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(54) Peristaltic pump, method for manufacturing a hose therefor, and hose for such a pump

(57) A pump for circulating a medium comprises:
an elastically deformable hose which lies against a pressing surface, and has a medium inlet and a medium outlet; and
pressing elements which move along the hose and press the hose part in contact with a pressing element against the pressing surface while locally compressing and closing the hose part;
whereby medium is drawn in via the medium inlet and discharged under pressure via the medium outlet.

The pump has the special feature that the pressing surface, the hose and the pressing elements are situated in a bath with lubricant, and that the hose consists solely of a thermoplastic vulcanizate (TPV).

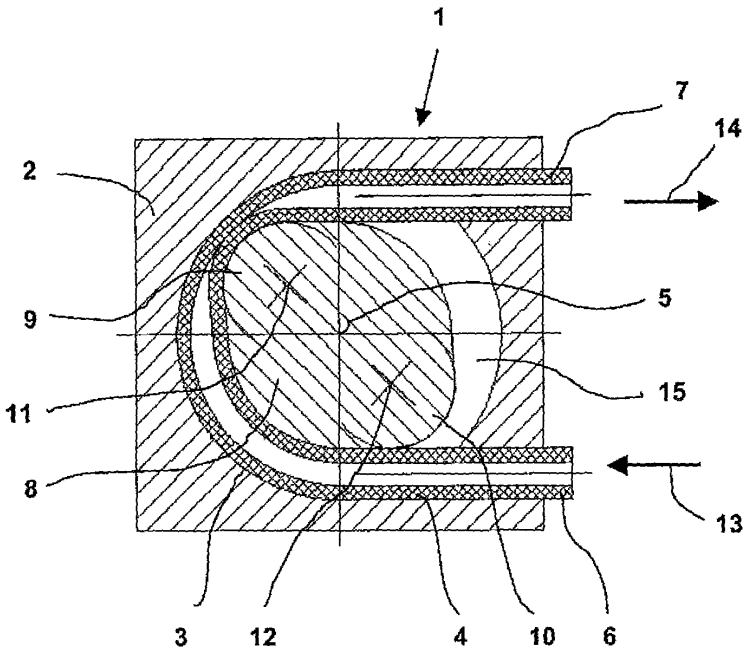

Fig. 1

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Description

[0001] The invention relates to a peristaltic pump for circulating a medium, such as a liquid, a gas, a slurry, a granulate or a combination of two or more thereof, which pump comprises:

a pump housing;
a pressing surface present in this pump housing;
an elastically deformable hose, a part of which lies against the pressing surface, which hose has a medium inlet and a medium outlet; and
pressing means with a number of equidistantly placed pressing elements such as rollers or cams;
which pressing means are drivable such that the pressing elements move along the hose; and
which pressing elements during operation press the hose part in contact with the relevant pressing element against said pressing surface part while locally compressing and closing the hose part;
this such that during driving of the pressing means medium is drawn in via the medium inlet and discharged under pressure via the medium outlet.

[0002] Such a peristaltic pump is known for instance from US-A-2006/0018777.

[0003] Owing to the local compression, and thereby closing of the hose by the pressing elements, and the displacement of this local compression under the influence of the pressing elements driven along the hose, the medium present in the hose will be pushed along. After a pressing element has passed, the form of the hose is restored due to its elastic properties. Owing to this mechanism medium is drawn into the hose on the suction side.

[0004] Because it is ensured that the hose is always pressed shut locally by at least one locally acting pressing element, the pump operates as closing valve such that the delivery side and the suction side are separated from each other.

[0005] The hose is successively loaded locally in the peristaltic pump by the pressing elements passing under pressure. This causes fatigue in the material of the hose. A fatigue crack hereby occurring after a period of time can eventually result in breaking of the hose, whereby the medium which has been pumped and which is to be pumped can flow out of the hose, and lubricant possibly present on the outside of the hose can mix with pumped medium. Because the process of crack formation depends on many factors, the moment at which the break occurs is difficult to predict. A break causes the described technical disruptions, among others, and results in undesired maintenance at a non-predictable moment in time.

[0006] In the light of the foregoing it is an object of the invention to substantially increase the lifespan of the hose.

[0007] In addition, peristaltic pumps of the described known type are often not competitive with other displacement pumps because the pump capacity of peristaltic pumps is relatively small in relation to their dimensions and their cost price. Increasing the capacity by increasing the rotation speed could be considered, were it not for the fact that the lifespan of the hose would hereby be greatly shortened by the usual peristaltic pumps. It is therefore a further object of the invention to modify the known pump such that the lifespan of the hose is prolonged or the pump capacity is increased by increasing the rotation speed of the pump.

[0008] The pump known from said American patent US-A-2006/001877 comprises a layered hose, wherein the inner layer consists of PTFE (polytetrafluoroethylene) with which the chemical resistance of the hose is brought to a desired level. The carrier or casing can consist of various different elastomers, for instance a material commercially available under the name Santoprene. According to this American patent the pump hose has the chemical resistance of a fluoroplastic material and the resilience of an elastomer.

[0009] The problem which however occurs in this known hose is that, due to the continuously repeated compression and expansion, the pump is subject to premature delamination as a result of the strong shear forces occurring repeatedly each time. The hose hereby becomes unusable in a short time since the integrity of the PTFE layer is broken and the chemical resistance of the hose therefore becomes determined by that of the material of the carrier which is not specially designed or chosen for this purpose. The lifespan of this known pump hereby leaves a great deal to be desired.

[0010] With a view to the foregoing, the invention provides a peristaltic pump of the type stated in the preamble which has the feature that the pressing surface, the hose and the pressing means with the pressing elements are situated in a bath with lubricant; and
the hose consists solely of a homogeneous thermoplastic vulcanizate (TPV).

[0011] It is noted that US-A-2 428 619 shows a possible mechanical principle of a lubricated hose pump. Mention is made, in very general sense and without any further specification, of a plastic material such as a natural rubber, a synthetic rubber or a similar material which is suitable for the medium for circulating.

[0012] In no way whatsoever does this publication point in the direction of the possibility of the hose consisting solely of a homogenous thermoplastic vulcanizate as according to the teaching of the present invention. Attention is also drawn in this respect to the fact that this American patent refers to a hose with a layered structure, this even being wholly contrary to an important basic principle of the invention.

[0013] It must also be noted in this respect that the hose according to the invention, in accordance with the given definition, is free of any form of reinforcement such as embedded fibres with tensile strength, for instance in the form of a mat, as is known and usual per se for hose pumps.

[0014] In a preferred embodiment the pump has the feature that the material of the hose comprises ethylene propylene diene rubber (EPDM) and polypropylene (PP).

[0015] In a specific embodiment the pump has the special feature that the pump is of the linear type. "Linear" is understood to mean a pump wherein the pressing elements follow an at least more or less linear path along the pressing surface, which pressing surface likewise has an at least more or less linear form.

[0016] A peristaltic pump is further known for circulating a medium, which pump is of the rotating type and comprises:

a pump housing;
a curved pressing surface which is present in this pump housing and at least a part of which takes the general form of a circular arc with a central axis;
an elastically deformable hose, of which a part lies against the pressing surface, which hose has a medium inlet and a medium outlet;
a rotor with a number of pressing elements, such as rollers or cams, placed at equal angular and radial positions;
which rotor is rotatingly drivable around a central axis; and
which pressing elements during operation press the hose part in contact with the relevant pressing element against said pressing surface part while locally compressing and closing said hose part;
this such that during the rotation of the rotor medium is drawn in via the medium inlet and discharged under pressure via the medium outlet.

[0017] This pump is particularly important in the context of the invention because such a pump, generally referred to as "hose pump", is very common and is highly suitable for adaptation in terms of the teaching of the present invention.

[0018] According to the invention this said rotating peristaltic pump has the feature that the pressing surface, the hose and the pressing means with the pressing elements are situated in a bath with lubricant; and
the hose consists solely of a homogeneous thermoplastic vulcanizate (TPV).

[0019] It is noted that while this rotating pump has a construction other than for instance a linear pump according to the invention, the principles implemented therein are nevertheless the same. The results of the teaching according to the invention can hereby also be easily realized in the rotating pump.

[0020] The invention further relates to a method for manufacturing a hose for a peristaltic pump of the specified type, according to which method a granulate consisting of a rubber and a thermoplastic plastic is pressed through an annular extrusion nozzle at increased temperature and at pressure, and the hose-like extrudate leaving the extrusion nozzle is cooled, and a hose of the desired length is separated from the thus obtained extrudate.

[0021] According to this method "new" material is used, i.e. material which in principle has not been previously used.

[0022] The stated material choice according to the invention is also suitable for recycling of for instance already used hoses of the type according to the invention. In this respect the invention also provides a method for manufacturing a hose for a pump, according to which method a previously manufactured and possibly already used hose is finely ground such that a granulate is obtained consisting of a rubber and a thermoplastic plastic, which granulate is pressed through an annular extrusion nozzle at increased temperature and at pressure, and the hose-like extrudate leaving the extrusion nozzle is cooled, and a hose of the desired length is separated from the thus obtained extrudate.

[0023] The invention further relates to a hose which is intended and embodied to be applied as component of a peristaltic pump of the type according to the invention. This hose has the feature according to the invention that the material of the hose is a thermoplastic vulcanizate (TPV).

[0024] There now follow three definitions for the purpose of elucidating the invention:

(1) A thermoplastic vulcanizate or TPV is a thermoplastic elastomer (TPE) with a chemically cross-linked rubber phase produced by means of dynamic vulcanization.
(2) A thermoplastic elastomer or TPE forms part of a family of rubber-like materials which, other than the usual vulcanized rubbers, can be processed and recycled in the same manner as thermoplastic materials. Thermoplastic elastomers provide performance and properties corresponding with usual cured rubber products, but can be processed with the speed, efficiency and business economic advantages of thermoplasts.
(3) Dynamic vulcanization is the process of melting an intimate mixture of a thermoplastic polymer and a suitably reactive rubber polymer in order to obtain a TPE with a chemically cross-linked rubber phase, resulting in properties closer to those of a thermocuring rubber than in the case of the same composition that is not cross-linked.

[0025] The invention will now be elucidated with reference to the only figure.

[0026] This figure shows a cross-section through a peristaltic pump 1 according to the invention of the rotating type.

[0027] The pump 1 comprises:

a pump housing 2;
a pressing surface present in this pump housing 2 and having the general form of a half-cylinder extending through 180° and having a central axis 5;

an elastically deformable hose 4 which has a medium inlet 6 and a medium outlet 7; a rotor 8 with two pressing cams 9, 10 which are placed diametrically to each other, i.e. at mutual angles of 180° and equal radial positions relative to central axis 5, also the central axis of rotor 8, and which in this embodiment are embodied as partly cylindrical cams with respective central axes 11, 12, which rotor 8 is rotatingly drivable around central axis 5 by means of drive means (not shown);
which pressing cams 9, 10 press during operation the part of hose 4 in contact with the relevant pressing cam 9, 10 against said pressing surface 3 while locally compressing and closing the hose part;
this such that during the rotation of rotor 8 medium is drawn in via medium inlet 6 and discharged under pressure via medium outlet 7.

[0028] The indrawn medium is indicated with an arrow 13. The medium discharged under pressure is indicated with an arrow 14.

[0029] The construction of pump 1 is per se known. The invention lies in the choice of the material of hose 3. This material is a thermoplastic vulcanizate (TPV).

[0030] A very suitable material comprises ethylene propylene diene rubber (EPDM) and polypropylene (PP). This material has an excellent resistance to acids, bases, oxidizing substances, alcohols, aldehydes and non-fatty foodstuffs.

[0031] Another option is for the material of the hose to comprise nitrile rubber (NBR) and polypropylene (PP). An example is Geolast™ from Advanced Elastomer Systems, Belgium. This material is highly suitable for the pumping of oils, bases and diluted acids.

[0032] Yet another option is that the material of the hose comprises nitrile rubber (NBR) and polyvinyl chloride (PVC). An example hereof is Nitrovin™ from Vi-Chem Corporation, USA. This material is suitable for pumping oils and fuels.

[0033] Yet another choice is for the material of the hose to comprise polyacrylate rubber (ACM) and polyamide (PA). An example hereof is zeotherm® from Zeon Chemicals, USA. This material is highly suitable for pumping hot oil, fuels and hydrocarbons.

[0034] Situated in pump space 15 is a liquid lubricant. Very suitable as liquid acting as lubricant and coolant is that commercially available from applicant under the name "Bredel Genuine Hose Lubricant". This is a liquid with a dynamic viscosity of about 600-700 mPa.s (20°C). This lubricant and coolant is registered in the United States at NSF under number 123204.

[0035] Tests have shown that the combination of the material for the hose according to the invention and a peristaltic pump according to the invention, wherein pressing surface 3, hose 4 and rotor 8 with pressing cams 9, 10 are situated in a lubricant, can have a lifespan which is three to seven times longer than:

(1) when the same material is used for the hose in a non-lubricated peristaltic pump, wherein the pressing cams 9, 10 are replaced by freely rotating rollers;
(2) when any other tested material is used in a non-lubricated peristaltic pump with rollers; and
(3) in a lubricated peristaltic pump with fixed cams and usual hose materials, for instance rubber hoses optionally provided with a reinforcement;
(4) in the pump according to US-A-2004/0018777, in which pump the hose has a strong tendency to delamination as a result of shear, and therefore has a short lifespan.

[0036] Tests have also demonstrated that the combination enables a three to ten times greater pump flow rate by increasing the rotation speed of rotor 8.

[0037] It is noted that the material of the hose is not limited to the stated examples.

Claims

1. Peristaltic pump for circulating a medium, such as a liquid, a gas, a slurry, a granulate or a combination of two or more thereof, which pump comprises:

   a pump housing;
   a pressing surface present in this pump housing;
   an elastically deformable hose, a part of which lies against the pressing surface, which hose has a medium inlet and a medium outlet; and
   pressing means with a number of equidistantly placed pressing elements such as rollers or cams;

   which pressing means are drivable such that the pressing elements move along the hose; and
   which pressing elements during operation press the hose part in contact with the relevant pressing element against said pressing surface part while locally compressing and closing the hose part;
   this such that during driving of the pressing means medium is drawn in via the medium inlet and discharged under pressure via the medium outlet;
   characterized in that
   the pressing surface, the hose and the pressing means with the pressing elements are situated in a bath with lubricant; and
   the hose consists solely of a homogeneous thermoplastic vulcanizate (TPV).

2. Peristaltic pump as claimed in claim 1, wherein the material of the hose comprises ethylene propylene diene rubber (EPDM) and polypropylene (PP).

3. Peristaltic pump as claimed in claim 1, wherein the material of the hose comprises nitrile rubber (NBR) and polypropylene (PP).

4. Peristaltic pump as claimed in claim 1, wherein the material of the hose comprises nitrile rubber (NBR) and polyvinyl chloride (PVC).

5. Peristaltic pump as claimed in claim 1, wherein the material of the hose comprises polyacrylate rubber (ACM) and polyamide (PA).

6. Peristaltic pump as claimed in any of the foregoing claims, wherein the material of the hose has a hardness in the range of 55-95 Shore A and is chosen subject to the dimension of the hose, the design back pressure of the medium in the hose, and the desired chemical resistance.

7. Peristaltic pump as claimed in any of the foregoing claims,
characterized in that
the pump is of the linear type.

8. Peristaltic pump as claimed in any of the foregoing claims for circulating a medium, which pump is of the rotating type and comprises:

a pump housing;
a curved pressing surface which is present in this pump housing and at least a part of which takes the general form of a circular arc with a central axis;
an elastically deformable hose, of which a part lies against the pressing surface, which hose has a medium inlet and a medium outlet;
a rotor with a number of pressing elements, such as rollers or cams, placed at equal angular and radial positions;
which rotor is rotatingly drivable around a central axis; and
which pressing elements during operation press the hose part in contact with the relevant pressing element against said pressing surface part while locally compressing and closing said hose part;
this such that during the rotation of the rotor medium is drawn in via the medium inlet and discharged under pressure via the medium outlet;

characterized in that
the pressing surface, the hose and the pressing means with the pressing elements are situated in a bath with lubricant; and
the hose consists solely of a homogeneous thermoplastic vulcanizate (TPV).

9. Method for manufacturing a hose for a peristaltic pump as claimed in any of the claims 1-8, according to which method a granulate consisting of a rubber and a thermoplastic plastic is pressed through an annular extrusion nozzle at increased temperature and at pressure, and the hose-like extrudate leaving the extrusion nozzle is cooled, and a hose of the desired length is separated from the thus obtained extrudate.

10. Method for manufacturing a hose for a pump as claimed in any of the claims 1-8, according to which method a previously manufactured and possibly already used hose is finely ground such that a granulate is obtained consisting of a rubber and a thermoplastic plastic, which granulate is pressed through an annular extrusion nozzle at increased temperature and at pressure, and the hose-like extrudate leaving the extrusion nozzle is cooled, and a hose of the desired length is separated from the thus obtained extrudate.

11. Hose, intended and embodied to be applied as component of a peristaltic pump as claimed in any of the claims 1-8,
characterized in that
the material of the hose is a thermoplastic vulcanizate (TPV) as according to any of the claims 1-6.

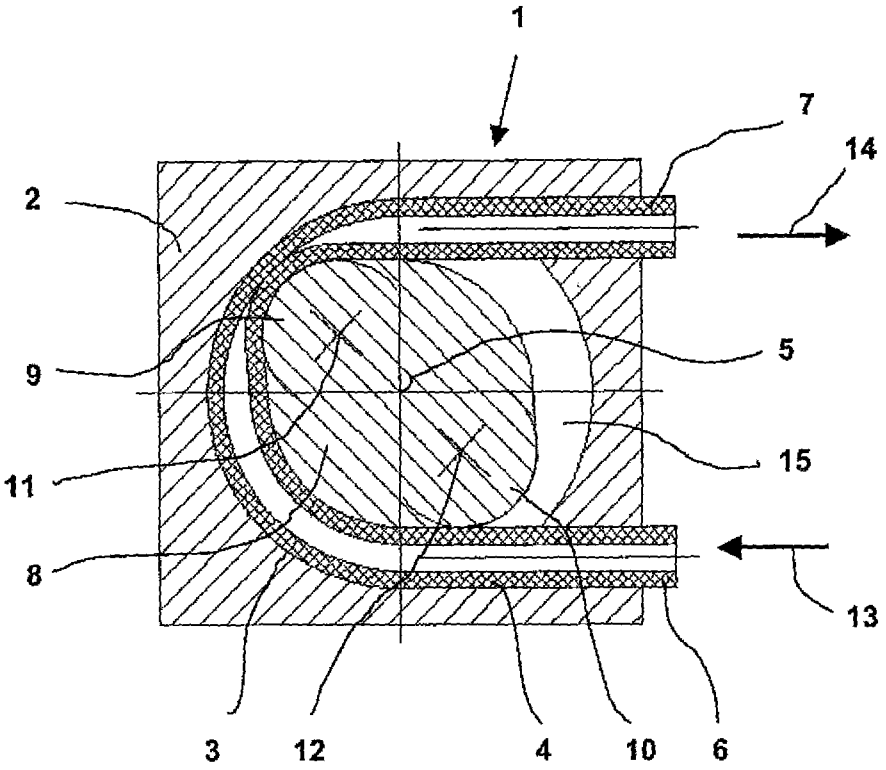

Fig. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 10 4378

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 September 2007	Avramidis, Pavlos

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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