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(54) **Cavitation thermogenerator and method for heat generation by the caviation thermogenerator**

(57) A cavitation thermogenerator is proposed providing heat generation by creation in a flow of liquid of zones of lowered and raised pressure and moving of a mixture of liquid with the cavitation bubbles formed in the zone of lowered pressure, from the zone of lowered pressure into the zone of raised pressure. The cavitation thermogenerator comprises a coaxially located hollow housing (1) having a bottom (2), a flow twisting means (3) with a cylindrical internal surface, a nozzle (4) and a braking element. The flow twisting (3) means is located between the nozzle (4) and the housing (1), and internal surface of the flow twisting means (3) forms a uniform cavity with the internal surface of a housing (1). A through aperture (5) is formed in the housing bottom (2) at the axis thereof, and the braking element it is formed by a face part of the nozzle (4) adjoining to the flow twisting means (3) which input aperture (5) has a smaller diameter than internal diameter of said cavity. The thermogenerator is placed in a tank (11) with a liquid medium (water) which has a function of a heat-carrier. By means of the pump (6) the liquid moves from the tank (11) into the thermogenerator flow twisting means (3) providing functioning thereof.

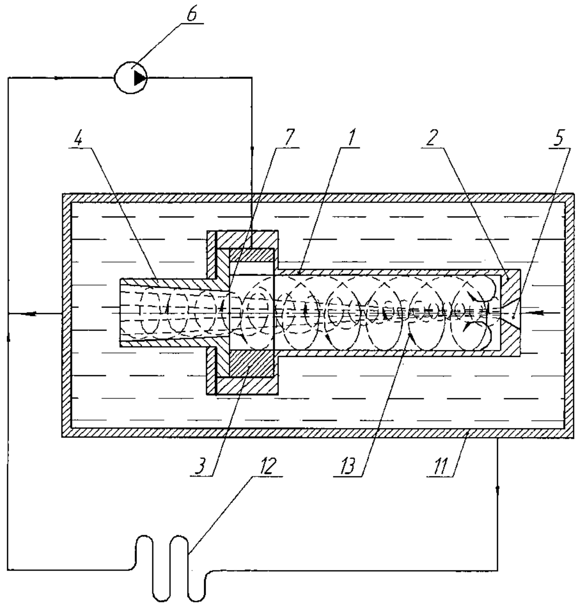

Fig. 1

EP 1 808 651 A2

Description

Field of the Invention

[0001] The invention relates to construction of cavitation thermogenerators providing heat generating due to creation of cavitation bubbles and their subsequent collapse, and also to a method of heat generating by the cavitation thermogenerator, and can be used in water heating systems, hot water supply and for other purposes where heated liquid is required.

Background of the Invention

[0002] A known method for heat generation in the cavitation thermogenerator (RU patent no. 2142604) provides forming of cavitation bubbles in a liquid flow due to creation of pressure in the liquid below the pressure of its vapor and moving of the mixture of liquid with the cavitation bubbles from the zone of lowered pressure into zone of raised pressure. In the zone of raised pressure the cavitation bubbles instantly collapse causing local hydraulic microshocks, accompanied by emissions of pressure and temperatures. Changing underpressure in the zone of lowered pressure and consumption of flowing liquid creates a resonant mode therein.

[0003] However for realization of this method a rotor-pulsation apparatus is required having a complex construction requiring hi-tech equipment and tooling for manufacturing thereof.

[0004] It is known a method for intensification of the cavitation apparatuses working processes (RU patent no. 2212596) in which circulating transfer of the cavitation bubbles from the paraxial zone of the basic vortex in the channel on its periphery and back is carried out in a rotating flow of liquid in the channel zone with cavitation bubbles.

[0005] Realization of the given method also requires an apparatus of complex construction that is caused by presence of symmetric cavities for forming of turbulence in the liquid promoting intensification of the cavitation process.

[0006] It is known a hydrodynamic cavitation apparatus (RU patent no. 2144627) in which process of cavitation occurs when liquid runs on a fixed element. The given apparatus comprises a pipe, a face cap at an inlet aperture, the cap having a function of a flow accelerator, a cylindrical chamber being a flow separator, a jacket chamber, a flow receiver, a cavitation insert- nozzle, placed in the confuser chamber formed as a ring channel, and a muffler chamber.

[0007] Deficiency of the device is in presence of a significant amount of non-rectilinear channels therein flowing through which the liquid loses speed and kinetic energy which is a main source of thermal energy. Reduction of the speed of liquid flowing through the device is undesirable because of slowing in this case of the liquid turnover in the closed cycle through the loading (consumer of the thermal energy) and the pump.

[0008] Another deficiency of the device is relative complexity of its constructions which is caused by presence of the jacket chamber, face cap, flow receiver with a plurality of through channels.

[0009] It is known a plant according to patent RU 2190162, comprising a means for twisting of the flow having inlet and outlet apertures, a housing formed by coils of a tube densely wound in form of a spring with rigid connection of the adjacent coils therebetween and having inlet and outlet branch pipes on the end coils, a braking element and a tank with a liquid medium in which the thermogenerator is placed. The discharge outlet of the flow twisting means directed inside the hollow housing tangentially and obliquely corresponds to the inclination angle of coils of the tube forming the wall of the housing (pipe).

[0010] Deficiency of this plant is in low intensity of cavitation generated therein.

Summary of the Invention

[0011] It is an object of the present invention to increase heat transfer of the cavitation thermogenerator by rising intensity of the cavitation process due to more effective organization of liquid medium flows movement with various value pressure gradients without complication in the thermogenerator construction. Another object of the invention is to decrease in harmful cavitation influence (erosion) on the thermogenerator construction elements due to localization and removal of its zone from the construction elements with simultaneous preservation of high speed of liquid flow movement through the thermogenerator.

[0012] The specified objects are resolved by that the cavitation thermogenerator comprising a coaxially located hollow housing having a bottom, a flow twisting means with a cylindrical internal surface, a nozzle and a braking element. Thus the flow twisting means is located between the nozzle and the housing, and internal surface of the flow twisting means forms a uniform cavity with the internal surface of a housing, thus a through aperture is formed in the housing bottom at the axis thereof, and the braking element it is formed by a face part of the nozzle adjoining to the flow twisting means which input aperture has a diameter smaller than internal diameter of said cavity.

[0013] The flow twisting means is mainly executed in form of a cylindrical casing with at least one tangential channel for input of the medium.

[0014] The lateral wall of the cavitation thermogenerator housing can be formed by coils of a tube densely wound in form of a spring with rigid connection of the adjacent coils therebetween, and the tube has an inlet and an outlet branch pipes at the end coils, thus at least one tangential channel for input of the medium of the flow twisting means is additionally inclined at an angle corresponding to the tube coils inclination angle. Thus the lateral wall of the housing can be formed by coils of several tubes densely wound in form of a multistart spring with rigid connection of the adjacent coils therebetween, and each tube has an inlet and an outlet branch pipes at the end coils. Such thermogenerator housing implementation allows providing additional heating of various liquids by supplying thereof into the tube cavity through its input branch pipe. Flowing through the heated wall at the wound tube the liquid in result of intensive heat exchange is heated and through the outlet branch pipe is fed to the consumer.

[0015] Preferably the internal surfaces of the cavitation thermogenerator contacting to the liquid flows are covered with a material chosen from the group of hydrophobic polymers.

[0016] The cavitation thermogenerator housing chamber can have both a cylindrical form and a form of truncated cone turned by the smaller basis to the flow twisting means.

[0017] In case of the cylindrical form of the chamber its length is preferably 2.7 - 4.5 of its internal diameter.

[0018] The aperture in the housing bottom of the cavitation thermogenerator preferably has a cone form and turned by the greater basis outside of the cone, and in case of the cylindrical form of the chamber the aperture in the housing bottom diameter is preferably 0.12 - 025 of the chamber internal diameter, and the cone angle is within the limits of 40° - 70°.

[0019] The cavitation thermogenerator nozzle has a form of diffuser which angle is preferably within the limits of 5.5° - 6.0°, and in case of the cylindrical form of the chamber diameter of the diffuser input aperture is 0.55 - 0.75 of the housing internal diameter, and the discharge outlet diameter is 0.85 - 0.95 of the housing internal diameter.

[0020] Besides, the specified objects are resolved by that the heat generating method includes generating in the liquid flow of zones of lowered and raised pressure and moving the mixture of the liquid with cavitation bubbles formed in the lowered pressure zone from the lowered pressure zone into the zone of raised pressure. Thus the specified zones and moving of the mixture of the liquid with the cavitation bubbles from the lowered pressure zone into the raised pressure zone are created by injecting into the cavitation thermogenerator placed in the tank with liquid, by means of a pump, of liquid from the tank with forming of a closed contour, thus the cavitation thermogenerator comprises serially coaxially located the housing with a bottom, a flow twisting means with a cylindrical internal surface, a nozzle and a braking element formed by the end face of the nozzle, and the internal surface of the flow twisting means defines a uniform cavity with internal surface of the housing, the bottom of the housing on the axis thereof is provided with a through aperture, and the braking element is formed by the adjoining the flow twisting means face part of the nozzle which input aperture has a diameter smaller than the internal diameter of said cavity.

[0021] Implementation of the through aperture in the center of the thermogenerator housing chamber bottom allowed to create a rectilinear axial flow of liquid due to ejection effect generated by pressure drop in the center of the liquid swirling flow inside the housing chamber at its bottom part, generating the flow rotation around the aperture. Implementation of this aperture in form of a truncated cone turned by the greater basis outside of the cone allowed to activate ejection of the liquid supplied in the chamber and thereby to increase axial flow speed of the liquid in the thermogenerator cavity.

[0022] Presence of the counter flows in the cylindrical chamber (axial, paraxial flows directed to the nozzle input aperture, and a spiral swirling flow moving in the direction to the bottom of the housing) promotes more effective organization of liquid medium flows movement with various value pressure gradients forming the cavitation zone in form of a truncated cone surface turned by the greater basis to the chamber outlet. The subsequent narrowing and expansion of the mixed flows, their straightness and high speed promote intensification of the cavitation process, collapse of bubbles and generating of additional heat.

[0023] Distancing of the cavitation zone from the chamber wall prevents destructive influence of the cavitation thereon.

[0024] Presence of a braking element in form of the nozzle face part attached to the flow twisting means promotes strengthening of the cavitation effect at preservation of speed and straightness of the liquid flow.

[0025] Covering the thermogenerator internal surfaces contacting with flows of the liquid medium by hydrophobic polymers essentially increases speed of flow and intensity of cavitation.

[0026] Cylindrical form implementation of the housing chamber is the most preferable in technological and functional aspects.

[0027] Implementation of the housing chamber in form of truncated cone complicates its manufacturing, but raises thus functional ability of the thermogenerator.

Brief Description of the Drawings

[0028] The invention is further explained in the specification of particular exemplary implementations thereof and with reference to the applied drawings in which:

Fig. 1 is a sectional side view of the first embodiment of the thermogenerator;

Fig. 2 is a sectional side view of the another embodiment of the thermogenerator represented in Fig. 1;

Fig. 3 is a sectional side view an embodiment of the thermogenerator with a wall formed by coils of a tube.

Detailed Description of the Invention

[0029] The cavitation thermogenerator shown in Fig. 1 comprises a hollow cylindrical housing 1 with a bottom

2, a flow twisting means 3 with a cylindrical internal surface and a nozzle 4. The housing 1 bottom 2 is provided with a through axial aperture 5 having form of truncated cone turned by the greater basis outside. The aperture 5 has a function of ejector of the auxiliary axial flow of liquid. Its smaller diameter is about 0.12 - 0.25 of the internal cylindrical housing 1 diameter, and the cone angle is within the limits of from about 40° to about 70°. Increase in aperture 5 diameter to more than 0.25 of the internal cylindrical housing 1 diameter worsens operation of the generator due to reduction of the axial flow speed that leads to unstable mode of the cavitation process. Reduction of the aperture 5 diameter to less than 0.12 of the cylindrical housing 1 internal diameter leads to falling of kinetic energy of the axial flow jet, hence, to deterioration of the cavitation process due to reduction of the surface area of the liquid counter flows interaction.

[0030] The length of the hollow housing is preferably 2.7 - 4.5 of its internal diameter. Increase in the length of the cylindrical housing for more than 4.5 of its diameter results in reduction in speed of the vortical peripheral flow and reduction of ejection speed of the auxiliary axial flow through the aperture 5 in the bottom of housing 1. Reduction of length of the housing to less than 2.7 of its diameter worsens the thermo generator power characteristics because of reduction of the interaction surface area of the basic and the auxiliary flows.

[0031] The flow twisting means 3 is provided in form of a cylindrical casing with at least one tangential channel for input of the medium, the channel being connected to a delivery branch pipe of the centrifugal pump 6. The internal surface of the flow twisting means 3 forms a uniform cavity with the internal surface of housing 1. The medium input channel has a spiral form, for example, an Archimedean spiral form and tangentially adjoins the cylindrical internal surface of the flow twisting means 3 at an angle to the longitudinal axis providing screw movement of the medium flow in the internal cavity of housing 1. The nozzle 4 is installed coaxially to housing 1 and to the flow twisting means 3 and adjoins the flow twisting means 3 from the side opposite to the housing. Thus the nozzle 4 input aperture has a diameter smaller than the internal diameter of said cavity so that the face surface of the nozzle 4 forms a braking element 7 for the medium flow moving in the direction from the bottom 2 of housings 1 to the nozzle 4 outlet. The nozzle 4 has a form of a diffuser which angle is preferably within the limits of 5.5° - 6.0°. Thus diameter of the nozzle 4 input aperture is preferably 0.55 - 0.75 of the housing internal diameter, and diameter of the discharge outlet is 0.85 - 0.95 of internal diameter of the housing. Increase in diameter of the nozzle 4 input aperture for more than 0.75 of the cylindrical housing internal diameter reduces the flow braking effect and, hence, intensity of the cavitation process, and reduction of this diameter to less than 0.55 of the internal diameter of the cylindrical housing destabilizes the thermogenerator work because of significant resistance to the liquid flow. Increase in the nozzle 4 diffuser aperture outlet diameter for more than 0.95 of the cylindrical housing internal diameter and the diffuser angle for more than 6° reduces the thermogenerator heat transfer, and reduction of nozzle 4 diffuser aperture outlet diameter to less than 0.85 of the cylindrical housing internal diameter and the diffuser angle to less than 5.5° increases resistance for the liquid discharge flow and destabilizes thermogenerator work.

[0032] The thermogenerator internal surfaces contacting the flows of liquid are covered (not shown conditionally) with a material chosen from the group of hydrophobic polymers. Said covering promotes increase in speed of the flow and, thereby, increase of the cavitation intensity.

[0033] The thermogenerator housing 1 in a further embodiment shown in Fig. 2 can have a form of truncated cone turned by the smaller basis to the flow twisting means 3 (Fig. 2). Such form of the housing complicates its manufacturing, but increases thus functional ability of the thermogenerator.

[0034] In additional embodiment of the cavitation thermogenerator shown in Fig. 3 the lateral wall of housing 1 is formed by coils of tube 8 densely wound in form of a spring with rigid connection of the adjacent coils therebetween. The tube 8 has an inlet 9 and an outlet 10 branch pipes at the end coils, thus at least one tangential channel for input of the medium of the flow twisting means 3 is additionally inclined at an angle corresponding to the coils inclination angle of tube 8. The lateral wall of housing 1 can also be formed by coils of several tubes 8 (not shown conditionally) densely wound in form of a multistart spring with rigid connection of the adjacent coils therebetween, and each tube has an inlet and an outlet branch pipes at the end coils. Such implementation of the thermogenerator housing 1 lateral wall allows to provide with heat several consumers additionally. Besides, owing to presence at the housing 1 internal surface, in case of such implementation of its lateral wall, of screw ledges and gaps the cavitation process proceeds more intensively. Thus the housing 1 form with lateral wall thus formed can be both cylindrical, and of truncated cone turned by the smaller basis to the flow twisting means 3 of the housing.

[0035] The cavitation thermogenerator works as follows.

[0036] The thermogenerator is located in tank 11 with a liquid medium (water) which has a function of the heat-carrier. Through the tank 11 discharge outlet and loading 12 cavity of the tank 11 is communicated to input of the pump 6 and also, omitting the loading 12, it is connected to the suction line of the pump 6. The loading 12 is an element of external contour. The working volume 13 of the housings 1 is defined by the cylindrical surface, its bottom 2 and a ring braking element 7 from the side of the nozzle 4 input aperture. The braking element 7 provides braking and narrowing of the flow which then expands in the diffuser part of nozzle 4.

[0037] The pump 6 supplies the liquid (water) at excessive pressure to the flow twisting means 3 where it is swirled tangentially to the housing internal surface in a spiral flow and moves simultaneously to the housings 1 bottom 2. Having a high kinetic energy the swirling flow forms on internal surface of the housings 1 bottom 2 a zone with lowered pressure in the center thereof which is a necessary condition for generation of a plurality of cavitation bubbles. Lowering of pressure in the center at the aperture 5 promotes ejection therethrough of the auxiliary axial flow of the liquid from the tank. Additional intensification of the cavitation process depends on speed of the flow, diameter of the aperture and its form.

[0038] At the border of interaction of the basic (spiral) and auxiliary (axial) flows, which border is a surface of a truncated cone, the flows of liquid having various speeds with various value of pressure gradients promote forming and further collapsing of the cavitation bubbles. This extracts energy that leads to intensive heating of the liquid. Presence of the braking element 7 having the above specified relative sizes allows to stabilize the working process and to compensate loss of speed of the discharge flow of the liquid. The heated liquid from tank 11 is supplied to the consumer on loading 12, whence after loss of a part of thermal energy it is returned via suction line of pump 6 to the flow twisting means 3.

[0039] In case of implementation of the housing 1 lateral wall in form of the coils of tube (tubes) 8 (Fig. 3) additional heating of different liquids is provided by feeding the liquid in cavity of the tube through its input branch pipe 9. Flowing through the heated wall on the wound tube the liquid in result of intensive heat exchange is heated and is supplied to the consumer through the outlet branch pipe 10. Thus, due to the housing internal surface formed by coils of tube 8 has a great area, the swirling flow having significant kinetic energy is additionally heated in result of friction on housing 1 wall internal surface. Separation of the swirling flow because of arisen speed difference promotes forming of a turbulent flow and cavitating zones that increases intensity of the process.

[0040] Creation of a cavitating zone in counter flows allowed intensifying the cavitation process due to preservation of high speed of liquid movement along the axis. Thus displacement of the cavitating zone to the thermogenerator axis allowed reducing harmful influence (erosion) of cavitation on its elements. Besides, the thermogenerator according to the present invention has simple construction, is compact, has low weight and is technological in manufacturing.

Claims

1. A cavitation thermogenerator comprising a coaxially located hollow housing having a bottom, a flow twisting means with a cylindrical internal surface, a nozzle and a braking element, **characterized in that** the flow twisting means is located between the nozzle and the housing, and internal surface of the flow twisting means forms a uniform cavity with the internal surface of a housing, thus a through aperture is formed in the housing bottom at the axis thereof, and the braking element it is formed by a face part of the nozzle adjoining to the flow twisting means which input aperture has a diameter smaller than internal diameter of said cavity.

2. The cavitation thermogenerator according to claim 1, **characterized in that** the flow twisting means has a form of a cylindrical casing with at least one tangential channel for input of the medium.

3. The cavitation thermogenerator according to claim 2, **characterized in that** the lateral wall of a housing is formed by coils of a tube densely wound in form of a spring with rigid connection of the adjacent coils therebetween, and the tube has an inlet and an outlet branch pipes at the end coils, thus at least one tangential channel for input of the medium of the flow twisting means is additionally inclined at an angle corresponding to the tube coils inclination angle.

4. The cavitation thermogenerator according to claim 2, **characterized in that** the lateral wall of the housing is formed by coils of several tubes densely wound in the form of a multistart spring with rigid connection of the adjacent coils therebetween, and each tube has an inlet and an outlet branch pipes at the end coils, thus tangential input for the medium of the flow twisting means is additionally inclined at an angle corresponding to the tube coils inclination angle.

5. The cavitation thermogenerator according to any of claims 1 - 4, **characterized in that** the internal surfaces contacting to the liquid flows are covered with a material chosen from the group of hydrophobic polymers.

6. The cavitation thermogenerator according to any of claims 1 - 4, **characterized in that** the hollow housing has a cylindrical form.

7. The cavitation thermogenerator according to claim 6, **characterized in that** the length of a hollow housing is 2.7 - 4.5 of its internal diameter.

8. The cavitation thermogenerator according to any of claims 1 - 4, **characterized in that** the hollow housing has a form of truncated cone turned by the smaller basis to the flow twisting means.

9. The cavitation thermogenerator according to claim 1, **characterized in that** the aperture in the housing bottom has a conic form and it is turned by the greater basis outside of the cone.

10. The cavitation thermogenerator according to claim 6, **characterized in that** the housing bottom diam-

eter is 0.12 - 0.25 of the chamber internal diameter, and the cone angle is within the limits of 40° - 70°.

11. The cavitation thermogenerator according to claim 1, **characterized in that** the nozzle has a form of a diffuser which angle is within the limits of 5.5° - 6.0°.

12. The cavitation thermogenerator according to claim 6, **characterized in that** the nozzle has a form of a diffuser, thus diameter of its input aperture is 0.55 of the housing internal diameter, and the discharge outlet diameter is 0.85 - 0.95 of the housing internal diameter.

13. A heat generating method including generating in the liquid flow of zones of lowered and raised pressure and moving the mixture of the liquid with cavitation bubbles formed in the lowered pressure zone from the lowered pressure zone into the zone of raised pressure, **characterized in that** said zones and moving of the mixture of the liquid with the cavitation bubbles from the lowered pressure zone into the raised pressure zone are created by injecting into the cavitation thermogenerator placed in the tank with liquid, by means of a pump of a liquid from the tank with forming of a closed contour, thus the cavitation thermogenerator comprises serially coaxially located the housing with a bottom, a flow twisting means with a cylindrical internal surface, a nozzle and a braking element formed by the end face of the nozzle, and the internal surface of the flow twisting means defines a uniform cavity with internal surface of the housing, the bottom of the housing on the axis thereof is provided with a through aperture, and the braking element is formed by the adjoining the flow twisting means face part of the nozzle which input aperture has a diameter smaller than the internal diameter of said cavity.

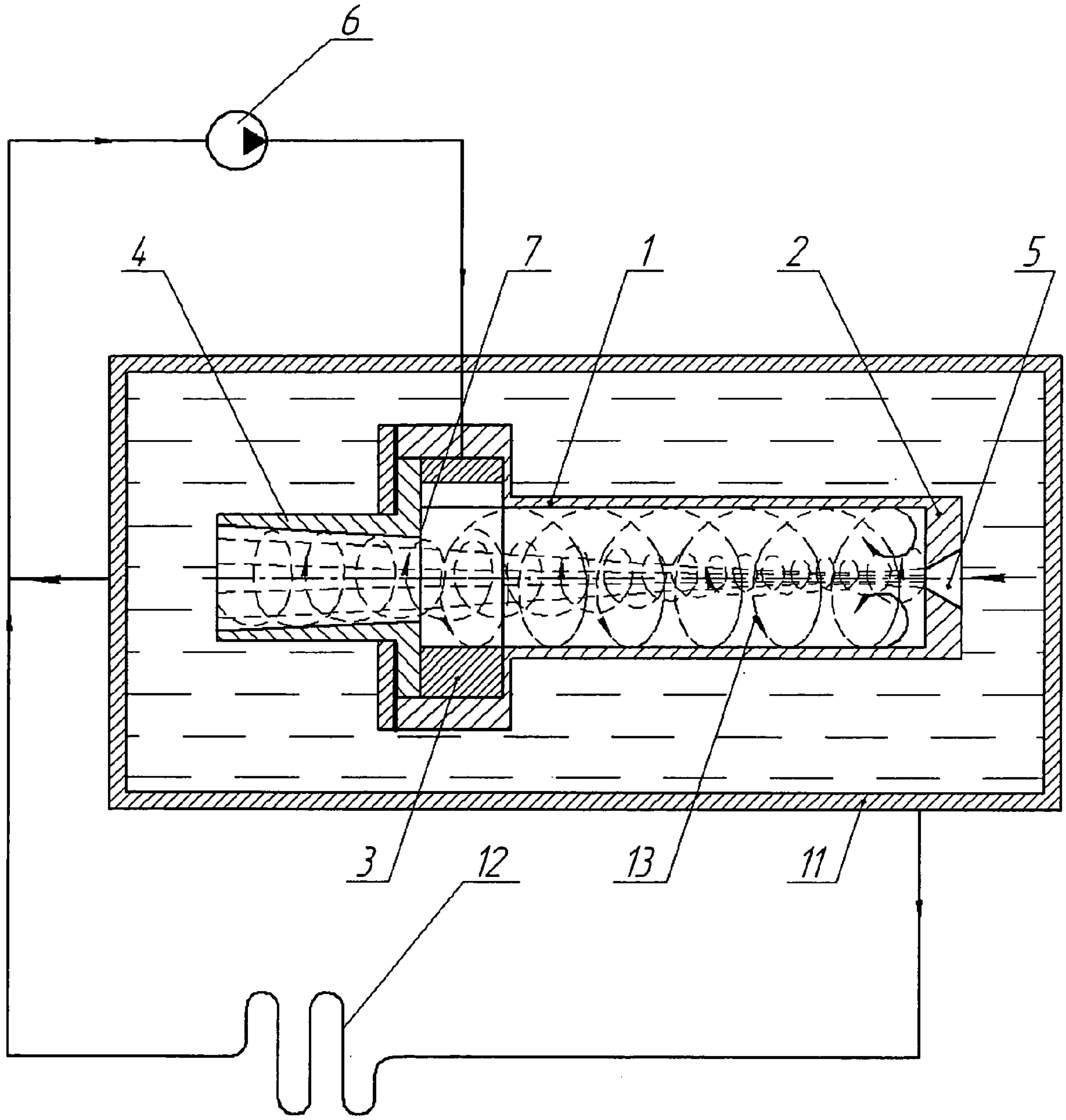

Fig. 1

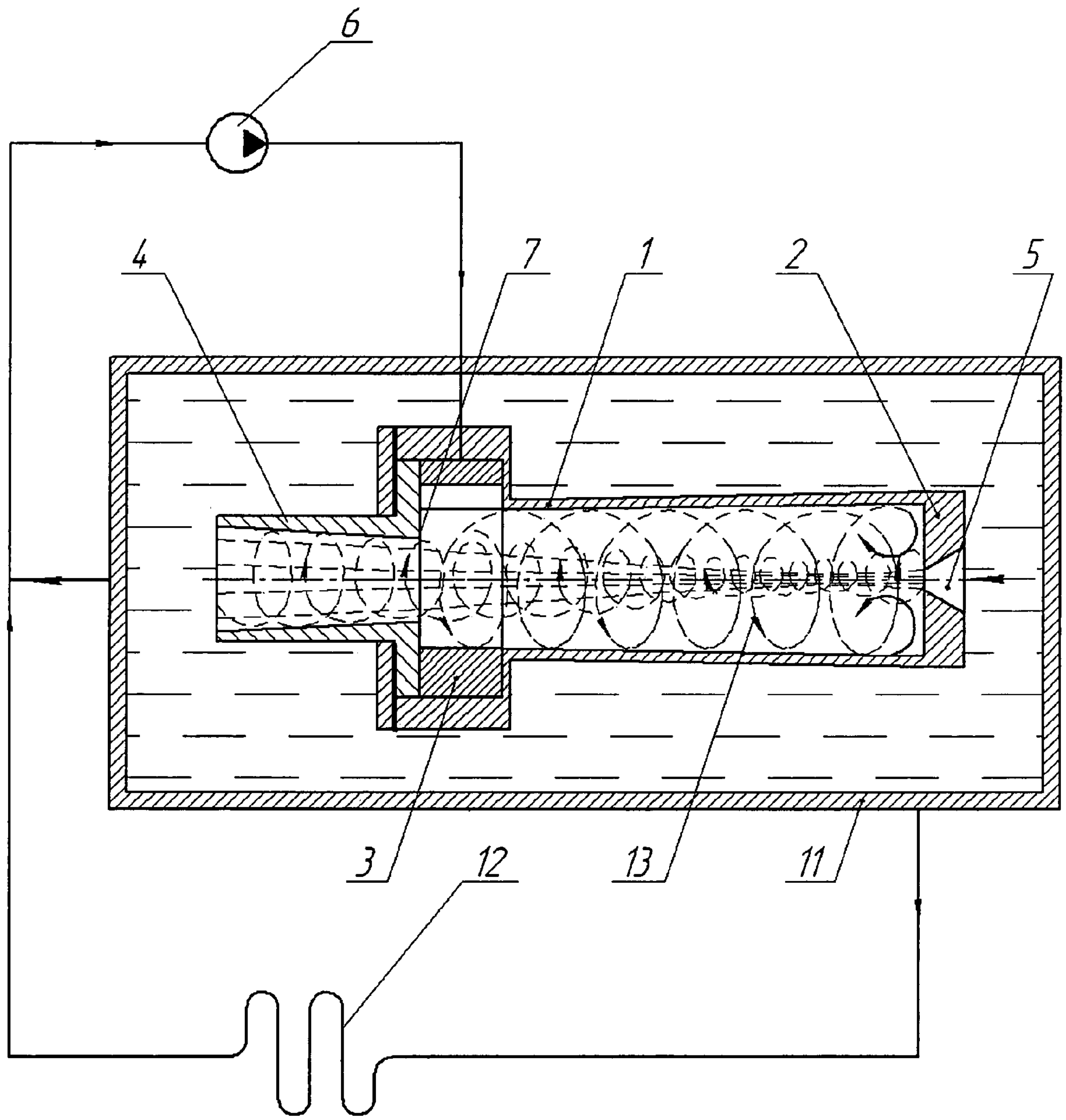

Fig. 2

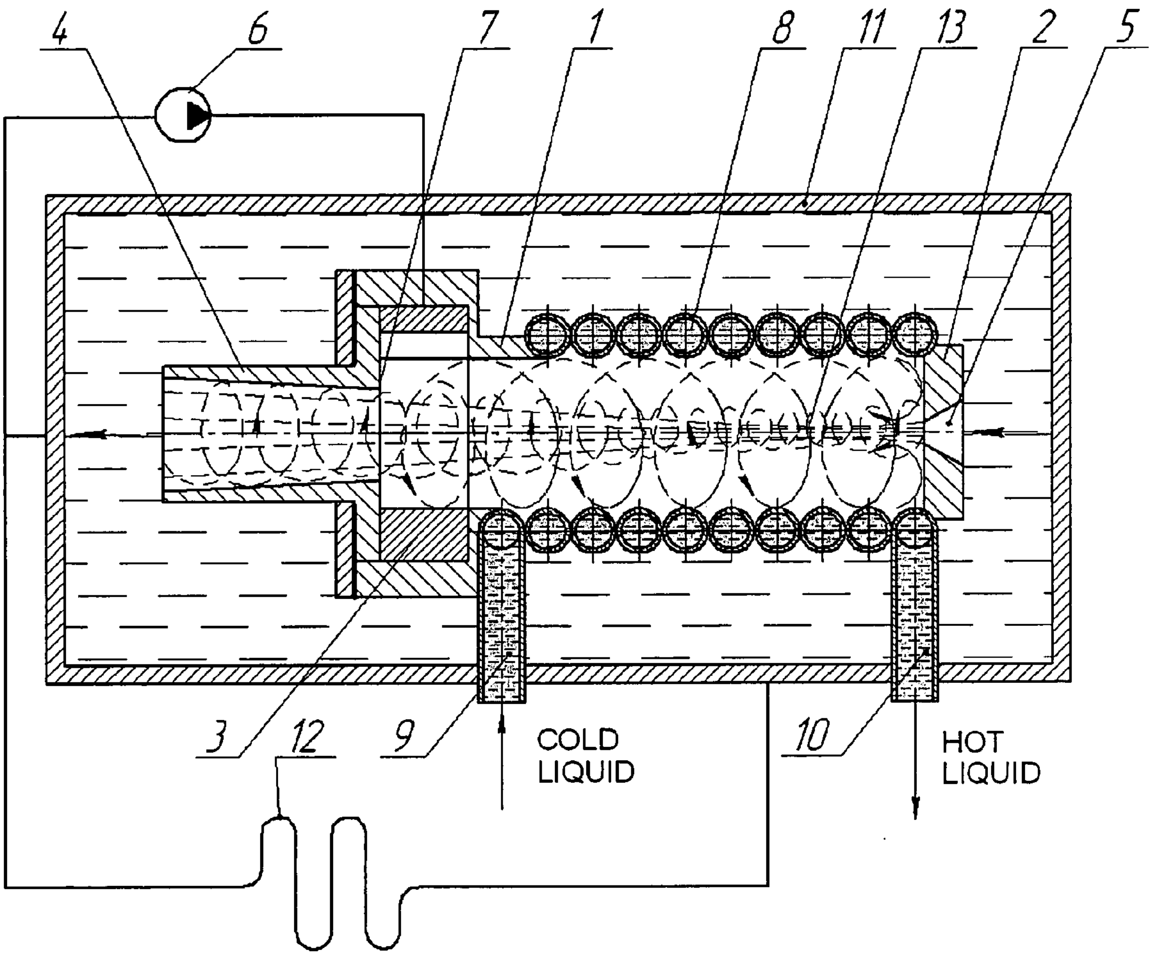

Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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- RU 2142604 **[0002]**
- RU 2212596 **[0004]**
- RU 2144627 **[0006]**
- RU 2190162 **[0009]**