BALL PUMP

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Abstact: A new and very effective ball pump is created. It can pump across the different liquids, for example: water, lubricants, oil, glycerine and even blood. Moreover it works not only like a pump but as a hydro-machine which can be applied in the various systems, namely, locomotives, robots and so on.

1. INTRODUCTION

There are very many types of pumps in the world and they have a lot of pairs of friction inside their bodies. It decreases the reliability and durability of pumps. That's why the main aim which we demonstrate in this article is the next: how to increase the operation life for a pump and how to make it more effective in practice. This important task is solved by means of improvement of the design.

2. NEW DESIGN

The new ball pump doesn't have any valves; it has minimum pairs of friction, can work as a hydro-machine, be reversible, and has a very high productivity. The pump design has a very small amount of basic parts only – body, rotor which has a shaft with two discs. There are four windows on the ball pump. Two of them stand duty as windows for injection of liquid and the others two are to throw the liquid out of the body. The volume which the ball pump can pump across is proportional to the diameter of a ball in the third power. Both the alteration of the direction for the liquid stream and the productivity adjustment in a ball pump can be realized by means of change of the discs' inclines relatively each other. This new ball pump in its design doesn't have any complicated junctions (Fig. 1).

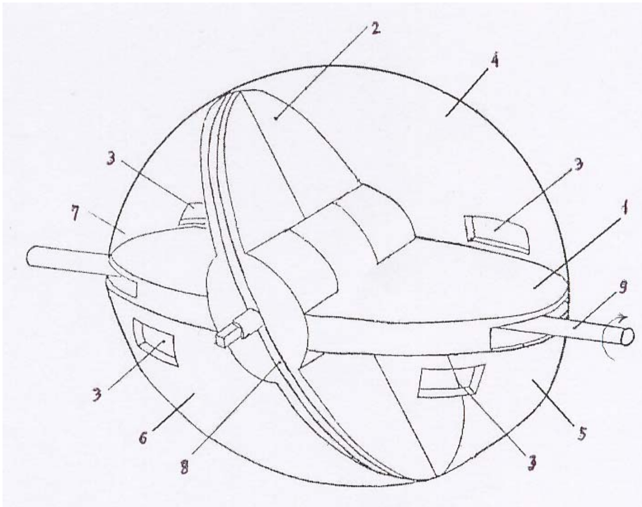

Fig. 1. The design of the new ball pump: 1 and 2 – discs which are connected by hinge; 4, 5, 6 and 7 are chambers which are joined with the windows 3; 8 - adjusting ring; 9 – shaft

Two discs 1 and 2 inside the ball pump divide the volume into four chambers (4-7) which are connected with the windows 3 for injection and to throw any liquid out. For this purpose in each window there is a coupling for the hose. When the shaft 9 rotates clockwise, the disc 1 opens two windows 3 and the volumes of chambers 4 and 6 begins to diminish and liquid from them is being forced out. At the same time the volumes in two chambers 5 and 7 are increasing and liquid in these chambers is being soaked through. These actions will be stopped when disc 1 closes appropriate windows 3 (after the moment when the shaft 9 made the turning on the 180^0). After it the role for the chambers 4 and 6 becomes another as for the chambers 5 and 7. Further the cycle will be repeated many times.

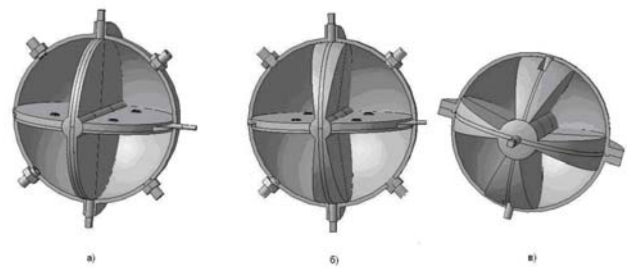

Fig. 2. Ball pump: a) old type with the flat discs; б), в) discs with the special shapes

Turning disc 2 by using adjusting ring 8 we can get the equal volumes in chambers when the angle between of two dicks will be 90^0. But if we continue the turn of the disc 2 in the same direction then the way of movement for liquid will be changed in the opposite direction instantaneously.

The analog of the new ball pump was suggested some years ago in Russia (reader B.A. Dezhinov) and it was named as a "pump for the artificial heart". But in the old version in one position the pump couldn't throw liquid out in full. Professor K. Voynov changed the shape of the discs made them like a cone (Fig. 2) (Патент 79619, 2009). In this case any liquid is being deleted constantly and completely.

3. THEORETICAL PART AND EXPERIMENT

The formula to the ideal feed for the pump (m^3 per hour) is the next: $Q_u=60 \cdot V_0 \cdot n$, where V_0 is the working volume of the pump (m^3); n is the frequency of the rotation for the shaft.

V0=(Vk/V).z.k.(V – Vr),

where V_k is the ideal feed from the each working chamber during one cycle; $V=(4/3) \cdot \pi \cdot R^3$ is the inner volume of the pump; R is the inner radius of the pump; z=4 are the numbers of the working chambers; k=1 is the number of the feeds from each chamber during one rotation of the shaft; V_r is the volume for the pump rotor.

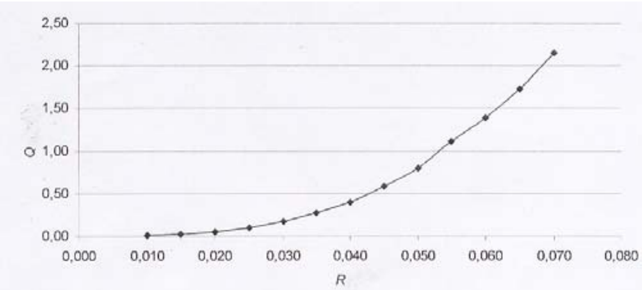

Fig. 3. Chart of the ideal feed Q of a pump-to-the inner radius R of the body ratio

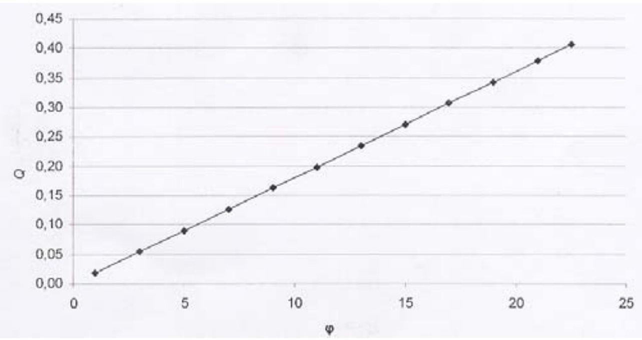

Fig. 4. Chart of the ideal feed Q of a pump-to-the angle φo ratio

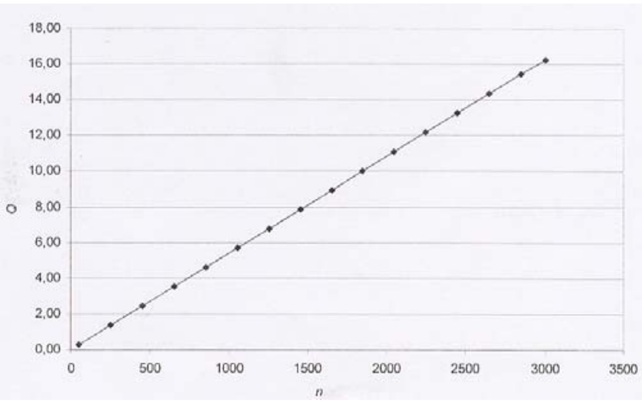

Fig. 5. Chart of the ideal feed Q of a pump-to-frequency n of rotor rotation ratio

Then $V_k=V_{max}-V_{min}=(4/3) \cdot R^3 \cdot \varphi$, φ is the angle of the incline for the driven disc which is counted out from the vertical axis, radian.

Finally the volume of rotor will be the next; $V_r=8 \cdot s \cdot (R^2 \cdot \arccos(a/R) - a \cdot \sqrt{(R^2 - a^2)}) - 8 \cdot b \cdot (r^2 \cdot \arccos(a/r) - s \cdot a) + 2 \cdot \pi \cdot r^2 \cdot b + (2/3) \cdot \pi \cdot (2 \cdot R^2 - r^2 - 2 \cdot R \cdot b) \cdot (2 \cdot R + b)$,

where s is the half of the disc's thickness; r is the radius of a hinge; $a=\sqrt{(r^2 - s^2)}$; $b=\sqrt{(R^2 - r^2)}$.

In Figures 3-5 there are three charts connected with the results of calculations.

The special experiments were made using a new apparatus (Fig. 6). Electric motor can change the speed of rotation. It results in the variation in a feed and a productivity of a ball pump. Because there are too little pairs of friction in the new pump (only one hinge) the reliability of this mechanical system is higher than there is in another known system. The effectiveness of a new ball pump was tested using different liquids, for example: water, oil, glycerine and even blood substitute. And at last the reliability of our ball pump is against than the same index for the prototype 1.26 times as large.

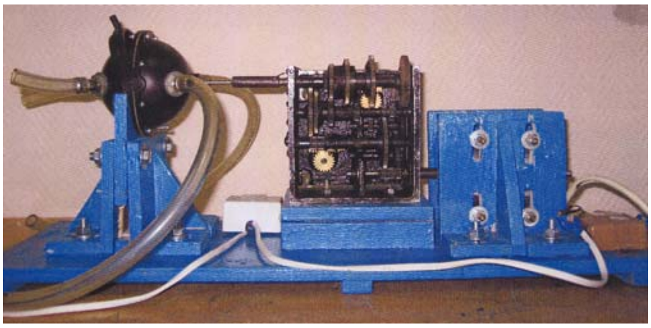

Fig. 6. The experimental apparatus with the new ball pump, gear box (in the middle) and a motor (on the right side)

4. CONCLUSION

1. The new and effective ball pump is created.
2. It can pump over different liquids which have various ductility.
3. Moreover this ball pump can work in a regime as the human heart is working (this fact some of Russian doctors have just confirmed) because the pump works with a pulsation too as our heart does.

REFRENCES

1. Патент 79619 Россия, C1 2008130797/22. 10.01.2009, F01C 3/00. Роторная объёмная машина / Дёжинов Б.А., Войнов К.Н., Черток Е.В. (Россия).