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(54) **FLOW HEATER WITH ELECTRO-ACOUSTIC HEATING ELEMENT**

(57) An electro-acoustic heating device using alternating electric current for a flow heater for heating water-based liquids that comprises an electro-acoustic tubular resonator causing the fluid in which it is immersed to be heated.

The resonator has three tubular electrodes, heating devices, of which the centre electrode 1 is the resonating element, and the two external electrodes 2 are buffering electrodes.

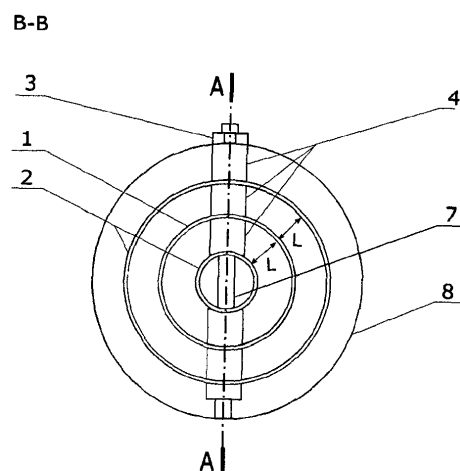


FIG. 4

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Description

[0001] The present invention relates to a method and apparatus for heating water or similar incompressible liquids in flow heaters, and in particular it relates to a flow heater apparatus with an electro-acoustic tubular heating element using resonant heating of the liquid. The heater containing an electro-acoustic heating element is applied in devices for water heating by flow, especially in household devices for hot utility water receiving and in devices for hot industrial water receiving.

[0002] In times of global warming, taxation of carbon dioxide emissions as well as electricity costs rising, it has become extremely important to find ways to save electricity. A hot water storage tank in a household or office is usually the largest single energy consumer.

[0003] Various methods of water heating by means of electricity are known, of which conventional resistance heating elements are considered the most efficient way to heat water and other liquids. Electric water heaters preferably produce hot water without consuming the fuel supplied for on-site combustion. Electric heaters may include an internal, bare heating element, which most often may be a resistance wire helix or an electrical resistance element in a glass or ceramic housing. The heat is transferred from the electric resistance heating element to the working liquid by the conductive heat of various types of heaters origin.

[0004] Apart from conventional resistance heating elements, there are heating systems that use other physical phenomena involving electricity, which, according to the inventors, are more efficient and use less energy to heat the same amount of liquids.

[0005] In solutions with a bare heating element, a series of metal ions are released from the heating elements into the heated water, which in combination with ions present in water form salts of various solubility. These salts, combined with chemical compounds dissolved in heated water at high temperature, cause the formation of deposits on the heating elements and the housing of the heaters, which causes erosion and corrosion of the heating elements and their housings, and in consequence their accelerated consumption. In the application description P.426906, the inventors describe a noncorrosive and erosion-free flow-through heating boiler, in which a method of application a suitable steel is described, which eliminates these phenomena, or at least reduces them to a large extent.

[0006] Heating systems, in which electric energy can be used to generate infrared rays, are less favorable in terms of electrical efficiency.

[0007] In some embodiments of WO2013 / 102830 an ultrasonic converter has been used to increase the efficiency of the heating system and thus reduce costs. The ultrasonic generator and the heating element are preferably connected by a common electrical input so that the device may be used to replace a conventional heating element.

[0008] Patent PL 220668 discloses a method and a device for application of this method of glycol heating by means of an electrode heater operating in two steps due to the sensitivity of glycol to high temperatures.

[0009] In the first step, the glycol is heated with electrodes in the so-called short cycle, and after the liquid is heated to the set temperature, a full cycle is started and the liquid is heated with electrodes in the entire tank. The essence of the device according to the patent PL 220668 consists in the fact that the steel electrodes of the heater immersed in glycol are connected to the AC mains supply circuit with the frequency of the industrial mains and can be made of steel pipes or bars. In the utility model application W. 124769 *Electro-dynamic conductive heater*, a device in which in the inner space of the heater there are electrodes heating the heating medium was presented. The device can work as a stationary or flow heater.

[0010] A similar solution applying other physical phenomena is presented in the devices described in the applications US2014270723 and PL424812.

[0011] The purpose of the invention is to provide a construction of heating element for a flow heater of any design applied for heating liquids, using electro-acoustic resonance resulting from the submerged electrodes supplied with low-frequency alternating pulsed current.

[0012] The essence of the solution is the fact that the electro-acoustic heating element using alternating electric current for the flow heater heating water-based liquids contains an electro-acoustic resonator causing heating of the liquid in which it is immersed. The heating element consists of three electrodes, of which the center tube-shaped electrode is the resonating element, and the two external tubular electrodes are the buffering electrodes.

[0013] The center electrode is connected to the phase wire, the current wire, and the two external electrodes are connected to the neutral wire. In order to ensure high resistance to corrosion and destructive metal salts deposition, the electrodes are made of austenitic steel with the symbol AISI 316L, preferably of chromium-nickel-molybdenum steel. The outer and inner surfaces of the electrodes are ground and polished, thus preventing the formation of deposits on their surfaces.

[0014] The electrodes of the heating element are connected to the AC mains circuit with a frequency of 50 - 60 Hz and a voltage of 110-240 V. The electro-acoustic heating element may be connected through a switch and an inverter to other sources of electric current, preferably obtained from sources of so-called renewable energy.

[0015] The electro-acoustic heating element according to the invention may be a component of a multi-element heating set.

[0016] The invention relates to an emission-free heating technique, which can be used in households and industry. The solution in which austenitic steel in a three-electrode system has been applied is a new solution and allows to increase the efficiency of the heating element as well as the boiler in which it was installed. Additionally, it prevents rapid corrosion and progressive erosion of the

boiler in result of the mineral compounds deposition on the surface of the electrodes.

[0017] The design of the device is shown in the drawings, in which Fig. 1 shows a sectional view of the heater, while Fig. 2 shows a longitudinal section A-A of the device, with attached detailed part A, Fig3. Figure 4 shows the cross-section of the heater B-B.

[0018] Marked in the figures:

- 1 - internal resonating electrodes
- 2 - external buffering electrodes
- 3 - electrode fixing caps
- 4 -ceramic / ebonite pads regulating mutual distances between the electrodes
- 5 - the phase current connection to the tubular resonating electrode inside the device
- 6 - the residual current connection to the tubular buffering electrode inside the device
- 7 the neutral current connection to the tubular buffering electrode and the resonating electrode outside the device
- 8 - heater housing
- L - distance between electrodes.

[0019] The solution in which austenitic steel is applied in a system of three tubular electrodes, of which the electrode 1 is the resonating electrode, and the pipes 2 are the two external and internal buffering electrodes of the heating element. Electrodes 1 and 2 are separated by insulating spacers 4 made of a material insulating electric energy, preferably made of glass, porcelain or ebonite. Caps 3 fasten the electrodes inside the device and at the same time they fasten them to the housing, ensuring the insulation of individual electrodes and their stability when connected to the housing. The distance between electrodes is 3 - 5 mm. The length of the device according to the invention is less than or equal to 1000 mm.

[0020] The connections of the power cables 5 and 6 allow the current to be supplied to the electrodes of the heating element. Connection 5 corresponds to the phase current and connection 6 corresponds to the neutral circuit. The entire power supply is provided by the connection 7 located on the housing through the cap 3.

[0021] The presented tubular heating element is a new solution ensuring more efficient application of electricity for heating liquids that can be used in households and for industrial purposes.

[0022] The construction and application of the device that is the subject of the invention application is described in the embodiment. The presented device is a laboratory device used during the tests concerning the electrical efficiency of the device.

Example 1

[0023] An embodiment of an electro-acoustic heating element device according to the invention is shown in Figures 1 and 2. The heater shown in Fig. 1 comprises

an electro-acoustic heating element consisting of two external buffering electrodes 2 made of austenitic steel with the symbol AISI 316L, with the following dimensions: length of 70 mm and thickness of 2 mm. At the of electrodes a connection was made to connect the neutral electric wire 6.

[0024] The central resonating electrode 1 was made of austenitic steel with the symbol AISI 316L, chromium-nickel-molybdenum steel X2CrNiMo17-12-2 / 1.4404 with dimensions of 60 mm x 8 mm and a thickness of 2 mm.

[0025] At the end of the electrode a phase connection was made for the electric wire 5. Buffering electrodes and resonating electrode have been connected through a hole with a diameter of 6 mm, with a plastic screw 7, separating them by the ring-shaped spacers 4 made of porcelain, with a hole sized to match the outer diameter of the electrodes and a thickness of 3 mm.

[0026] In the efficiency test of the heater with an electro-acoustic heating element, two independent experiments were performed with the use of the same parameters of the experiment. A heater with an electro-acoustic heating element and a typical electric heater have been used to heat the water. Devices with a power of 1850 W have been connected to the power of 7.8 A and 230V. Water with an initial temperature of 25°C has been used. After 10 minutes of heating water with a volume of 100 l and a liquid flow of 10 l / min, the temperature for water heated by a heater with an electro-acoustic heating element was 60°C, and for a typical heater, 35°C.

[0027] The result of the experiment fully confirms the greater efficiency of the heater with electro-acoustic heating element. The invention described above is only a description of an embodiment and it does not limit the methods of making other modifications and dimensions of the device in the spirit of the invention essence and the data set out in the claims.

Claims

1. An electro-acoustic heating element using alternating current for a flow heater for heating water-based liquids, **characterized in that** it comprises an electro-acoustic tubular resonator for heating the liquid in which it is immersed.
2. Electro-acoustic resonator according to claim 1, **characterized in that** it has three tubular electrodes, heating elements, of which the middle one is a resonating element, and the two extreme electrodes are buffering electrodes.
3. The electrodes according to the claim 2 **characterized in that** the central one is connected to the phase conductor, the current one, and the two external electrodes are connected to the neutral conductor.

4. The electrodes according to the claim 2, distinguished by that they are made of austenitic steel with the symbol AISI 316L, preferably made of chrome-nickel-molybdenum steel. 5
5. The electrodes according to the claim 2, distinguished by that their inner surface as well as the outer one is ground and polished, thus preventing the formation of salt deposits on their surfaces. 10
6. The electrodes according to the claim 2, distinguished by that they have the shape of a tube with an outer diameter less than or equal to 1000 mm.
7. The electrodes according to the claim 2, distinguished by that the thickness of metal electrodes is less than or equal to 10 mm. 15
8. The electrodes according to the claim 2, distinguished by that the two external buffering electrodes are 5-10% longer than the centre resonating electrode. 20
9. The electrodes according to the claim 2, distinguished by that they are separated by ring-shaped spacers made of porcelain, glass, ebonite with a hole of the dimensions matching the outer diameter of the electrodes and a thickness less than or equal to 50 mm. 25
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10. An electro-acoustic heating device according to the claim 1, distinguished by that the electrodes of the heating element are connected to an industrial AC mains circuit with a frequency of 50 - 60 Hz and a voltage of 110-240 V. 35
11. The electrodes according to the claim 1, distinguished by that they are supplied with alternating current of a power less than or equal to 20,0 kW. 40
12. An electro-acoustic heating device according to the claim 10, distinguished by that the electrodes of the heating device can be connected via a switch and an inverter with other sources of electric current, preferably obtained from sources of the so-called renewable energy. 45
13. An electro-acoustic heating device according to the claim 1, distinguished by that it may be a component of a multi-element heating set. 50

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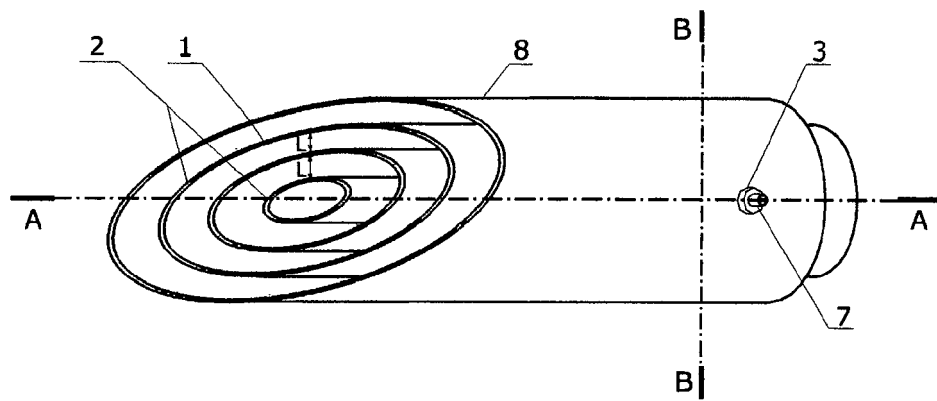
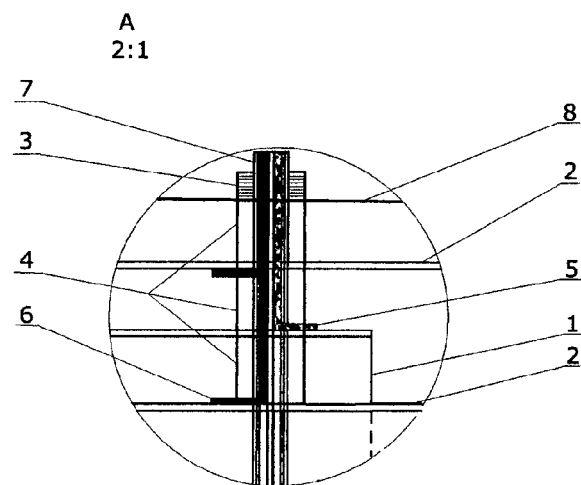
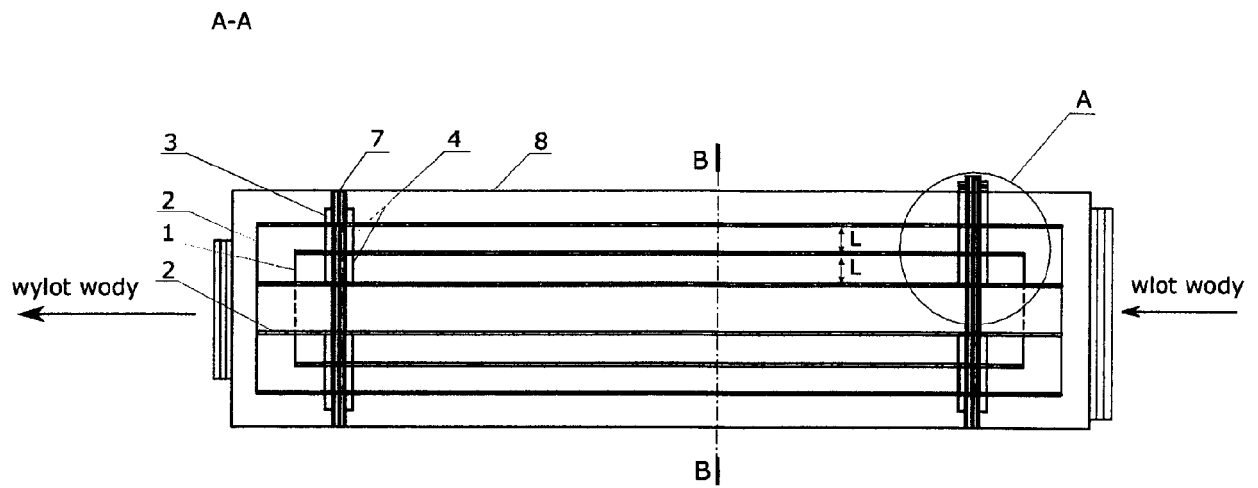


FIG. 1



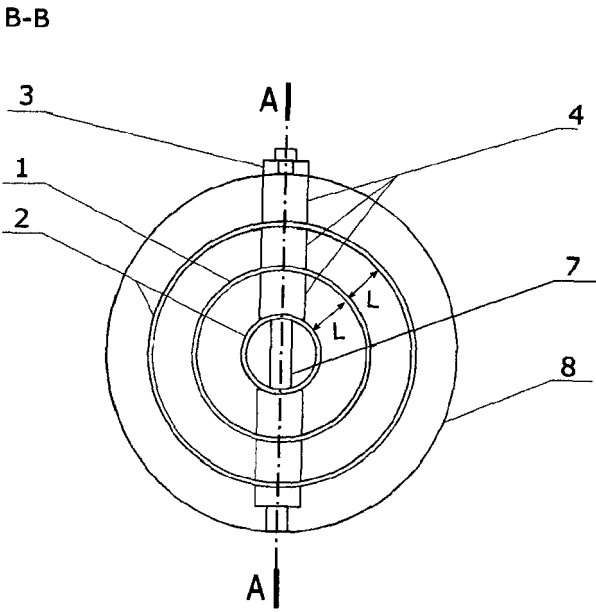


FIG. 4



EUROPEAN SEARCH REPORT

Application Number

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2015/082944 A1 (KOÓS-VARJU JÁNOS [HU]; KOÓS-VARJU ZSÓFIA [HU] ET AL.) 11 June 2015 (2015-06-11) * page 6, line 30 - page 15, line 14; claims 1,8; figures 1-5 *	1,10-13	INV. F24H1/10 H05B1/02 H05B6/54
X	US 2014/270723 A1 (FROUSSART GERARD HENRI [FR]) 18 September 2014 (2014-09-18) * paragraph [4621-]; claim 1; figures 1,6,7 *	1,10-13	
Y		2-9	
Y	US 2009/074389 A1 (NOE NATHAN H [US] ET AL) 19 March 2009 (2009-03-19) * paragraphs [0024] - [0026]; figure 1 *	2-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			F24H H05B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 January 2022	Examiner Hoffmann, Stéphanie
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2015082944 A1	11-06-2015	CA 2932367 A1	11-06-2015
		CN 105830531 A	03-08-2016
		DK 3078241 T3	17-02-2020
		EA 201691110 A1	30-11-2016
		EP 3078241 A1	12-10-2016
		ES 2770580 T3	02-07-2020
		HK 1225562 A1	08-09-2017
		HR P20200159 T1	01-05-2020
		IL 245960 A	29-04-2021
		JP 6611717 B2	27-11-2019
		JP 2017502461 A	19-01-2017
		LT 3078241 T	25-02-2020
		PL 3078241 T3	18-05-2020
		PT 3078241 T	19-02-2020
		SI 3078241 T1	31-03-2020
		UA 121109 C2	10-04-2020
		US 2016309547 A1	20-10-2016
		WO 2015082944 A1	11-06-2015
US 2014270723 A1	18-09-2014	US 2014270723 A1	18-09-2014
		WO 2014146118 A1	18-09-2014
US 2009074389 A1	19-03-2009	CN 101889472 A	17-11-2010
		EP 2215888 A1	11-08-2010
		US 2009074389 A1	19-03-2009
		WO 2009049194 A1	16-04-2009

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2013102830 A [0007]
- PL 220668 [0008] [0009]
- US 2014270723 A [0010]
- PL 424812 [0010]