(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 December 2009 (23.12.2009)

PCT

(10) International Publication Number
WO 2009/152785 A2

(51) International Patent Classification:
F03B 3/12 (2006.01) *F03B 5/00* (2006.01)

(21) International Application Number:
PCT/CZ2009/000084

(22) International Filing Date:
17 June 2009 (17.06.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PV 2008-382 19 June 2008 (19.06.2008) CZ

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: ROLLING FLUID TURBINE

(57) Abstract: The invention relates to a rolling fluid turbine which consists of a stator (1) provided with a fluid inlet (13) and a fluid outlet (14), wherein the stator (1) is firmly attached to the generator (7) by means of the cover (9) of the stator (1) and fixtures (8) on the generator (7). A rotor (2) is placed inside the stator (1); the rotor (2) is firmly attached to one end of the shaft (3) of the rotor (2), while the other end of the shaft (3) of the rotor (2) is firmly attached to the head of the ball joint (4), which is installed on the inner side of the cover (9) of the stator (1). The head of the ball joint (4) is provided with a longitudinal opening (12) for fixing one end of a flexible shaft (5) and the shaft (6) of the generator (7) is provided with a longitudinal opening (11) for fixing the other end of the flexible shaft (5). Thanks to the flexible shaft (5), the rotation of the head of the ball joint (4) leads to the rotation of the shaft (6) of the generator (7).

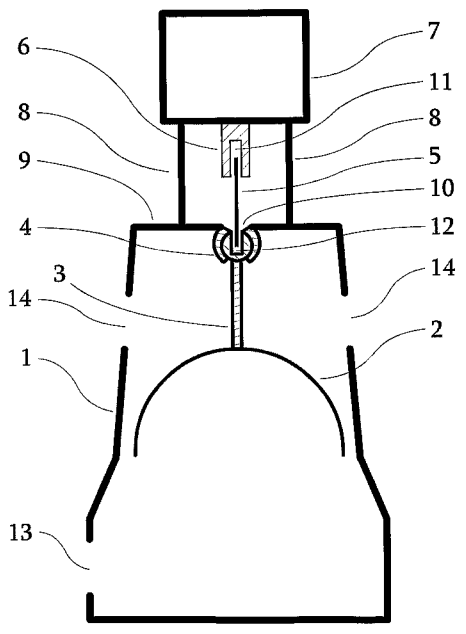

Fig. 1

WO 2009/152785 A2

Published:

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Rolling fluid turbine

Technical field

The invention relates to a rolling fluid turbine which consists of a cylindrical or conical stator, in which a rotor of a rotary shape, which can circulate along the inner wall of the stator, is mounted on a shaft.

Background art

Fluid turbines based on the rolling principle are generally known, consisting of a stator, usually in the shape of an inlet socket, and a rotor of a rotary shape, very often in the form of a hemisphere or cone. For example according to the Czech patent No. 284483 Rolling Fluid Machine and the European patent EP1015760 B1 Rolling Fluid Machine, the current art knows a water turbine comprising a fluid storage tank provided with an inlet and at least with one outlet nozzle, where a rolling rotor of a rotary shape is mounted on a holding device in the area of the outlet nozzle. This machine can work as a water turbine, when the water that flows around the rotor deviates the rotor toward the inner wall of the outlet nozzle and starts rolling it in the outlet nozzle - in the stator. The solution of the rolling fluid motor designed according to the Czech utility model No. 7606 Hydraulic Motor and the European patent EP1082538 B1 Hydraulic Motor can be used for the production of energy. Likewise, the solution based on the Czech patent No. 294708 Rolling Fluid Turbine represents a rolling-type water-powered motor, with hydraulic channels arranged in the places of mutual contact between the rotor and the stator; these channels also perform the function of gearing, thus preventing rotor slip inside the stator. According to the Czech

invention application PV 2007 - 520 Fluid Turbine and the Czech utility model 17908 Fluid Turbine, a solution of the rolling turbine exists in which the shaft, with a rotor at one end, is installed in a non-rotating manner, with the possibility of axial deflection in all directions. The generator is installed in the rotor and rotated so that either the generator motor or the generator stator is connected to the rotor.

The fundamental disadvantage of the turbines briefly mentioned above, fitted with gearing that transforms the turbine's mechanical power to the electricity generator, is that there are losses during the transformation of the mechanical power from the turbine shaft to the generator shaft. If they are not fitted with gearing and the generator is placed in the turbine rotor, there are losses on the torque in the o-rings that prevent the fluid from penetrating inside the rotor. The disadvantage of the solution of the by-pass generator installed on a free-rotating crank shaft is the arrangement of the crank shaft, which has to be dimensioned extremely precisely to make sure that the rotor is rolled along the stator surface with a certain thrust and the rotor does not get far from the stator surface and does not push against it unreasonably. Another disadvantage of all solutions in which the shaft is installed in a free-rotating manner is that the shaft has to be fitted with a certain number of bearings to withhold the axial and radial forces affecting it as the fluid is flowing through the turbine.

The goal of the proposed invention is an arrangement of the rolling turbine in which the method of transfer of the torque to the electricity generator is as simple as possible and efficient enough so that the transformation of the generated mechanical energy into electric power is accomplished

without any transmission mechanisms and losses in the o-rings and the axial and radial forces affecting the shaft are not suppressed by a bearing or a set of bearings and could be easily retained within the stator cover.

Disclosure of the invention

The mentioned goal is achieved by means of a rolling fluid turbine comprising a stator fitted with at least one inlet opening and at least one outlet opening. Through the stator cover and the generator fixtures, the firmly attached to the generator and a rotor is arranged inside the stator; the rotor is firmly attached to one end of the rotor shaft, while the other end of the rotor shaft is, according to the invention, firmly attached to the head of a ball joint, installed on the inner side of the stator cover. The ball joint housing is firmly attached to the stator cover and is fitted, in the direction of the longitudinal rotor shaft, to the ball joint head, with an opening for the passage of a flexible shaft whose one end is lodged in a longitudinal cylindrical cavity located in the longitudinal axis of the ball joint head and whose other end is lodged in the longitudinal cylindrical cavity located in the longitudinal axis of the generator shaft.

The attachment can be made by gluing, welding, sealing etc. The longitudinal cylindrical cavity located in the longitudinal axis of the ball joint head starts at the surface of the ball joint head and its length is 0.2 to 0.9 times the diameter of the ball joint head; the longitudinal cylindrical cavity located in the longitudinal axis of the generator shaft starts at its outer end and its length is 0.2 to 0.9 times the length of the generator shaft, located outside the generator. The generator is lodged using generator fixtures on the stator cover and the longitudinal axis of the generator shaft is

located in the longitudinal axis of the turbine. The rotation of the rotor shaft around its longitudinal axis so that the rotor rolls along the inner wall of the stator results in the rotation of the ball joint head, and therefore the flexible shaft, which turns the generator shaft so that the turbine's mechanical power is transformed into electric power.

The advantage of the solution according to the invention is that the electricity generator is rotated without any gearing mechanism because the flexible shaft lodged in the ball joint head as well as in the generator shaft transfers the torque between the ball joint head and the generator shaft without any greater losses. The flexible shaft also absorbs the precessional motion of the ball joint head, the rotor shaft and the rotor created due to the rolling of the rotor along the inner wall of the stator, which is transferred to the flexible shaft and is significantly suppressed in it. The rotation of the flexible shaft is accompanied by its deformation in the form of two connected arches in a specific section of its length between the ball joint head and the generator shaft. The first arch connected to the ball joint head is the outcome of the angular deflection of the ball joint head due to the precessional motion of the rotor shaft and the other arch, connected to the generator shaft, is the outcome of the constant longitudinal position of the generator shaft in the turbine's longitudinal axis.

In the advantageous embodiment, the flexible shaft is made from a plastic material, sufficiently flexible in flexure, partly flexible in tension and suitable for the transfer of the torque. This plastic material has the shape of a cylinder, with a diameter of 0.1 to 0.7 times the diameter of the rotor shaft, and the opening in the ball joint housing for the passage of

the flexible shaft has a diameter of 0.15 to 0.75 times the diameter of the rotor shaft.

According to another advantageous embodiment, the flexible shaft can have the shape of a steel rope that transfers the torque in the direction in which all individual strands are twisted.

According to another advantageous embodiment, the longitudinal cylindrical cavity inside the ball joint head can be extended axially to the rotor shaft and, after a certain length under a specific angle, directed outside the rotor shaft, and its total length can be 0.2 to 0.5 times the length of the rotor shaft. Likewise, the longitudinal cylindrical cavity in the generator shaft whose beginning is located at the outer end of the generator shaft can be directed, after a certain length under a specific angle, outside the generator shaft and its total length can be 0.2 to 0.9 times the length of the generator shaft, located outside the generator. In case of this solution, each end of the flexible shaft can be arranged so that it is not flexible and does not permit the rotation of the flexible shaft inside the longitudinal cavity in the ball joint head and the rotor shaft and inside the longitudinal cavity of the generator shaft. The flexible shaft whose ends protrude into the free space from the rotor shaft and the generator shaft can be also fitted with auxiliary mechanisms, which are not shown, at each end to prevent its rotation inside the longitudinal cylindrical cavities, and therefore its longitudinal movement and retraction into the longitudinal cavity of the rotor shaft or the longitudinal cavity of the generator shaft.

Brief description of drawings

The rolling fluid turbine according to this invention will be described in greater detail on specific embodiments using drawings, where fig. 1 shows the first embodiment of the turbine with a ball joint according to the invention, schematically with partial cross-section in side view. Fig. 2 shows the second embodiment of the turbine with a ball joint according to the invention, schematically with partial cross-section in side view.

Examples of the design of the invention

The embodiment of the rolling fluid turbine shown in fig. 1 consists of a stator 1 provided with an inlet opening 13 for the fluid and with outlet openings 14 for the fluid. It also consists of a rotor 2 placed in the central section inside the stator 1, which has the form of an inlet socket in the direction from the fluid inlet opening 13 to the fluid outlet openings 14 and which is firmly attached to the generator 7 by means of the cover 9 of the stator 1 and fixtures 8 on the generator 7. The rotor 2 is firmly attached to one end of the shaft 3 of the rotor 2, while the other end of the shaft 3 of the rotor 2 is firmly attached to the head of the ball joint 4, placed on the inner side of the cover 9 of the stator 1. The ball joint 4 is attached to the cover 9 of the stator 1 firmly and the cover 9 of the stator 1 and the housing of the ball joint 4 are provided with a conical opening 10 for the insertion of a flexible shaft 5. The ball joint 4 is arranged so that its head contains a longitudinal opening 12, and the shaft 6 of the generator 7 is arranged so that it contains a longitudinal opening 11. The conical opening 10 in the housing of the ball joint 4 has the smallest diameter 0.6 times the

diameter of the shaft 3 of the rotor 2 and the biggest diameter 0.7 times the diameter of the shaft 3 of the rotor 2, and in the cover 9 of the stator 1 it has the smallest diameter 0.7 times the diameter of the shaft 3 of the rotor 2 and the biggest diameter 0.9 times the diameter of the shaft 3 of the rotor 2. The flexible shaft 5 is made from a suitably flexible plastic cylinder with a diameter of 0.4 times the diameter of the shaft 3 of the rotor 2 and is sealed with one end in the longitudinal opening 12 in the head of the ball joint 4 and sealed with the other end in the longitudinal opening 11 in the shaft 6 of the generator 7. The longitudinal opening 12 in the head of the ball joint 4 and the longitudinal opening 11 in the shaft 6 of the generator 7 have the same diameter, i.e. 0.45 times the diameter of the shaft 3 of the rotor 2. The length of the flexible shaft 5 is dimensioned so that when the rotor 2 deflects toward the inner wall of the stator 1, the flexible shaft 5 creates two connected arches in the section between the edge of the longitudinal opening 12 in the head of the ball joint 4 and the edge of the longitudinal opening 11 in the shaft 6 of the generator 7; through these arches, the flexible shaft 5 absorbs the precessional motion of the rotor 2, the shaft 3 of the rotor 2 and the head of the ball joint 4. The rolling of the rotor 2 along the inner wall of the stator 1 due to the fluid flowing through the stator 1 results in the rotation of the rotor 2, and therefore in the rotation of the shaft 3 of the rotor 2 around its longitudinal axis, and thus also the rotation of the head of the ball joint 4, which leads to the rotation of the flexible shaft 5; this in turn results in the rotation of the shaft 6 of the generator 7 and the production of electricity.

In another embodiment shown in fig. 2, the rolling fluid turbine according to the invention is, unlike in the embodiment

in fig. 1, provided with a longitudinal opening 18 passing through the whole head of the ball joint 4 and a part of the shaft 3 of the rotor 2 which protrudes out of the shaft 3 of the rotor 2. It is also provided with a longitudinal opening 17 passing through the shaft 6 of the generator 7 which protrudes from the shaft 6 of the generator 7. The longitudinal opening 18 discharges from the shaft 3 of the rotor 2 under an angle of 45 degrees at a distance corresponding to the diameter of the head of the ball joint 4 and the longitudinal opening 17 discharges from the shaft 6 of the generator 7 under an angle of 45 degrees at a distance corresponding to the diameter of the shaft 6 of the generator 7. The longitudinal opening 18 and the longitudinal opening 17 have the same diameter. The flexible shaft 5 is made from a suitably flexible plastic material in the shape of a cylinder and its diameter is 0.75 times the diameter of the longitudinal opening 18 and the longitudinal opening 17. One third of the flexible shaft 5, which is partly located inside the longitudinal opening 18, in the direction from the end 16 of the flexible shaft 5 that protrudes from the shaft 3 of the rotor 2 and one third of the flexible shaft 5, which is partly located inside the longitudinal opening 17, in the direction from the end 15 of the flexible shaft 5 which protrudes from the shaft 6 of the generator 7, are not flexible. The remaining third of the flexible shaft fulfills the function of torque transfer and eliminates the precessional motion of the rotor 2, the shaft 3 of the rotor 2 and the head of the ball joint 4, just like in the previous embodiment in drawing No. 1. Both end thirds of the flexible shaft 5 that are not flexible fulfill the function of a fixing element that disables the rotation of the flexible shaft around its own longitudinal axis inside the longitudinal opening 18 and inside the longitudinal opening 17. If the fluid starts flowing through the stator 1, the rotor 2 starts rolling

along the inner wall of the stator 1, which rotates the shaft 3 of the rotor 2, the head of the ball joint 4, the flexible shaft 5, and in turn also the shaft 6 of the generator 7, and ultimately this results in the production of electricity.

During practical tests it was verified that, with a rotor diameter of 58mm and at a flow rate of 0.38 to 1.2 liters per second and a water pressure of 0.4 to 2.4 bar, the rolling fluid turbine according to the invention achieved an electric output of 3.2 to 58.6W, depending on the efficiency of the electric generator used.

Industrial applicability

The rolling fluid turbine with a ball joint according to this invention can be especially used for the production of electrical energy on very low flaw rates at a water pressure from several tenths of bar to several bar, when the torque can be transferred using a suitably selected flexible shaft. The simplicity of the design allows easy installation and simple deployment in places with suitable water resources.

List of relation symbols

1 stator
2 rotor
3 rotor shaft
4 ball joint
5 flexible shaft
6 generator shaft
7 generator
8 generator fixture
9 stator cover
10 conical opening
11 longitudinal opening in generator shaft
12 longitudinal opening in ball joint head
13 fluid inlet opening
14 fluid outlet opening
15 part of the flexible shaft protruding from the generator shaft
16 part of the flexible shaft protruding from rotor shaft
17 longitudinal opening in the generator shaft protruding outside the shaft
18 longitudinal opening in the ball joint head and in the rotor shaft protruding out of the shaft

C L A I M S

1. A rolling fluid turbine comprising a stator (1), provided with a fluid inlet (13) and a fluid outlet (14), wherein a rotor (2) is attached to one end of the rotor shaft (3) inside the stator (1), **characterized by the fact that** the shaft (3) of the rotor (2) is firmly attached to the head of the ball joint (4) at one end and the housing of the ball joint (4) is firmly attached to the cover (9) of the stator (1), and the a conical opening (10) is provided in the housing of the ball joint (4) and in the cover (9) of the stator (1).

2. The rolling fluid turbine as in Claim 1, **characterized by the fact that** the head of the ball joint (4) is provided with a longitudinal opening (12) for fixing one end of a flexible shaft (5) and the shaft (6) of the generator (7) is provided with a longitudinal opening (11) for fixing the other end of the flexible shaft (5).

3. The rolling fluid turbine as in Claim 1 or 2, **characterized by the fact that** the flexible shaft (5) has a diameter 0.1 to 0.5 times the diameter of the shaft (3) of the rotor (2) and the conical opening (10) in the housing of the ball joint (4) for the insertion of the flexible shaft (5) has a diameter 0.15 to 0.75 times the diameter of the shaft (3) of the rotor (2).

4. The rolling fluid turbine as in Claim 1, 2 or 3, **characterized by the fact that** the head of the ball joint (4) is provided with a longitudinal opening (18), extended axially to reach the shaft (3) of the rotor (2), in which

it is discharged outside the shaft (3) of the rotor (2) at an angle of 5 to 85 degrees.

5. The rolling fluid turbine as in any of the above Claims, **characterized by the fact that** the shaft (6) of the generator (7) is provided with a longitudinal opening (17) that is discharged in it outside the shaft (6) of the generator (7) at an angle of 5 to 85 degrees.

6. The rolling fluid turbine as in any of the above Claims, **characterized by the fact that** the flexible shaft (5) is made from steel rope and/or plastics and/or composite material.

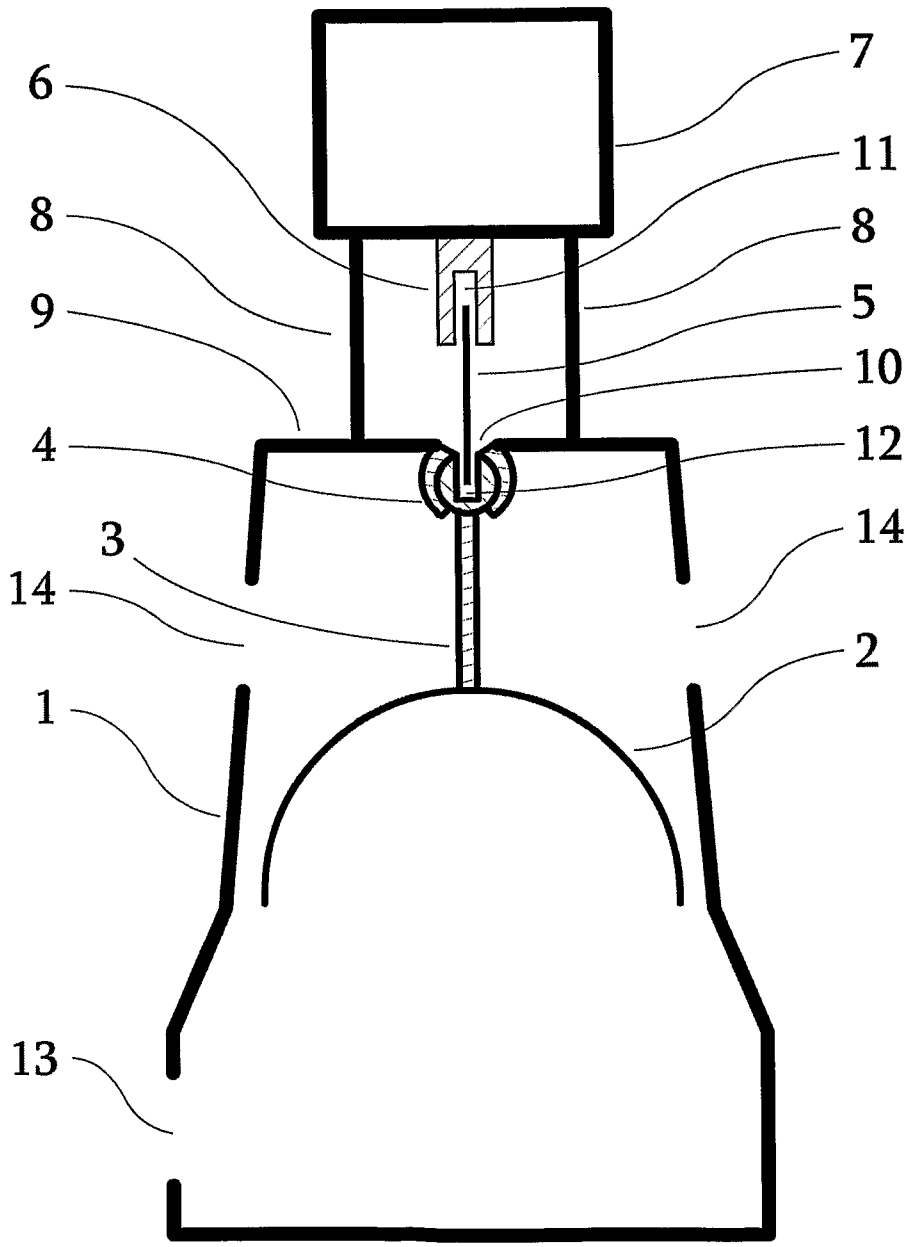

Fig. 1

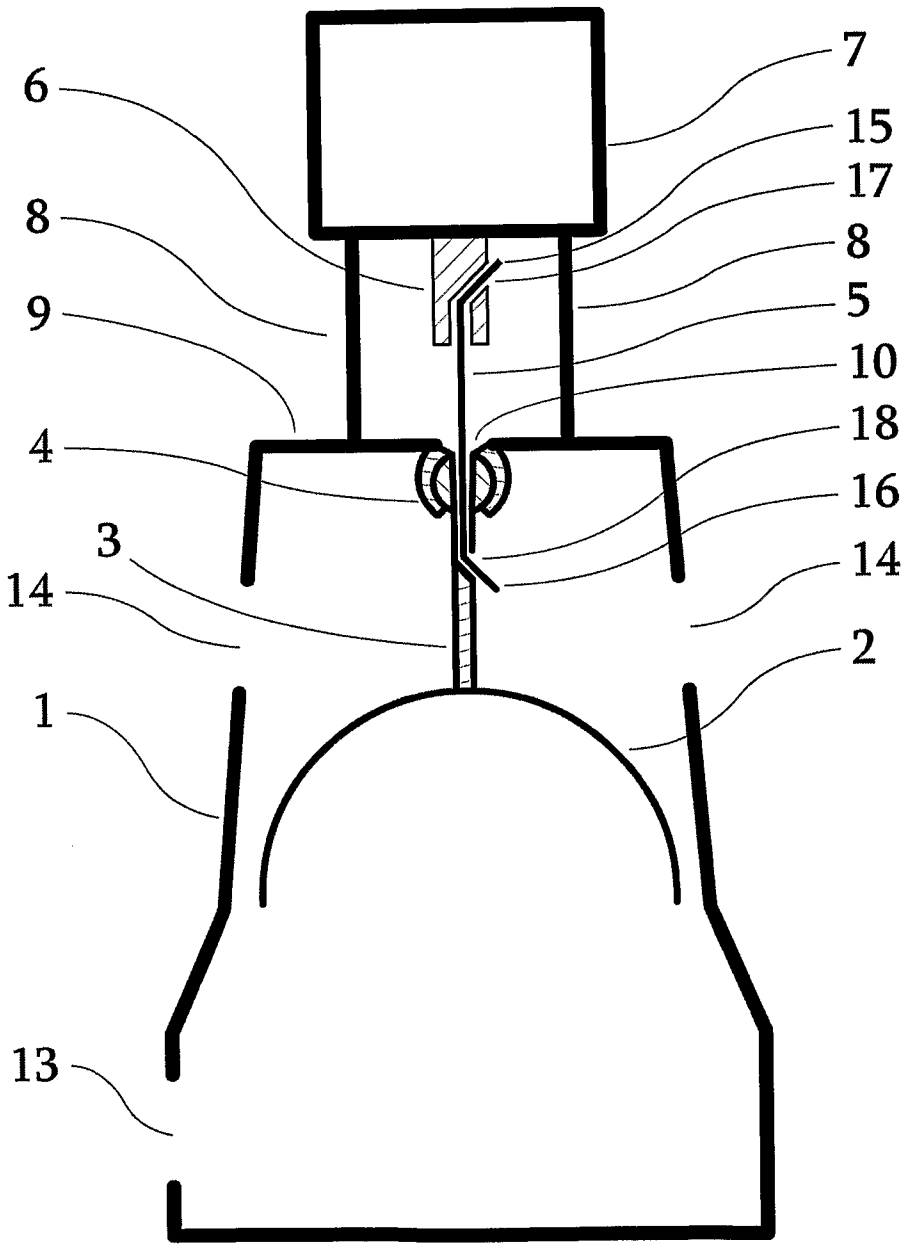

Fig. 2