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(54) **PUMPING SYSTEM**

(57) Pumping system comprising a cylindrical container (1) provided with a piston (2) which is moved by means of a rod (3) ending in a T-shaped profile provided at its lower end with a support (4) fixing two nitinol springs (5, 5'), which have the other two ends rigidly fixed; wherein the upper part of the rod T-shaped profile acts at the ends of the stroke two double microcontacts (M_1, M_1'; M_2, M_2'), which control: the closing and opening of an electrovalve (6) which supplies liquid to the cylindrical container (1), the starting of fans (7, 7') which cool the nitinol springs (5, 5'), and the disconnection of heating circuits of the nitinol springs (5, 5'), said heating circuits being controlled alternately by two relay contacts (k_1, k_2) via a microcontroller (8).

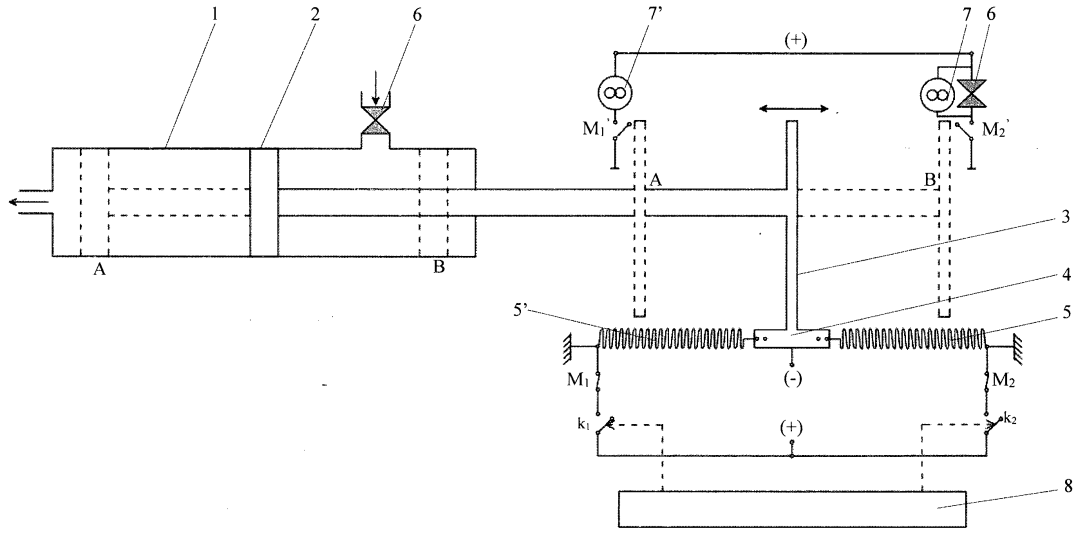

Fig.1

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Description

[0001] The invention relates to a pumping system made on the basis of elastic elements of Nitinol, intended for dosing constant amounts of liquid.

[0002] In order to make devices for pumping fluids, a solution is known, (KIMURA S., Micropump. Patent application no. JP33528492A / 19.11.1992) which consists mainly in the use of an elastic pipe provided at the ends with two unisense valves and which has concentrically placed on its surface an arc of shape memory material commanded in the current. By feeding, respectively, by supply interruption of the spring with shape memory, the elastic pipe contracts and expands transporting the fluid along its length.

[0003] The disadvantages of the described solution are that the placement of the spring of smart material along the length of the pipe leads to difficult control of the amount of liquid pumped, errors in determining the amount of liquid conveyed, high complexity of execution due to thermal insulation and changes in the elastic pipe properties because is subjected to temperature variations.

[0004] The technical problem solved by the invention consists in the realization of a pumping system, controlled by a pair of nitinol springs, to which the pumped liquid quantity and the actuation time can be controlled.

[0005] The pumping system according to the invention eliminates the disadvantages presented by the fact that it consists mainly of a cylindrical container, provided with a piston which is actuated by a system with two nitinol springs heated alternately by the Joule effect and through a timing circuit controls the movement of the piston through the cylindrical container, thus ensuring the pumping of a set amount of liquid.

[0006] The invention has the following advantages:

- constructive simplicity;
- elimination of pumped flow control errors;
- high operational safety and increased reliability;
- high fluid control accuracy.

[0007] An embodiment of the invention is given below in connection with Figure 1 which is an overview of the pumping system.

[0008] The pumping system according to the invention consists mainly of a cylindrical container 1, provided with a movable element (piston) 2 whose rod 3 ends with a T-shaped profile, provided at the lower end with a support 4 which fix two springs with nitinol 5 and 5 ', which have the other two ends fixed rigidly. The upper part of the rod profile 3 acts at the ends of the stroke the double microcontacts M_1, M_1' and respectively M_2, M_2', which control the closing and opening of the electrovalve 6 and the fans 7 and 7 'and disconnects the heating circuits of the nitinol springs 5 and 5' controlled alternately by the contacts of relays k_1 and k_2 via a microcontroller 8.

[0009] The microcontroller 8 controls for a set time the closing of the relay contact k_2 (the contact M_2 in the heating circuit being normally closed), feeds the spring 5 (which is heated by the Joule effect and compresses when the switching temperature is reached), moving the piston 2 until in point B, when the microcontact M_2 is actuated, which controls the normally closed contact (thus interrupting the supply of the nitinol spring 5) and at the same time the normally open contact M_2' which simultaneously supplies the electrovalve 6 (which supplies the cylindrical container 1) and fan 7 that will cool the nitinol spring 5. Once the timing of relay k_2 expires, it will be controlled by the microncontroller 8 for a new period of time to actuate the contact of the relay k_1, which supplies the nitinol spring 5' (which heats and compresses) making it possible to move the piston 2 to point A and pump the liquid outwards, and when the rod 3 reaches point A, the microcontact M_1 will be activated, opening the normally closed contact which interrupts the supply of the spring 5' and at the same time the normally open contact M_1' is actuated, starting the fan 7' which will help to cool the spring 5'. When the set timing expires, the cycle is resumed, and depending on the timing set by the microcontroller 8, controlled amounts of fluid can be pumped or the pumped flow can be set.

[0010] The pumping system according to the invention can be reproduced with the same characteristics and performances whenever necessary, which is an argument in favour of respecting the industrial applicability criterion.

References

[0011]

[1]. KIMURA S., *Micropump.* Patent application no. JP33528492A/19.11.1992.

Claims

1. Pumping system, **characterized in that** it consists mainly of one of a cylindrical container (1), provided with a piston (2) which is moved by means of a rod (3) ending in a shaped profile of T, provided at the lower end with a support (4) fixing two nitinol springs (5) and (5 '), which have the other two ends rigidly fixed, and the upper part of the rod profile (3) acts at the ends of the stroke of the doubles microcontacts (M_1), (M_1') respectively (M_2), (M2'), which controls the closing and opening of the electrovalve (6), the fans (7) and (7') and disconnects the heating circuits of the nitinol springs (5) and (5 ') controlled alternately by the contacts of relays k_1 and k_2 via a microcontroller (8).

2. Pumping system according to claim 1, **characterized in that** the microcontroller 8 controls for a set time the closing of the relay contact (k_2) (the contact (M_2) in the heating circuit being normally closed), the

nitinol spring (5) is fed (which is heated by the Joule effect), moving the piston (2) to point B, at which point the microcontact (M_2) is actuated, which controls the normally closed contact (thus interrupting the spring supply) and at the same time the normally open contact (M_2') which simultaneously supplies the electrovalve (6) (which supplies liquid to the cylindrical container (1)) and the fan (7) which will cool the nitinol spring (5) and once its timing expires (k_2) it will be controlled by the microcontroller (8), for a a new period of time, the actuation of the relay contact (k_1), which supplies the nitinol spring (5') (which is heated and compressed) making it possible to move the piston (2) to point A and pump the liquid outwards, and when the rod (3) reaches point A the microcontact (M_1) will be actuated, opening the normally closed contact which interrupts the supply of the spring (5') and at the same time the normally open contact (M_1') is actuated and starts the fan (7') which will help at the spring cooling. When the set timing expires, the cycle is resumed, and depending on the timing set by the microcontroller (8), controlled flows and controlled quantities of fluid can be pumped.

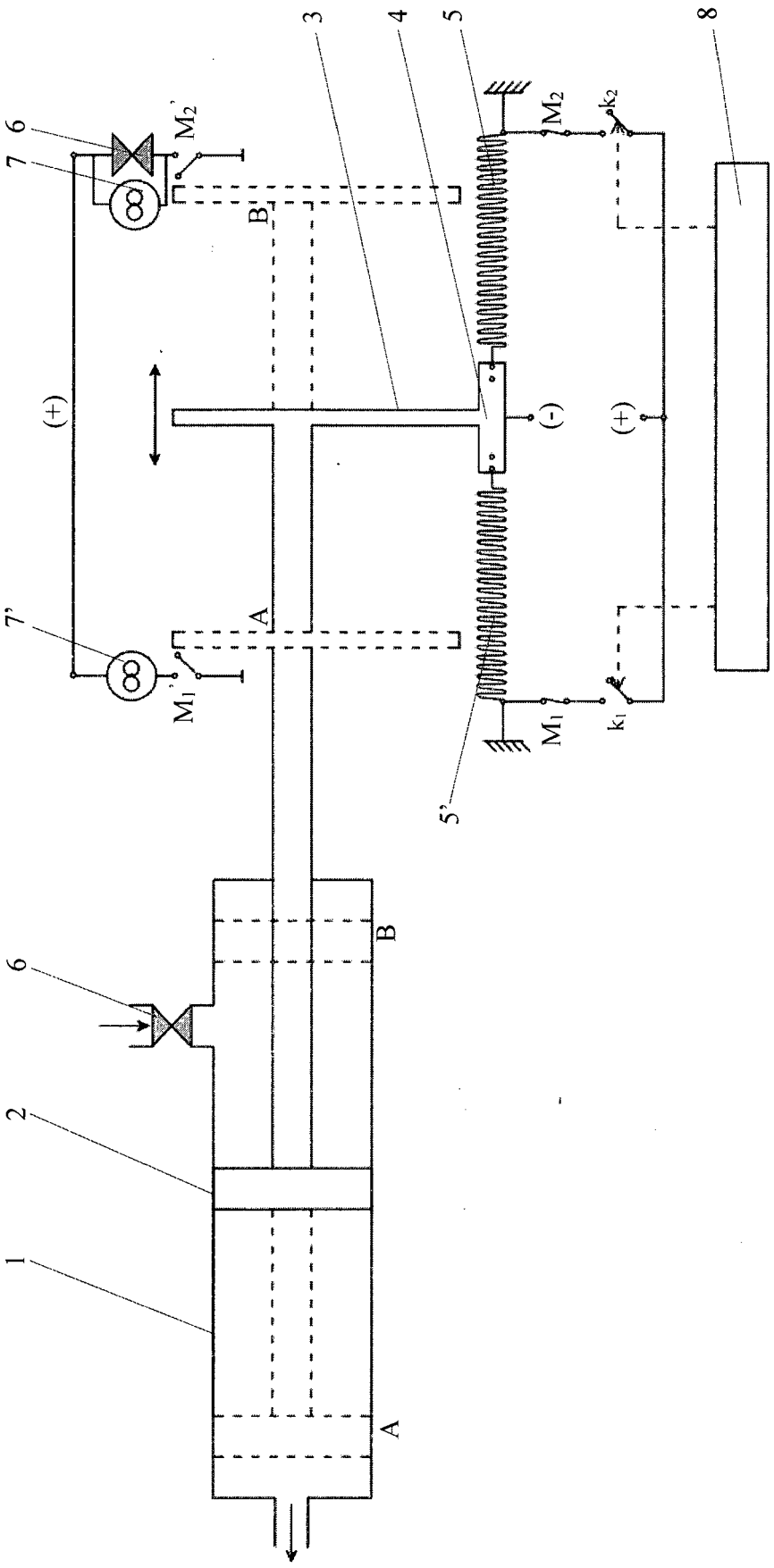

Fig.1

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EUROPEAN SEARCH REPORT

Application Number
EP 20 46 4011

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	RO 132 827 A2 (UNIV STEFAN CEL MARE DIN SUCEAVA [RO]) 28 September 2018 (2018-09-28) * the whole document *	1,2	INV. F04B17/00 F04B9/02 F04B13/00 F04B7/00
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TECHNICAL FIELDS SEARCHED (IPC)

F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 November 2020	Olona Laglera, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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REFERENCES CITED IN THE DESCRIPTION

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