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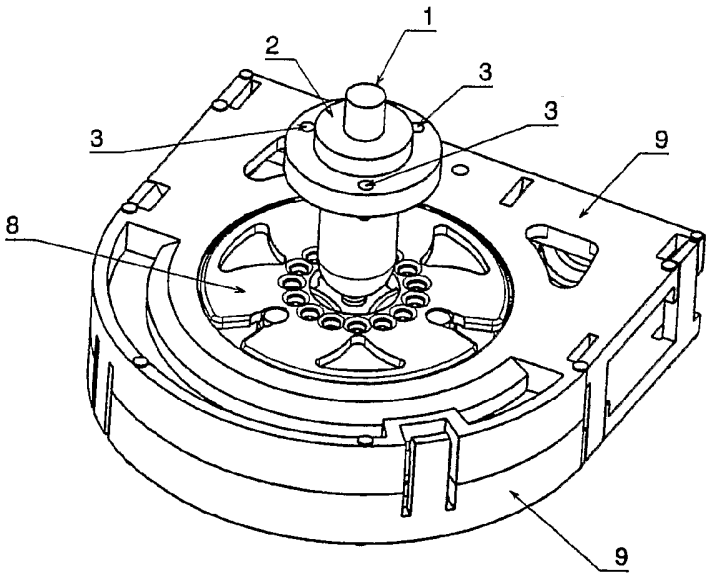
(54) Title: PERISTALTIC PUMPING SYSTEM



(57) Abstract: Peristaltic pumping system comprising a flexible tube, a substantially cylindrical rotating roller unit (8,11) containing a series of rollers (11) which are freely rotating around their axes and freely moving along a radial segment, holding means (8) for commonly holding the rollers (11), a central spreader element (5) for pushing the rollers (11) against the flexible tube and a driving unit (1,2) comprising a driving coupling element (1), characterized by the fact that said holding means (8) is made of at least one planar element (8) having retaining and guiding means for rollers (11), said planar element (8) being furthermore adapted to be directly coupled to said coupling element (1,2) in such a way that rollers (11) are driven through said planar element (8).

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Peristaltic pumping system

The invention relates to peristaltic pumping systems comprising a flexible tube, a series of rollers adapted to compress the flexible tube in a peristaltic way, a driving unit and a housing which comprises a preferable cylindrical raceway for receiving the flexible tube.

A peristaltic pump unit of this kind is disclosed for instance in US 5 044 902. This unit discloses the use of a central shaft which is in direct contact with the rollers. The shaft has two functions, namely, driving the rollers during use and pushing them against the flexible tube when the shaft is inserted into the system. This unit shows however some disadvantages. For instance, it wears rapidly and frequently blocks due to the opposite rotation direction of adjacent rollers.

One object of the invention is to provide a peristaltic pumping system of the type defined above, which is of a simple and robust construction and which allows an efficient pumping over prolonged period of time.

The peristaltic pumping system according to the invention comprises a flexible tube, a substantially cylindrical rotating roller unit containing a series of rollers which are freely rotating around their axes and freely moving along a radial segment, holding means for commonly holding the rollers, a central spreader element for pushing the rollers against the flexible tube and a driving unit comprising a driving coupling element, characterized by the fact that said holding means is made of at least one planar element having retaining and guiding means along such radial segment for rollers, said planar element being furthermore adapted to be directly coupled to said coupling element in such a way that rollers are driven through said planar element.

When the roller unit and the housing are separated from the driving unit, the rollers are brought back to the center under the pressure of the tube at rest, this tube remaining open, which makes possible an easy and complete sterilization.

The housing has preferably an internal groove with a concave cross-section into which is housed the flexible tube, while the rollers are externally barrel-shaped, with a convex curvature combined with the concave curvature of the groove of the housing, to rest against the flexible tube; such a housing with a concave internal profile allows a self-centering of the tube and the rollers.

The tubular rollers are generally made of a flexible plastic material. Their shape is not limited to shape indicated previously. They may be cylindrical or conical. They may also be of a flexible material to improve the elastic functioning of the peristaltic pumping system.

The driving unit preferably comprises a driving shaft provided with a support containing pins which are adapted to cooperate with holes in the planar element of the roller unit.

Preferably the spreader is loosely mounted on an extension of the driving shaft to avoid any friction with the rollers during use.

The invention consists, besides the arrangements explained above, in a number of other arrangements which will be more explicitly explained below with respect to the particular embodiments described with reference to the attached drawings, but which are in no way restrictive.

FIG. 1 of these drawings is a perspective view of a roller unit according to the invention.

FIG. 2 is an enlarged view of a portion of the roller unit of fig. 1.

FIG. 3 shows a peristaltic pump unit according to the invention including the roller unit, the housing, the driving shaft and the spreader.

FIG. 4 represents the roller unit of fig. 1 containing the spreader.

FIG. 5 is a longitudinal cross-section of the roller unit with the spreader-shaft arrangement in a non-active position.

FIG. 6 is a longitudinal cross-section of the roller unit with the spreader-shaft arrangement in an active position.

FIG. 7 is en enlarged view of a disc portion.

With reference to the drawings, a peristaltic pump system can be seen on figure 3, comprising a housing **9** containing a raceway **10** for receiving a flexible tube (not shown), forming the body of the pump. The tube is interposed between the housing walls and a roller unit **8**,**11** capable of co-operating with a support **2** fixed to a driving shaft **1** which is, in turn, driven by an electric motor (not shown).

Figure 3 and 5 represents a non-active position where the driving shaft **1** has not penetrated the roller unit **8**,**11**.

The roller unit **8**,**11** is made of three rollers **11** held between two separator discs **8**, the rollers **11** are commonly retained and guided through their axis ends **12** to the separator discs **8**. At least one separator disc **8** contains a plurality of receiving means **13** which are adapted to receive the pins **3** of the driving support **2**.

The driving shaft distal end extends from the driving support **2** and is covered by a sheath **5** freely rotating around the driving shaft **1**. The sheath **5** is sufficiently large in order to act as a spreader which pushes the rollers **11** against the flexible tube when the shaft distal end penetrates the roller unit **8**,**11** (see figures 4 and 6).

When the housing **9** and the roller unit **8**,**11** are stored separately from the driving unit **1**,**2** , the rollers **11** are brought back to the center under the pressure of the tube at rest, as can be seen in Figure 1, this tube remaining open until stabilization of the rollers in a perpendicular position of reciprocal support. This

allows to avoid a plastic deformation of the walls of the tube during storage, which could occur if the tube were stored in compressed condition and thereby induce a change in peristaltic performance during use (in particular with regard to flow rate and accuracy).

The tube can be kept in position by two welded stop rings foreseen for being clamped into accurate recesses under the pressure of a supporting collar integral with the cover of the cartridge.

When manufactured in series, this tube is mounted very quickly into the cartridge.

The peristaltic pump unit operates as follows :
The housing **9** and the roller unit **8**,**11** are first placed on the driving unit **1**,**2** (see fig. 4 and 6) . By this movement, the central shaft distal end, together with the sheath **5**, pushes the rollers **11** against the tube and, in addition, the pins **3** engage the receiving means **13** of the discs **8**. The coupling of said pin **3** in the receiving means can be self-aligned by having receiving means which are close to each other with a taper at the periphery to guide the pin into said receiving, said pin having a conical end.

Alternatively, the coupling can also be obtained by pins being placed on the disc **8** and the receiving means being placed on the driving unit **2**.

The pumping action is obtained when the motor is started to rotate, driving the discs **8** and the rollers **11**.

Alternatively, the driving of the disc **8** can also be obtained by a gear coupling on the periphery of such planar disc.

When the roller unit **8**,**11** and the housing **9** are separated from the driving unit **1**,**2** the rollers **11** are brought back to the centre under the pressure of the tube at rest, this tube remaining open.

In an alternative embodiment (not shown) the rollers are not able to return to the center position once they have been pushed by the central shaft and sheath **5** against the flexible tube. In such a case, once the central shaft has been removed the peristaltic system remains occlusive, such as to prevent free-flow after use. This can, for example, be obtained by having a cliquing position **14** on the separator discs at the position of the roller axis ends on the radial segment **15** of the separator discs so that the roller axis end has to pass such click **14** when the central shaft is inserted, but cannot return afterwards when the central shaft is removed.

Alternatively, this can also be obtained by having the sheath **5** remaining inside the roller unit **8,9** after the shaft is removed.

Claims

1. Peristaltic pumping system comprising a flexible tube, a substantially cylindrical rotating roller unit (8,11) containing a series of rollers (11) which are freely rotating around their axes and freely moving along a radial segment (15), holding means (8) for commonly holding the rollers (11), a central spreader element (5) for pushing the rollers (11) against the flexible tube and a driving unit (1,2) comprising a driving coupling element (1), characterized by the fact that said holding means (8) is made of at least one planar element (8) having retaining and guiding means for rollers (11), said planar element (8) being furthermore adapted to be directly coupled to said coupling element (1,2) in such a way that rollers (11) are driven through said planar element (8).

2. Peristaltic pumping system according to claim 1 wherein said holding means is made of two parallel planar elements (8), the rollers (11) being situated between said planar elements (8).

3. Peristaltic pumping system according to claim 1 or 2 wherein said spreader element (5) is freely mounted on the distal end of the driving shaft (1).

4. Peristaltic pumping system according to claim 1, 2 or 3 wherein said driving coupling element is directly fixed around the basis of the central spreader element to be coupled to the planar element by underneath.

5. Peristaltic pumping system according to claim 4, wherein the driving coupling element comprises centering means adapted to allow a self centering of the driving coupling element.

6. Peristaltic pumping system according to claim 1, 2, 3, 4 or 5 wherein said planar element(s) (8) contain(s) a series of holes (13) situated along a circle which is coaxial with respect to the rotating axis of the roller unit (8,11) and wherein said driving unit (1,2) contains at least one pin (3) adapted to be received in one of said holes (13), the pin (3)-hole(13)

combination allowing the fixation of the planar element (8) to the driving unit (1,2).

7. Peristaltic pumping system according to claim 6 wherein said holes (13) are adjacent along the circle, allowing thereby always a fixation (automatic alignment) of the planar element (8) to the driving unit (1,2) when both elements are approached.

8. Peristaltic pumping system according to claim 1, 2 or 3 wherein said driving coupling element (1,2) is directly fixed around the periphery of the planar element (8).

9. Peristaltic pumping system according to any of the previous claims comprising clicking means (14) adapted to maintain the rollers against the flexible tube when the central shaft is withdrawn.

Fig. 1

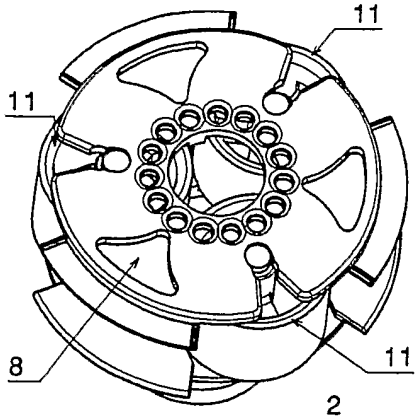


Fig. 2

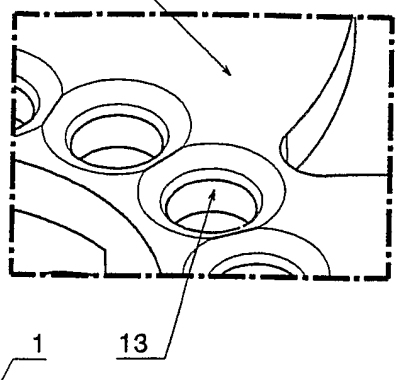


Fig. 3

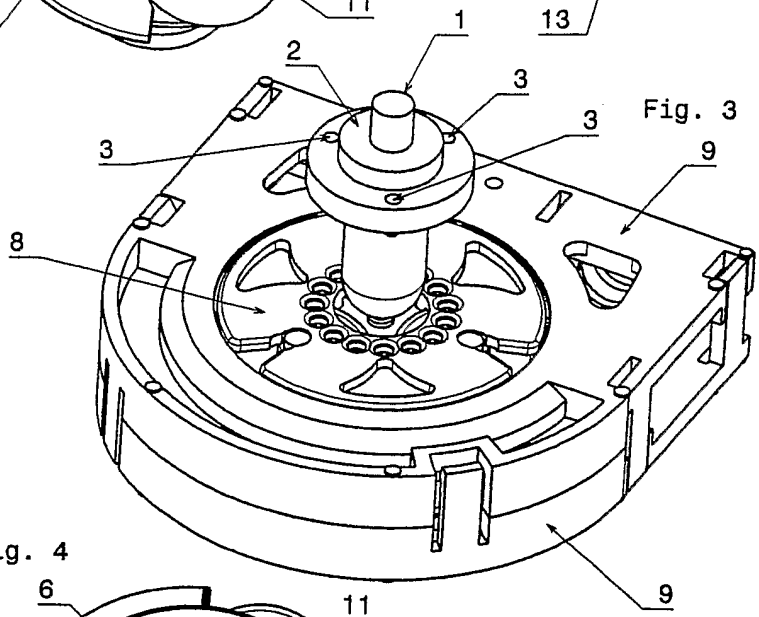


Fig. 4

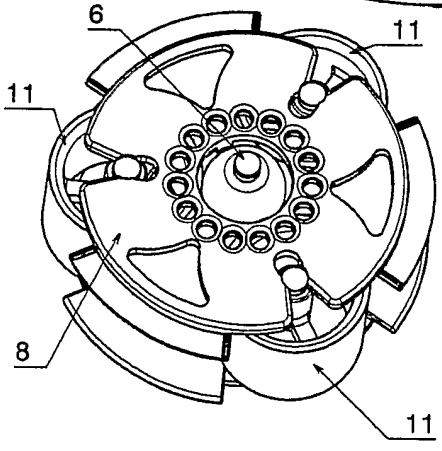


Fig. 7

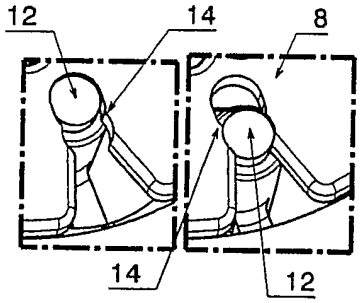


Fig. 5

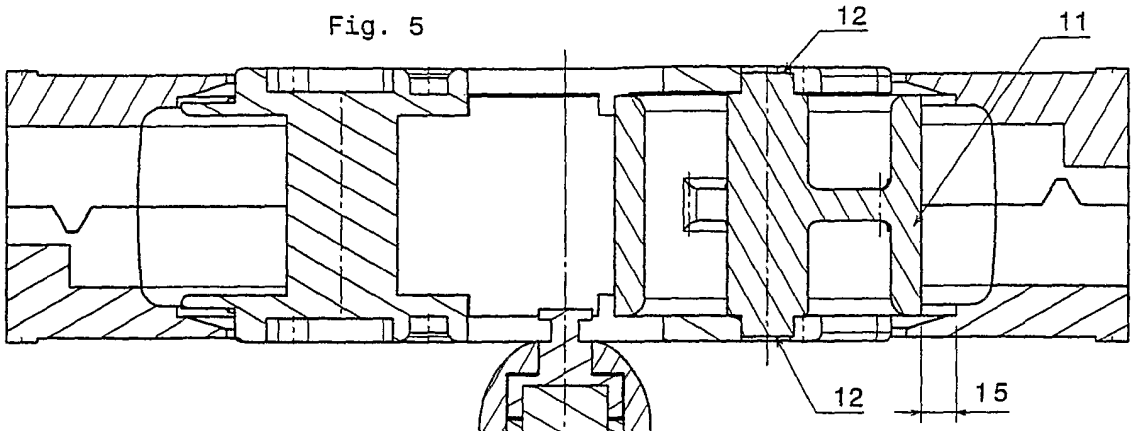
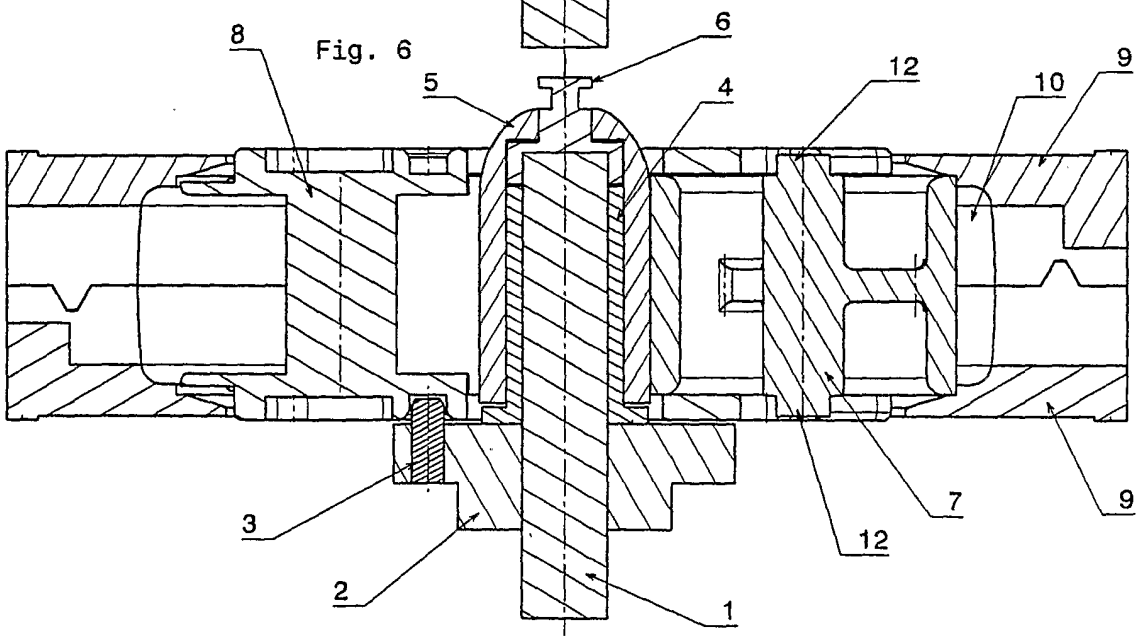


Fig. 6



INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F04B43/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 044 902 A (MALBEC EDOUARD) 3 September 1991 (1991-09-03) cited in the application the whole document	1
A	US 5 927 956 A (FOX BRIAN J ET AL) 27 July 1999 (1999-07-27) column 2, line 28 - column 3, line 5	1
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☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 July 2005	01/08/2005

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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