CONTRIBUTIONS ON THE APPLICATION OF THE REVERSAL TECHNIQUE FOR THE ACHIEVEMENT OF THE ELECTROMECHANICAL ACTUATORS WITH LIQUID

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Abstract: *In this study are presented some aspects concerning the achievement of new models of the electromechanical pumps and actuators with liquid, obtained using of the reversal technique. It is important to use the creation methods with intuitive character, methods that are applied to stimulate the spontaneous creation on the achievement of the innovative models in the technical domain.*
Keywords: *electromechanical pumps, actuators, reversal technique, questions.*

Introduction

The stereotypical approach of the problem in the designing is characterized, frequently, by unfruitfulness of the idea. On the contrary, the change of the point of view concerning the theme of technical creation can constitute a mean to eliminate or to diminish the psychological inertia.
The reversal technique supposes the application of the following questions: *Which are the opposited elements? Why doesn't is replaced the positive with negative? Why from down to up and not from up to down? Why horizontal position and not vertical position? Why the approach of the problem from the end and not from the beginning? Why from general to particular and not inverse? Why not to be placed at the opposite extremity?*

Consideration regarding the achievement of the electromechanical micropumps with liquid.

In order to use small quantities of liquids, in technique there are meet certain solutions known as electrochemical micropumps [3]. Such model of micropump is the subject of a study presented in [4], [5].

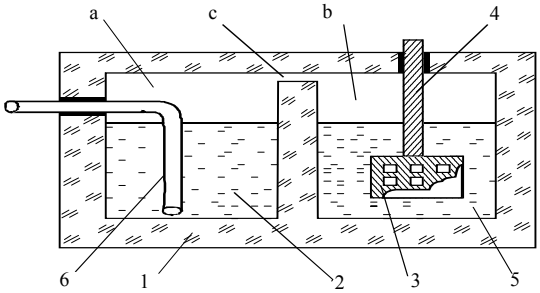

Figure 1. Model of electromechanical pump with liquids,
where: a – cavity with evacuated liquid; b – electrolysis cell; c – microchannel for communication; 1 – carcass; 2 – evacuated liquid; 3 – platinum electrod; 4 – isolating support; 5 – generating liquid of gases; 6 – drain channel.

The pump consists mainly in a parallelepiped carcass made of glass, foreseen with two cavities connected through a capillary glass tube, situated in the wall that separates the two cavities. In one of the cavities it is assembled an electrolysis cell consisting of two platinum contacts connected to a direct current source. These contacts are immersed in water, which it is decomposed into oxygen and hydrogen, by the action of the electrical current. This gaseous mixture penetrates through a microchannel into the second cavity in which is stored the liquid submitted to evacuation. This liquid, under the pressure of the gaseous mixture, is pushed outside through a drain microchannel.

Among other things, the solution described has the disadvantage of having a complex configuration and small sizes, leading to technologically increased difficulties for the making of the carcass.

Contribution on the achievement of new models of electromechanical pumps and actuators using the reversal technique.

Most of these disadvantages can be eliminated using the reversal method. One of the first questions applied in this case is: *Why more different axis and not unique axis?* The question is reported at initial solution of electromechanical micropump, which has those two cavities placed on the different axis.

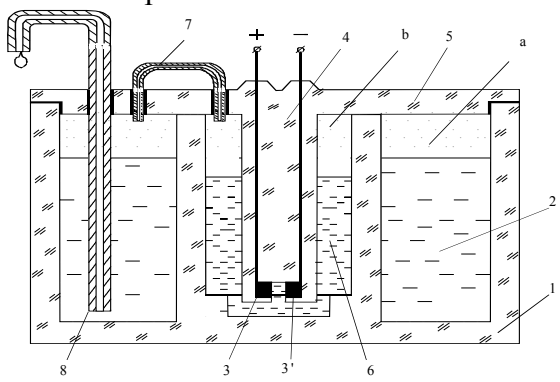

Figure 2. Model of electromechanical pump with concentric cavities,
where: a – cavity with evacuated liquid; b – electrolysis cell; 1 – carcass; 2 – evacuated liquid; 3 and 3' – platinum electrodes; 4 – isolating support; 5 – sealing head; 6 – generating liquid of gases; 7 – microchannel for communication; 8 – drain channel.

The response at this question suggests a solution for make an electromechanical pump, showed in the figure 2, which it is possible to achieve as it is searched the response at the question *Why the parallelipipedical shape and not the cylindrical shape?*
Referring to the used material for the carcass making, must be observed that the utilization of the glass supposes a complicated technology of fabrication. The processing of the glass supposes a relative high temperature, which must assure the fritting of the glass.

The question *Why inorganic and not organic?*, is possible to be used to suggest the solution of the replacement of the glass with plexiglas, a transparent plastic material, which is processed more easily than the glass by injection in the mould or by splintering. This technology is advantaged in order to use a cylindrical carcass, as is previously suggested.
Also, the question *Why from down to up and not from up to down?* suggests the variant of the electromechanical pump, showed in figure 3, which has the channel 8 for the evacuation of the fluid placed in the down part of the carcass.

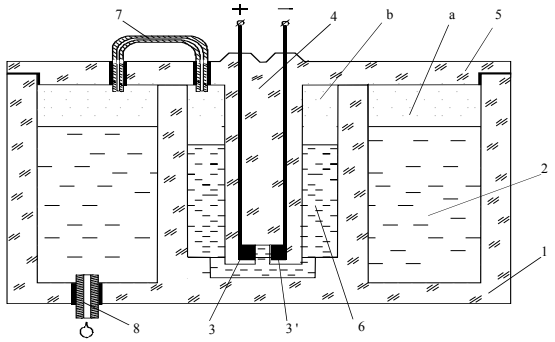

Figure 3. Model of electromechanical pump with concentric cavities,
where: a – cavity with evacuated liquid; b – electrolysis cell; 1 – carcass; 2 – evacuated liquid; 3 and 3' – platinum electrodes; 4 – isolating support; 5 – sealing head; 6 – generating liquid of gases; 7 – microchannel for communication; 8 – drain channel.

Responding at question *Why horizontal position and not upright?*, it is possible to achieve the model of the electromechanical pump characterized by two coaxial superposed cavities (figure 4).
Unlike the previous case, cavity *b* that contains the electrolyser, it is assembled in a superposed coaxial variant with the cavity *a* containing the drained liquid 2, and both cavities could have the same sizes. In this case, the volume of the electrolyser and the afferent liquid 7 can have the same value as the volume of the cavity filled with the evacuated liquid 2. The volume of each cavity can be modified according to the necessity, by acting in the direction of changing the level of the cylinder volume meant for each cavity.

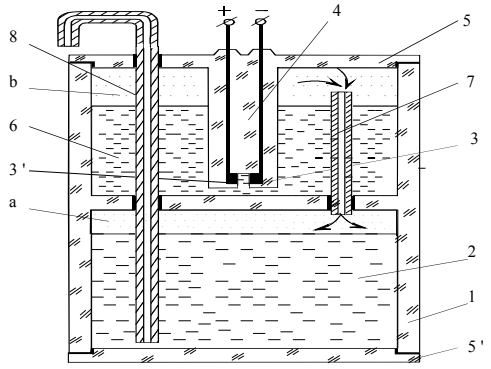

Figure 4. Model of electromechanical pump with superposed coaxial concentric cavities, where: a – cavity with evacuated liquid; b – electrolysis cell; 1 – carcass; 2 – evacuated liquid; 3 and 3' – platinum electrodes; 4 – isolating support; 5 and 5' – sealing head; 6 – liquid for gases generation; 7 – microchannel for communication; 8 – drain channel.

As a result from presented solution, for the making of the pumps were used two different liquids, one of these being the evacuated liquid and another being the generator liquid.

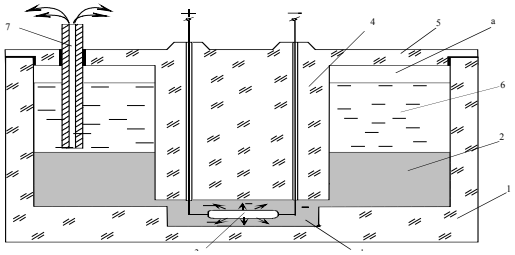

Figure 5. Model of electromechanical pump with immiscible liquids
where: a – main cavity; b – auxiliary cavity; 1 – carcass; 2 – generating liquid of gases; 3 – heating resistor; 4 – isolating support; 5 – sealing head; 6 – evacuated liquid; 7 – drain channel.

Using the question *Why miscible and not immiscible?*, make possible the variant of electromechanical pump showed in figure 5. The generating liquid of gases or vapours is the transformer insulating oil, placed in the lower layer. The insulating oil is decomposed in a gaseous mixture, due to Joule-Lenz effect, and actions on the evacuated liquid. The model, presented in figure 5, can be applied just if the specific weight of the insulating oil is highat than that of the evacuated liquid placed in the upper layer. The model, showed in figure 5, eliminates one of the two cavities of the pumps. In the contrary case, the positions of the liquids are reversed and this imposes another solution with particular character, presented in [4].

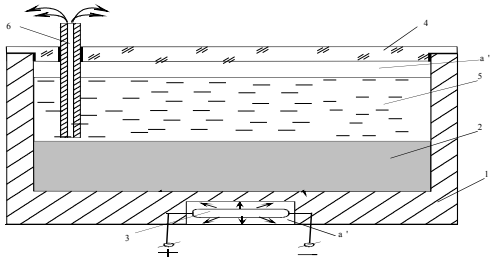

Figure 6. Model of electromechanical pump with immiscible liquids with outside heating source, where: a – main cavity; b – auxiliary cavity; 1 – carcass; 2 – liquid for gases generation; 3 – heating resistor; 4 – isolating support; 5 – evacuated liquid; 8 – drain channel.

If it is analised all solutions, it is evidently the placement of the heating source inside of one cavity, which suppose the complications about the technological making. To eliminate this disadvantage, the heating source is placed outside of cavities, as response at question *Why inside and not outside?*. In figure 6 is showed an model of pump, which has a heating resistor 3, placed outside of the cavity. In the previously cases, the decomposition of the generating liquid is going on inside of the unique cavity.

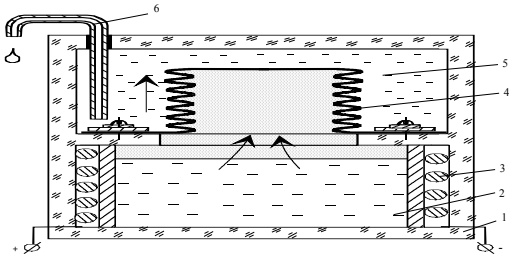

Figure 7. Model of actuator with outside heating source,
where: 1 – carcass; 2 – generating liquid of gases; 3 – heating source; 4 – bellow; 5 – evacuated liquid; 6 – drain channel.

There are cases when the direct contact between the liquids must be avoided, these not being compatible, and it is imposed an outside source of actuation.

A question as *Why toghether and not separatelly?* is a way to obtain the variant of the electromechanical actuator, showed in figure 7. The evacuated liquid 5 and the

generating liquid are separated by an elastic wall constituted by the bellow 4. By action of the pressure of the decomposed gases or vapoures, the bellow is deformated and can act for the evacuation of the liquid 5.

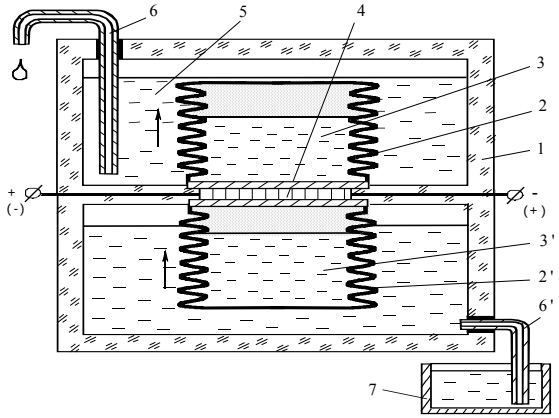

Figure 8. Model of actuator with two bellows,
where: 1 – carcass; 2 and 2' – bellows; 3 and 3' – generating liquids of gases; 4 –Peltier dispozitiv; 5 – evacuated liquid; 6 and 6' – drain channel; 7 – liquids reservoir.

Using the question *Why evacuation of the liquid and not absorbtion?*, is achieved an variant of actuator with two bellows, each of these acting into one of that two cavities of the actuator, by thermal action of the Peltier device (figure 8). The temperature of one of the surfaces of the Peltier device increases and of the other surfaces decreases. As a effect, the pressure, created inside of the elastic cavities, evoluates in the opposed directions on the bellows, the upper bellow being dilated and the lower bellow being contracted.
Therefore, the liquid is evacuated in the upper cavity and is absorbed in the lower cavity, by the depression created by contraction of the bellow 3'.

Conclusions

- The creation technique named *reversal* that consist essentially by an inversed approach of an problem, represent a principal way to eliminate the psychological inertia and to detach from the conception and the conviction obtained by routine.
- This creation technique was used in the research of the electromechanical pumps and actuators and was obtained a number of seven original solutions characterized by: novelty, inventive level and technological applicability. These solutions can represent the object of the patent application.
- Certainly, the identification and the utilisation of another questions can increase the number of the solution in the domain of the electromechanical pumps and actuators with liquid.

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