In another embodiment, line set 300 is made from a single line whereby pumping portion 190 comprises the same material as lumen 350. In another embodiment, pumping portion 190 is separable from lumen 350.

[0026] It is appreciated that the pumping portion 190 can be any portion of line set 300.

[0027] FIG. 4 is a flow diagram of an exemplary method 400 for positive grip peristaltic pumping in accordance with embodiments of the present invention.

[0028] At 402, 400 includes moving a pumping finger from an initial position to an extended position to occlude a portion of a pumping segment of an infusion pump. It is appreciated that adhesion between the pumping finger and the pump segment may or may not occur at 402.

[0029] At 404, 400 includes removably coupling the pumping finger of the infusion pump to the pumping segment of the infusion pump at the occluded portion of the pumping segment. It is appreciated that the coupling of the pump finger

with the pumping segment can occur at any point in process 400, whether the pumping fingers move to create flow of fluid in the tubing.

[0030] In one embodiment, the steps of 400 can occur in any order. For example, in one embodiment, 404 is performed prior to 402. In another embodiment, 402 and 404 are performed simultaneously.

[0031] At 406, 400 includes such that when the pumping finger is moved from the extended position to the initial position, the coupling between the pumping segment and the pumping finger forcibly restores the pumping segment to a non occluded state.

[0032] In one embodiment, the coupling of the pumping finger with the pumping segment includes applying a vacuum source to the pumping segment. In one embodiment, the coupling between the pumping segment and the pumping finger is maintained through steps 402, 404, and 406.

[0033] In one embodiment, the coupling of the pumping finger with the pumping segment includes applying an adhesive material between the pumping segment and the pumping finger.

## CONCLUSION

[0034] Thus, those of skill in the art will appreciate that the positive grip pump fingers of the present invention reduces lumen occlusion, improves patient safety and reduces costs.

[0035] One skilled in the art will appreciate that the positive grip pump fingers may be adapted to carry out the objects and obtain the ends and advantages mentioned, as well as those inherent therein. The methods, procedures, and devices described herein are presently representative of embodiments and are exemplary and are not intended as limitations on the scope of the invention. Changes therein and other uses will occur to those skilled in the art which are encompassed within the spirit of the invention and are defined by the scope of the disclosure.

[0036] It will be apparent to one skilled in the art that varying substitutions and modifications may be made to the invention disclosed herein without departing from the scope and spirit of the invention.

[0037] Those skilled in the art recognize that the aspects and embodiments of the invention set forth herein may be practiced separate from each other or in conjunction with each other. Therefore, combinations of separate embodiments are within the scope of the invention as disclosed herein.

[0038] The invention illustratively described herein suitably may be practiced in the absence of any element or elements, limitation or limitations which is not specifically disclosed herein. Thus, for example, in each instance herein any of the terms "comprising", "consisting essentially of" and "consisting of" may be replaced with either of the other two terms. The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention that in the use of such terms and expressions indicates the exclusion of equivalents of the features shown and described or portions thereof. It is recognized that various modifications are possible within the scope of the invention disclosed. Thus, it should be understood that although the present invention has been specifically disclosed by embodiments and optional features, modification and variation of the concepts herein disclosed may be resorted to by those skilled in the art, and that such modifications and



variations are considered to be within the scope of this invention as defined by the disclosure.

What is claimed is:

1. A method for positive grip peristaltic pumping in a tube type infusion pump, said method comprising:

providing an adhesion region on a pumping finger of said infusion pump for creating an adhesion between said pumping finger and a pumping segment of said infusion pump; and

such that when said pumping finger is moved from an occluded position to an initial position said adhesion forcibly restores said pumping segment from an occluded state to a non occluded state.

2. The method of claim 1 further comprising:

coupling an infusion line set with said infusion pump wherein said infusion set comprising said pumping segment.

3. The method of claim 1 wherein said adhesion region comprises a vacuum source.

4. The method of claim 1 wherein said adhesion pulls on an outer surface of said pumping segment to restore said pumping segment from said occluded state to said non occluded state.

5. The method of claim 1 wherein said providing an adhesion region comprises:

applying an adhesive between said pumping segment and said pumping finger.

6. A method for positive grip peristaltic pumping in a tube type infusion pump, said method comprising:

moving a pumping finger from an initial position to an extended position to occlude a portion of a pumping segment of said infusion pump;

removably coupling said pumping finger of said infusion pump to said pumping segment of said infusion pump at said occluded portion of said pumping segment; and

such that when said pumping finger is moved from said extended position to said initial position, said coupling forcibly restores said pumping segment to a non occluded state.

7. The method of claim 6 wherein said removably coupling comprises:

applying a vacuum force to couple said pumping segment to said pumping segment.

8. The method of claim 6 wherein said removably coupling comprises:

applying an adhesive between said pumping segment and said pumping finger.

9. The method of claim 6 further comprising:

coupling an infusion line set with said infusion pump wherein said infusion set comprising said pumping segment.

10. The method of claim 1 wherein said adhesion pulls on an outer surface of said pumping segment to restore said pumping segment from said occluded state to said non occluded state.

11. A positive grip peristaltic pump comprising:

a pump comprising a plurality of pumping fingers for pumping fluid in a linear direction through a pumping segment of a line set;

an adhesion region on one of said plurality of pumping fingers for creating an adhesion between said pumping finger and said pumping segment; and

such that when said pumping finger is moved from an occluded position to an initial position said adhesion forcibly restores said pumping segment from an occluded state to a non occluded state.

12. The positive grip peristaltic pump of claim 11 wherein said adhesion region comprises a vacuum force.

13. The positive grip peristaltic pump of claim 11 wherein said adhesion region comprises an adhesive.

14. The positive grip peristaltic pump of claim 11 wherein said pumping finger comprises a vacuum source.

15. A line set for use in a peristaltic pump comprising:

one or more lines configured for administering fluids to a patient;

one or more pumping segments coupled with said lines configured to adhere to an adhesion region on a pumping finger of an infusion pump such that when said pumping finger is moved from an occluded position to an initial position said adhesion forcibly restores said pumping segment from an occluded state to a non occluded state.

16. The line set of claim 15 wherein said pumping segment is configured to adhere to a vacuum source of said pumping finger.

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