

(19) **DANMARK**



Patent- og
Varemærkestyrelsen

(12)

Oversættelse af europæisk patentskrift

(10) **DK/EP 2852761 T3**

-
- (51) Int.Cl.: **F 04 B 43/12 (2006.01)** **A 61 M 5/142 (2006.01)** **F 04 B 43/00 (2006.01)**
F 04 B 43/08 (2006.01) **F 04 B 49/06 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2016-07-25**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2016-04-06**
- (86) Europæisk ansøgning nr.: **13730290.7**
- (86) Europæisk indleveringsdag: **2013-05-21**
- (87) Den europæiske ansøgnings publiceringsdag: **2015-04-01**
- (86) International ansøgning nr.: **FR2013051100**
- (87) Internationalt publikationsnr.: **WO2013175115**
- (30) Prioritet: **2012-05-23 FR 1254691**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
- (73) Patenthaver: **Physidia, 39 Boulevard de la Romanerie, 49124 Saint-Barthelemy-d'Anjou, Frankrig**
- (72) Opfinder: **FERME, Philippe, 4 rue des Cerisiers, F-49124 Le Plessis Grammoire, Frankrig**
MARINE, Julien, 50 rue Eblé, F-49000 Angers, Frankrig
VINCENT, Eric, 8 rue des Chaffauds, F-49000 Angers, Frankrig
- (74) Fuldmægtig i Danmark: **RWS Group, Europa House, Chiltern Park, Chiltern Hill, Chalfont St Peter, Bucks SL9 9FG, Storbritannien**
- (54) Benævnelse: **LINEÆR PERISTALTISK PUMPE**
- (56) Fremdragne publikationer:
EP-A1- 0 837 242
BE-A- 685 301
FR-A1- 2 594 496
GB-A- 953 579
GB-A- 2 230 301
US-A- 4 617 014
US-A1- 2006 228 240
US-A1- 2010 106 082

DESCRIPTION

The present invention generally relates to peristaltic pumps.

5 The invention relates more particularly to a peristaltic pump, for example for a dialysis machine, on the one hand comprising a plate, called pump body, that comprises a substantially planar surface against which a flexible fluid passage tube is intended to be positioned, and on the other hand, a system for
10 applying force comprising a plurality of bearing members, such as rollers, and means for driving the movement of said bearing members making it possible to move said bearing members against the tube to deform it against said pump body.

15 It has been observed that with certain peristaltic pumps the flexible tube is not able to be sufficiently clamped between the pump body and the force application system, which does not permit the fluid to circulate through the tube at a sufficient flow rate and/or regularity. Conversely, with other pumps, the
20 flexible tube is clamped too tightly between the pump body and the force application system which may also impede the circulation of the fluid and damage the tube.

Pumps comprising a support part for a fluid passage tube which
25 is movable relative to a force application system are also disclosed in the documents GB 2.230.301, GB 953.579, BE 685.301 and EP 0.837.242. The movement permitted between the support part for the fluid passage tube and the force application system serves to clear a passage for the
30 introduction of the tube or to reduce or increase the contact surface area between the force application system and the tube in order to reduce or increase the flow rate of fluid through the tube. However, the relative positioning between the pump body and the force application system remains difficult to
35 implement reliably, accurately and repeatedly. Moreover, such pumps do not prevent the relative positioning between the pump body and the application system from being poorly adapted to the tube, thus leading to the risk of damaging the tube. The

document FR 2.594.496 relates to a fluid transfer pipe having an intermediate part comprising a section which is wider and a wall having a thickness which is, in particular, smaller and a resistance to deformation which is lower than that of the
5 other parts of said pipe.

The object of the present invention is to propose a peristaltic pump permitting the aforementioned problems to be remedied.

10

To this end, the subject of the invention is a peristaltic pump, for example for a dialysis machine, on the one hand comprising a plate, called pump body, that comprises a substantially planar surface against which a flexible fluid
15 passage tube is intended to be positioned, and on the other hand, a system for applying force comprising a plurality of bearing members, such as rollers, and means for driving the movement of said bearing members making it possible to move said bearing members against the tube to deform it against
20 said pump body, said pump body being mounted so as to be able to move relative to the force application system between a position separated from said force application system, and a position close to said force application system,

25 characterized in that said pump comprises means for determining a property representative of the force applied on the tube, in the state of said tube positioned between the force application system and the pump body,

30 and in that said pump also comprises means for controlling the movement of the pump body relative to the system as a function of said determined property.

Said determined force corresponds to the clamping force to
35 which the tube clamped between the force application system and said pump body is subjected when one is moved toward the other. Taking into account this force applied to the tube in order to control the movement of the pump body relative to the

force application system permits the pump body to pass from a position separated from the force application system, in which the flexible tube may be freely positioned in order to introduce it easily into the pump, to a close position in which the tube is clamped with a clamping force which is automatically adapted by measuring the force applied to the tube, so that said clamping force is sufficient in order to permit the force application system to deform it and thus to circulate the fluid efficiently, whilst being limited so as not to damage the tube. Said measured force is in principle transverse, preferably orthogonal, relative to the axis of the tube. Advantageously, this measurement of force is carried out in the absence of the circulation of fluid through the pipe, i.e. when the elements of the force application system which serve to circulate the fluid, for example rolls, have stopped (relative to one another).

Said force is measured at a given frequency until the setpoint value or a value contained in a given range around the setpoint value is reached, so as to be able to control the relative movement of the pump body in relation to the force application system substantially in real time.

The choice of measuring the clamping force to control the movement of the pump body relative to the force application system is particularly advantageous in order to ensure a sufficient flow rate of fluid through the tube, whilst reducing the risk of damaging the tube, since due to this applied force parameter, the same degree of clamping may be obtained in an accurate, reliable and repeatable manner for tubes of different diameter or material.

In particular, the control of the movement of the pump body as a function of the clamping force applied to the tube permits the clamping force of the tube to be automatically adapted in order to reach a setpoint value so that said force is sufficient to permit the force application system to deform the tube, and thus to circulate the fluid efficiently, whilst

being limited so as not to damage the tube and permit an efficient circulation of the fluid.

Such a design of the pump facilitates the positioning of the
5 tube, for example a single-use blood line, in the pump body.

According to an advantageous feature of the invention, said pump body is mounted translatably in a direction transverse, preferably orthogonal, to said planar surface of the pump
10 body.

According to an advantageous feature of the invention, said pump comprises motor means for driving the movement of said pump body between said closed position and said separated
15 position.

According to an advantageous feature of the invention, said control means comprise means for defining a setpoint value of said property, and regulating means configured to regulate the
20 movement of the pump body in a direction bringing the force application system closer or further away based on the determined value of said property to achieve said setpoint value.

25 According to an advantageous feature of the invention, said means for determining a property representative of the force applied on the tube comprise at least one strain gauge, preferably a plurality of strain gauges.

30 According to an advantageous feature of the invention, said means for driving the movement of the bearing members comprise a loop element that connects the bearing members to one another, and two rotating rolls, positioned inside and at opposite ends of said element, at least one of the rolls being
35 motorized to drive the movement of the loop element around said rolls.

According to an advantageous feature of the invention, said

pump comprises a frame in which the system and the pump body are housed and the pump body is mounted movably relative to said frame.

5 According to an advantageous feature of the invention, said pump comprises a frame in which the system and the pump body are housed, and said pump comprises a membrane which in the state of the tube inserted between the force application system and the pump body, extends around the peripheral wall
10 of said tube to form, in cooperation with a wall of the frame, a protective housing around said tube.

The sealed flexible membrane permits the interior of the pump to be insulated relative to the tube, which permits soiling of
15 the inside of the machine to be avoided in the case of leakage. Moreover, the sealed flexible membrane also improves the sound insulation of the pump.

According to an advantageous feature of the invention, said
20 membrane is made from a liquid-tight flexible material.

The invention will be understood clearly from reading the following description of exemplary embodiments with reference to the accompanying drawings, in which:

25

- figure 1 is a schematic view of a linear peristaltic pump according to an embodiment of the invention;

- figure 2 is a perspective view of the interior of a part of
30 the pump of figure 1;

- figure 3 is a perspective view of a sealed membrane designed to surround the tube introduced into the pump of figure 1;

35 - figure 4 is a perspective view of the pump body and the force application system of the pump of figure 1 in the position separated from one another for the insertion of said tube;

- figure 5 is a perspective view of the pump body and the force application system of the pump of figure 1 in the position moved closer to the other.

5

With reference to the figures and as mentioned above, the invention relates to a linear peristaltic pump 1 for a dialysis machine. Said peristaltic pump 1 comprises a plate, called the pump body 3, which comprises a substantially planar surface 32 against which a flexible tube 5 for the passage of fluid is designed to be positioned. Said surface 32 is considered as planar, or flat, i.e. straight, relative to the surfaces in contact with the tube of so-called rotary peristaltic pump bodies, which have a circular-arc shape.

10

The peristaltic pump 1 also comprises a force application system 2 provided with a plurality of bearing members 7 and means for driving the movement of said bearing members 7 permitting said bearing members to be moved against the tube to deform it against said pump body 3.

15

Said pump body 3 and said system 2 are arranged relative to one another to permit the positioning of a flexible tube 5 for the passage of fluid between the planar surface 32 of the pump body 3 and the system 2. The movement of said bearing members 7 is carried out along a closed looped path as detailed below. This closed looped path comprises a portion oriented toward the side of the pump body 3 which permits the bearing members 7 passing through this portion to press the pipe against the planar surface 32 of the pump body 3.

20

25

Preferably, said pump is used for pumping blood in a dialysis machine. In this case, said tube 5 forms a blood line.

30

Said planar surface 32 is oriented toward said force application system 2 to permit said system to apply a compressive force on the peripheral wall of said flexible tube 5 positioned against the pump body 3.

35

Said pump body 3 is movably mounted relative to the force application system 2 between a position separated from said force application system 2 (see figure 4) and a position close to said force application system 2 (see figure 5). Said pump body 3 and the application system 2 thus define relative to one another a space for inserting the flexible tube which is substantially straight since it extends along the planar surface 32 of the pump body.

In the separated position of said force application system 2 relative to the pump body, the space left free between the force application system 2 and the pump body is sufficient to introduce the tube 5 freely between the force application system 2 and the pump body 3. Once the tube 5 is positioned against the planar face 32 of the pump body 3, the pump body 3 and the system 2 are brought into the close position to permit the system 2 to apply a force on the peripheral wall of the tube 5 from one end of the space for inserting the tube toward the other end.

The application of a force on the peripheral wall of the tube 5 is implemented by the bearing of said bearing members 7 on the peripheral wall of said tube so as to deform it progressively along its portion bearing against the planar face 32 of the pump body 3 and thus circulate the fluid contained in the tube 5 from one end of the surface 32 to its other end. Said pump body 3 is movably mounted in translation in a direction D31 which is transverse, preferably orthogonal, to said planar surface 32 of the pump body 3.

Said pump 1 comprises motor means 31 for driving the movement of said pump body 3 between said close position and said separated position.

Said pump 1 also comprises means 35 for determining a property representative of the force applied to the peripheral wall of the tube 5, in the state of said tube 5 positioned between the

force application system 2 and the pump body 3. Said means 35 for determining a property representative of the force applied to the tube 5 comprise at least one strain gauge. Advantageously, said at least one strain gauge is positioned
5 on a plate arranged so as to be deformed as a function of the relative position between the system 2 and said pump body 3. Preferably, said means 35 comprise two or four strain gauges.

Said pump 1 also comprises means for controlling 36 the
10 movement of the pump body 3 relative to the system 2 as a function of said determined property.

Said means for controlling are formed by an electronic and computer unit for processing and calculation. Said unit may be
15 embodied in the form of an electronic circuit provided with a microcontroller or microprocessor associated with a data storage memory. Thus, in the remainder of the description when it is specified that given means are configured to carry out a given operation, this means that the electronic and computer
20 system, which forms said means, comprises data processing instructions permitting said operation to be carried out.

Said control means 36 comprise means for defining 360 a setpoint value of said property. This setpoint value
25 corresponds to the desired clamping force of the tube 5 between the system 2 and the pump body 3. Said control means 36 also comprise regulating means 361 configured to regulate the movement of the pump body 3 in the direction of moving the force application system 2 closer or further apart as a
30 function of the determined value of said property in order to reach said setpoint value.

Thus, via the determining means 35 said regulating means 36 are configured to obtain the value of said property
35 representative of the force applied to the peripheral wall of the tube 5 and to compare this acquired value with the stored setpoint value. Depending on the result of this comparison, the control means 36 control the motor 31 so that it moves the

pump body 3 in the direction closer or further away from the system 2 until a value close to the setpoint or located in a given range relative to the setpoint value is reached.

5 Said means for driving the movement of the bearing members 7 comprise a loop element 6 which connects together the bearing members 7 and two rotating rolls 8 positioned inside and at opposing ends of said loop element 6. At least one of the rolls 8 is motorized to drive the movement of the loop element
10 6 about said rolls 8. Advantageously, the bearing members 7 are rollers.

The loop element 6 comprises a drive belt arranged in a loop around the rolls 8. One of the rolls 8 is set in motion by a
15 motor 81, such that said roll forms a driving wheel capable of driving the belt about said rolls. The other roll forms a support for guiding the movement of the belt.

The rollers 7 are mounted fixedly in terms of movement with
20 the belt 6 and protrude from the external face of said belt to permit the tube to be pressed during the movement of said rollers along the tube.

As explained above, the loop element comprises at least one
25 substantially straight portion which extends substantially parallel to the planar surface 32 of the pump body 3, such that the rollers which are displaced along this straight portion press the tube from one end of this portion to the other end.

30

Said pump comprises a frame 10, the system 2 and the pump body 3 being housed therein. Said pump body 3 is movably mounted relative to said frame 10.

35 As illustrated more particularly in figure 3, said pump 1 also comprises a membrane 9 which, in the inserted state of the tube 5 between the system 2 for force application and the pump body 3, extends around the peripheral wall of said tube 5 to

form a protective casing around said tube 5 in cooperation with a wall of the frame 10 opposing the bottom of the membrane.

5 Said membrane 9 is made from a liquid-tight flexible material.

Advantageously, it is possible to provide that the space left free between the system 2 and the pump body 3 is located in the upper part of the pump so as to be able to be easily
10 accessible by the operator.

The present invention is not limited in any way to the embodiments disclosed and shown but the person skilled in the art will know how to apply any variant thereto according to
15 the scope of the accompanying claims.

Patentkrav

1. Peristaltisk pumpe (1), for eksempel til en dialysemaskine, som omfatter på den ene side en bakke, kaldet
5 pumpehus (3), der omfatter en tilnærmelsesvis plan overflade (32), mod hvilken en fleksibel slange (5) til passage af fluid er beregnet til at placeres, og på den anden side et kraftpåtrykkelsessystem (2), der omfatter en flerhed af trykkeorganer (7), såsom ruller, og midler til at drive
10 trykkeorganernes (7) bevægelse, der gør det muligt at bevæge trykkeorganerne mod slangen for at deformere denne mod slangehuset (3),
hvor pumpehuset (3) er bevægeligt monteret i forhold til kraftpåtrykkelsessystemet (2) mellem en position fjernt fra
15 kraftpåtrykkelsessystemet (2) og en position nær kraftpåtrykkelsessystemet (2),
kendetegnet ved, at pumpen (1) omfatter midler (35) til bestemmelse af en størrelse, som er repræsentativ for den kraft, der påtrykkes slangen (5), når slangen (5) er placeret
20 mellem kraftpåtrykkelsessystemet (2) og pumpehuset (3),
og ved, at pumpen (1) også omfatter midler (36) til styring af pumpehusets (3) bevægelse i forhold til systemet (2) som funktion af den bestemte størrelse,
og ved, at styringsmidlerne (36) omfatter midler (360) til
25 fastsættelse af en indstillingsværdi af størrelsen og reguleringsmidler (361), der er konfigureret til at regulere pumpehusets (3) bevægelse i retning af en tilnærmelse eller en fjernelse i forhold til kraftpåtrykkelsessystemet (2) som funktion af den værdi, der er bestemt for størrelsen, med
30 henblik på at nå indstillingsværdien.

2. Pumpe (1) ifølge krav 1, kendetegnet ved, at pumpehuset (3) er monteret bevægeligt i translation langs en tværgående, fortrinsvis vinkelret retning i forhold til pumpehusets (3)
35 plane overflade (32).

3. Pumpe (1) ifølge et af de foregående krav, kendetegnet ved, at pumpen (1) omfatter motormidler (31) til at drive

pumpehusets (3) bevægelse mellem den nære position og den fjerne position.

4. Pumpe (1) ifølge et af de foregående krav, kendetegnet ved, at midlerne (35) til bestemmelse af en størrelse, som er repræsentativ for den kraft, der påtrykkes slangen (5), omfatter mindst en trykføler, fortrinsvis en flerhed af trykfølere.

10 5. Pumpe (1) ifølge et af de foregående krav, kendetegnet ved, at midlerne til at drive trykorganernes (7) bevægelse omfatter et løkkeelement (6), som forbinder trykorganerne (7) indbyrdes, og to roterende ruller (8), som er placeret inden i og i modsatte ender af løkkeelementet (6), idet mindst en af
15 rullerne (8) er motoriseret for at drive bevægelsen af løkkeelementet (6) rundt om rullerne (8).

6. Pumpe (1) ifølge et af de foregående krav, kendetegnet ved, at pumpen omfatter et stel (10), i hvilket systemet (2)
20 og pumpehuset (3) er placeret,
og ved at pumpehuset (3) er monteret bevægeligt i forhold til stellet (10).

7. Pumpe (1) ifølge et af de foregående krav, kendetegnet ved, at pumpen omfatter et stel (10), i hvilket systemet (2)
25 og pumpehuset (3) er placeret,
og ved, at pumpen (1) omfatter en membran (9) som, når den er indsat i slangen (5) mellem kraftpåtrykkelsessystemet (2) og pumpehuset (3), strækker sig omkring slangens (5) perifere væg
30 for sammen med en væg af stellet (10) at danne en beskyttelseskappe omkring slangen (5).

8. Pumpe (1) ifølge krav 7, kendetegnet ved, at membranen (9) er fremstillet af et bøjeligt, væsketæt materiale.

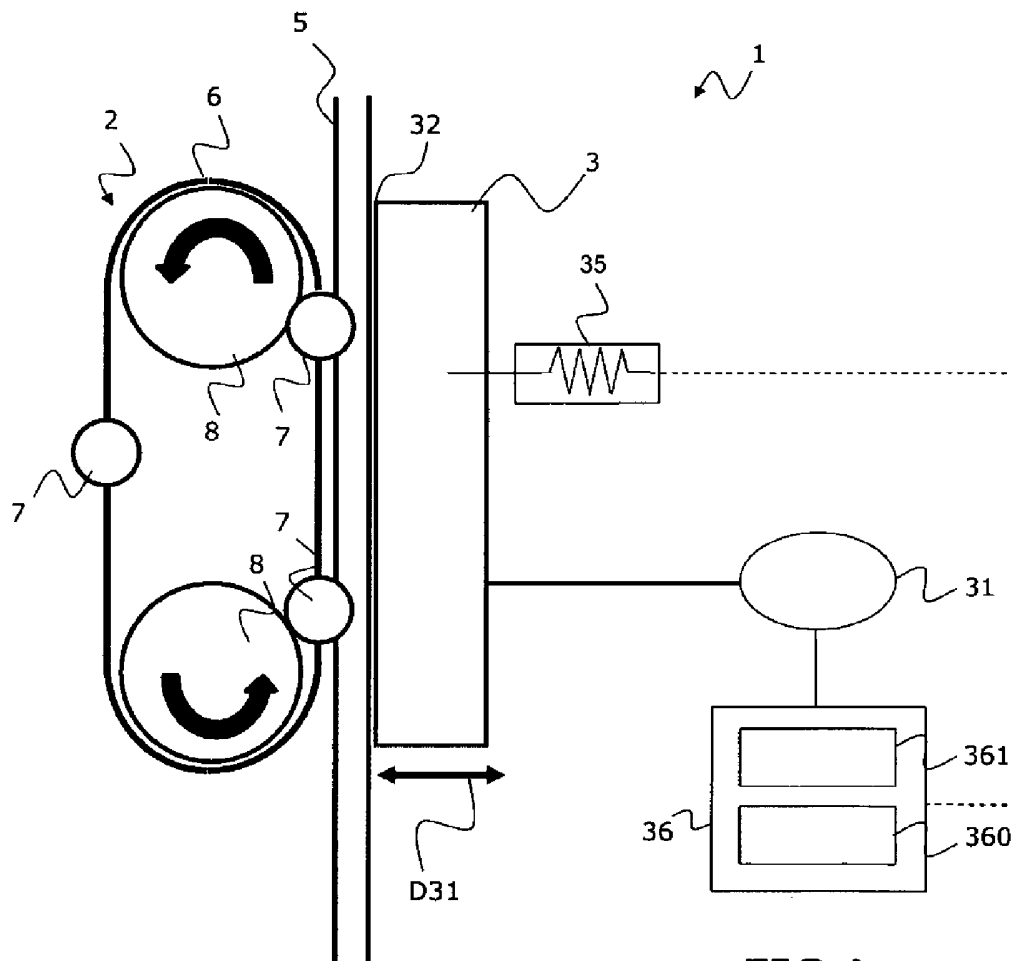


FIG.1

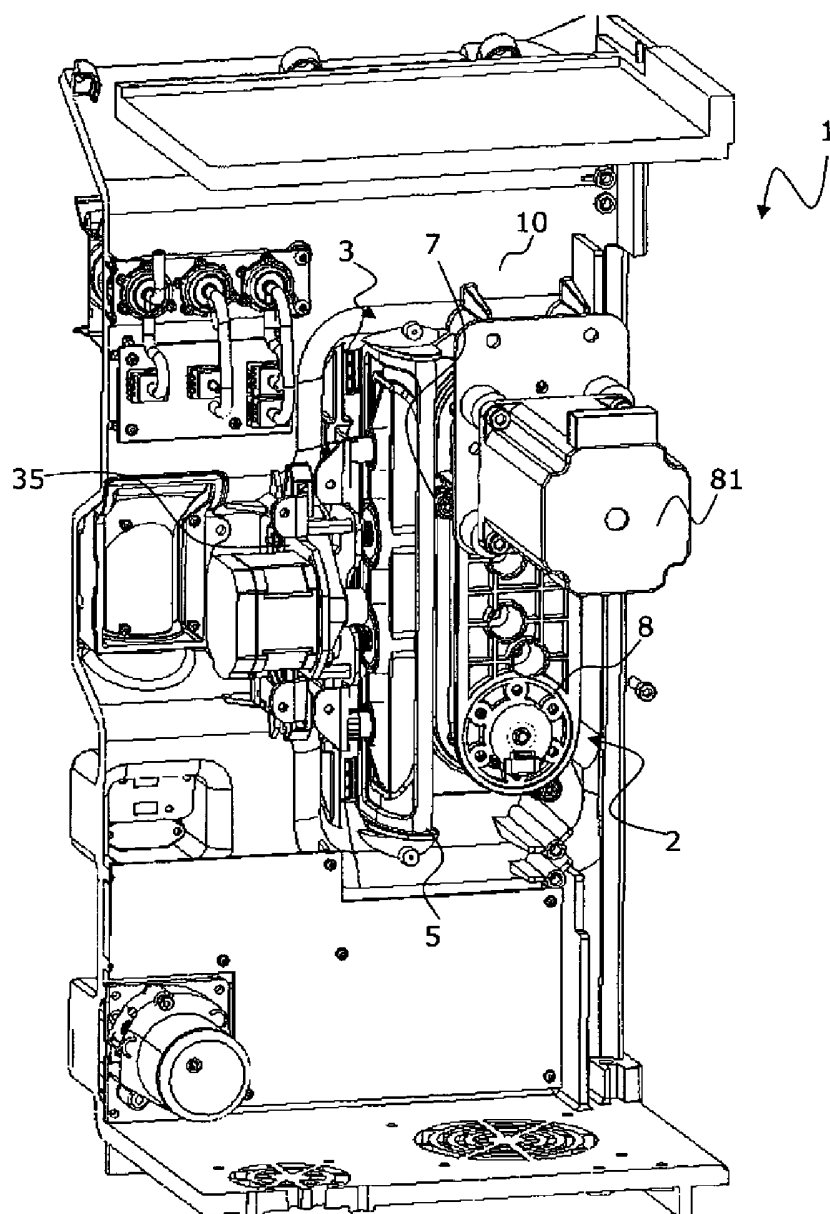


FIG.2

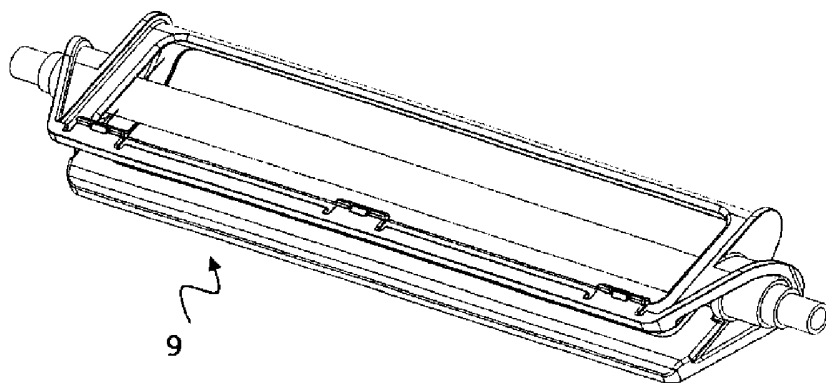


FIG.3

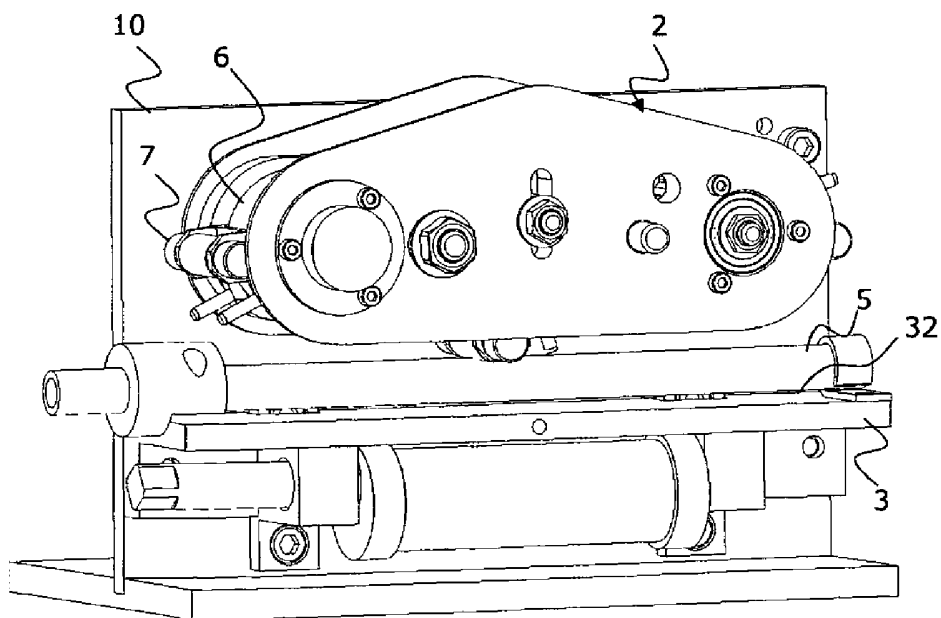


FIG.4

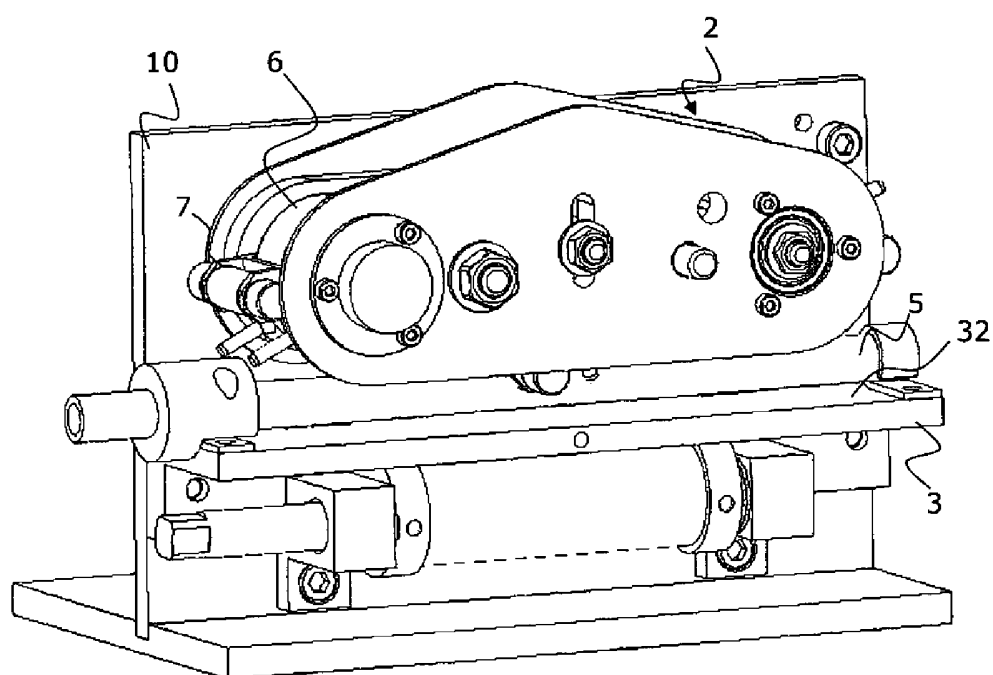


FIG.5