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(54) **Title**: HEAT SUPPLY SYSTEM BASED ON AT LEAST ONE THERMAL RECEIVER

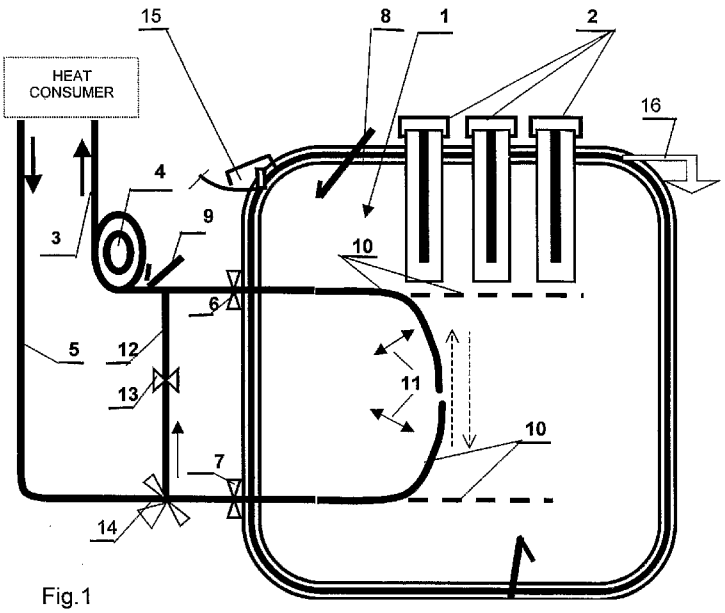


Fig.1

(57) **Abstract**: Heat supply system based on at least one thermal receiver has: a flow-through heat-insulated tank contained liquid heat carrier and used as thermal receiver; at least one heater of heat carrier; a feed pipe duct the input end of which is connected to the tank's upper part; a circulation pump built-in in feed pipe duct; a return pipe duct, the input end of which is connected to near-bottom of the tank; locking and regulating devices, which are arranged respectively at the input in the feed pipe duct and at the output from the return pipe duct, sensors for measuring of liquid heat carrier's temperature; and at least single-circuit adjustable mixer relatively hot heat carrier taking off from the tank, and relatively cold heat carrier taking off from the return pipe duct.

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HEAT SUPPLY SYSTEM BASED ON AT LEAST ONE THERMAL RECEIVER

Field of the Invention

This invention relates to structure of heat supply systems based on at least one liquid thermal receiver equipped with (preferably but not necessarily electrical) at least one heater. These systems are meant for:

hot-liquid heating and/or hot-water supply of preferably detached apartment houses or public buildings and production areas; and/or

relatively low-temperature heating of various process liquids (for example such as dyestuffs and cleansing agents those may be used at the time of textile goods dyeing, wash liquids, pickling solutions etc.).

Background Art

It is well known that energy consumption in industrialized countries in the daytime, when the most of enterprises and public conveyances operate intensively, exceeds its consumption by night substantially. This difference manifests in respect of electrical energy and other (especially hydrocarbonaceous) energy carriers (preferably such as natural gas and liquefied petroleum gas).

Therefore, stand-alone heat supply systems based on liquid (not necessarily water) thermal receivers, which are equipped with heaters, pipe manifold and suitable locking and regulating devices (e.g., valves or cocks), were developed for a long time.

These systems allow accumulating of thermal energy at night and consumption of it in the rest of the time. It is especially profitable in countries having advanced thermal and/or atomic power industry because night electricity tariff is substantially less in comparison with respective day tariff.

It is obvious that aforesaid heat supply systems must be very effective and must provide economical accumulation and consumption of thermal energy.

A part of these requirements is easy executable by use of resistive electric heaters (see, for example: "Политехнический словарь". – М.: "Советская Энциклопедия", 1976, статья "Электрический нагрев", с.575; in English: "Polytechnic Dictionary". – Moscow: Publishing House "Soviet Encyclopaedia", 1976, the entry "Electrical heating", page 575), or available in the market burners providing low-temperature catalytic combustion of natural gas.

In fact, said heaters have almost 100% efficiency that – on the assumption of enough heat-insulation of a thermal receiver and a pipe manifold – ensures effective accumulation and reservation of thermal energy.

There are known many attempts to improve such heaters. In particular, substitution of hard resistive elements made from expensive Nichrome by low-price resistive elements based on low-concentrated water solutions of easily-available salts was proposed lately (see, for example, Ukrainian utility model patent № 23333 or RU № 66873 U).

Further, high-performance catalytic, submersible and other suitable gas burners as components of the liquid thermal receivers are well known too.

However, these palliative engineering solutions have slight influence on effectiveness of aggregate heat supply systems based on thermal receivers.

Therefore, manufacturers equip such systems with complicate and expensive controlling means (see, for example: US 6,347,748; WO 2006/109994 A1; WO 2007/101592 A1; US 2007/0187521 and many others).

The US Patent 1,858,606 (filed as far back as 1930) discloses such heating and ventilating equipment based on stand-alone heat source that is nearest technically to proposed below heat supply system. This equipment has:

a heater (in particular, water radiator) that is placed within an air duct,

a ventilator meant for inflow of air into a heating room through said air duct,

a mixer of heated and atmospheric air, and

an automated control system, which defines temperature of heat carrier at the input into said heater and temperature of air within said heating room and controls streams of said water and air heat carriers by locking and regulating means.

Mixing of heated and atmospheric air depending on temperature within the heating room allow to use the described equipment in wide temperature range.

However, use of air as intermediate heat carrier makes for voluminosity of described equipment and does not flexible regulate temperature of liquid heat carrier at the input into arbitrary heat consumer, as heat storage in a thermal source (especially in a thermal receiver) would be exhausting.

Summary of the Invention

The invention is based on the problem to create such heat supply system based on at least one liquid thermal receiver having built-in heaters, which may provide flexible regulation of temperature and consumption of liquid heat carrier at the input into arbitrary heat consumer, as heat storage in a thermal receiver would be exhausting.

This problem is solved, in general, by modification of pipe manifold and by optimization of arrangement of locking and regulating devices. Correspondingly, a proposed heat supply system based on at least one thermal receiver has:

at least one flow-through heat-insulated tank which contains liquid heat carrier and serves as thermal receiver,

at least one heater of mentioned heat carrier connected to said tank,

a feed pipe duct having input end, which is connected to upper part of said tank, and output end, which is meant for connection to the input of a heat consumer,

a circulation pump that is built-in between said tank and said output end of said feed pipe duct,

a return pipe duct having input end, which is meant for connection to the output of said heat consumer, and output end, which is connected to the near-bottom part of said tank,

locking and regulating devices, which are arranged respectively at the input in said feed pipe duct from said tank and at the output from said return pipe duct into said tank,

at least two sensor of liquid heat carrier's temperature, which are arranged respectively within upper part of said tank and on said feed pipe duct before the input into said circulation pump or after the output from it, and

at least single-circuit adjustable mixer of relatively hot liquid heat carrier taking off from said tank and relatively cold liquid heat carrier taking off from said return pipe duct.

Incorporation of at least single-circuit adjustable mixer into structure of said heat supply system allows maintaining optimal temperature at the input into heat consumer by makeup of it only such amount of relatively hot liquid heat carrier, which is substantively need to keeping of desired temperature.

First additional feature consists in that the single-circuit adjustable mixer is equipped with placed within said tank hoses those are connected respectively, on the one hand, to the feed pipe duct's input end and to the return pipe duct's output end and, on the other hand, to controllable drivers for their closing in or moving away.

Second additional feature consists in that the single-circuit adjustable mixer has tubular passageway that is placed between the feed pipe duct's input end and the return pipe duct's output end, and is equipped with locking and regulating device.

Each such separately used additional feature allows simple optimizing of temperature and consumption of liquid heat carrier at the input into any heat consumer.

Third additional feature consists in that said passageway is made as direct tube section that is transversely connected to said ends of the feed and return pipe ducts. This simplifies making of said passageway.

Fourth additional feature consists in that a three-way cock is fixed in bifurcation zone of said output end of the return pipe duct and said passageway in order to facilitate accurate regulation of liquid heat carrier's temperature at the input of heat consumer.

Fifth additional feature consists in that said passageway is made as direct tube section that is obliquely connected to said ends of the feed and return pipe ducts.

Sixth additional feature consists in that said passageway is made as bow-shaped tube section, input and output ends of which are placed within said ends of the feed and return pipe ducts and directed downstream and upstream respectively.

Each such separately used additional feature allows to correct conditions of withdrawal and mixing of relatively hot liquid heat carrier taking off from said tank and relatively cold liquid heat carrier taking off from said return pipe duct.

Seventh additional feature consists in that said adjustable mixer is equipped with two circuits for mixing of relatively hot liquid heat carrier taking off from said tank and relatively cold liquid heat carrier taking off from said return pipe duct, namely:

first said circuit, which has placed within said tank flexible hoses those are connected respectively, on the one hand, to the feed pipe duct's input end and to the return pipe duct's output end and, on the other hand, to controllable drivers for their closing in or moving away, and

second said circuit, which has tubular passageway between the feed pipe duct's input end and the return pipe duct's output end, and this passageway is equipped with locking and regulating device.

Such two-circuit mixer is especially suitable for automated heat supply systems and/or hot-water supply based on liquid thermal receivers.

It is clear for each person skilled in art that mentioned below embodiments of the invention in no way restrict possibilities of subsequent improvements of the proposed heat supply systems using usual knowledge, and that scope of rights is limited by claims only.

Brief Description of the Drawings

The invention is further explained by a detailed description of the proposed heat supply system with references to accompanying drawings in which:

Fig.1 shows a structural flowchart of a heat supply system based on at least one liquid thermal receiver;

Fig.2 shows a first variant of arrangement of an oblique tubular passageway between feed and return pipe ducts;

Fig.3 shows a second variant of arrangement of the oblique tubular passageway between feed and return pipe ducts;

Fig.4 shows an arrangement of a bow-shaped tubular passageway between feed and return pipe ducts.

Best Embodiments of the Invention

The proposed heat supply system has (see Fig.1):

at least one flow-through heat-insulated tank 1 which contains liquid heat carrier (for example, water, antifreeze etc.) and serves as thermal receiver,

at least one heater 2 of mentioned heat carrier connected to said tank (thermal receiver) 1 (but preferably a set of such heaters 2, which are placed, as a rule, within the tank 1 and capable to operate independently of one another),

a feed pipe duct 3 having input end, which is connected to upper part of said tank (thermal receiver) 1, and output end, which is meant for connection to the input of a heat consumer (for example, to the input of at least one hot-water radiator for heating of separate apartment or production area),

a suitable (e.g. rotary or peripheral) circulation pump 4 that is built-in between said tank (thermal receiver) 1 and the feed pipe duct's 3 output end,

a return pipe duct 5 having input end, which is meant for connection to the output of said heat consumer, and output end, which is connected to the near-bottom part of the tank (thermal receiver) 1,

locking and regulating devices 6 and 7 (e.g., suitable two-way valves or cocks), which are arranged respectively at the input into said feed pipe duct 3 from the tank (thermal receiver) 1 and at the output from said return pipe duct 5 into said tank (thermal receiver) 1,

at least two sensor 8 and 9 of liquid heat carrier's temperature, which are placed

respectively within upper part of the tank (thermal receiver) 1 and the feed pipe duct 3 (usually before the input into the circulation pump 4 but sometimes after the output from it), and

an in detail described below at least single-circuit adjustable mixer of relatively hot liquid heat carrier taking off from the tank (thermal receiver) 1 and relatively cold liquid heat carrier taking off from the return pipe duct 5.

It is clear for each person skilled in art that the feed and return pipe ducts 3 and 5, the circulation pump 4 and other aforesaid heat supply system's parts, which have developed heat exchange surfaces, must be coated with heat-insulation (despite the fact that it not shown on drawings).

First simplest adjustable single-circuit mixer (see Fig.1) has placed within the tank (thermal receiver) 1 flexible hoses 10. They are connected respectively, on the one hand, to the feed pipe duct's 3 input end and to the return pipe duct's 5 output end and, on the other hand, to controllable drivers 11 for their closing in or moving away. These drivers 11 are symbolically shown on Fig.1 by two oblique double-headed arrows. In practice, these drivers 11 may be selected from many suitable controllable mechanisms (for instance, such as «screw-nut» with manual or automatic motion of the lead screws, hydraulic cylinders, waterproof step electric motors etc.).

Second simplest adjustable single-circuit mixer has a tubular passageway 12 that is placed between the feed pipe duct's 3 input end and the return pipe duct's 5 output end. This passageway 12 is equipped with a two-way locking and regulating device 13.

The passageway 12 is made usually as direct tube section that is connected, as a rule, transversely to aforesaid ends of the feed and return pipe ducts 3 and 5 (see Fig.1). Moreover, such variants are possible, if direct passageway 12 is obliquely connected to aforesaid ends of the feed and return pipe ducts 3 and 5 as it is shown on Figures 2 and 3.

It is desirable, if a three-way cock 14 would be fixed in bifurcation zone of the return pipe duct's 5 output end and the direct passageway 12.

And, finally, the passageway 12 may be made as bow-shaped tube section, input and output ends of which are placed within said ends of the feed 3 and return 5 pipe ducts and directed downstream and upstream respectively (see Fig.4). Clearly, that this bow-shaped passageway 12 is equipped with said locking and regulating device 13.

Sometimes adjustable mixer may have at once two above described circuits for mixing of relatively hot liquid heat carrier taking off from the tank (thermal receiver) 1 and relatively cold liquid heat carrier taking off from the return pipe duct 5.

It is clear that the tank (thermal receiver) 1 may have –

various geometrical form, which must be defined depending on an arrangement place and serviceability of it, and

various volumetric capacity, which must be defined depending on maximally admissible heat consumption during the time, when the heaters 2 must be off.

Each tank (thermal receiver) 1 is usually equipped with:

a regulator 15 of heat carrier's level,

an overflow pipe 16, which is meant for drain of liquid heat carrier's surplus and/or pressure releasing, and at least a part of which may be made from transparent material,

at least one additional temperature-sensor 17, which is placed, in particular, in near-bottom part of the tank (thermal receiver) 1, and

at least one not shown especially on drawings means for delivery of liquid heat carrier at the time its pouring into tank (thermal receiver) 1 or its unloading from this tank 1 (in particular, for the purpose of servicing or repair).

Heat consumer is represented usually as closed loop heating system and/or such heater of process water or liquids that is based on not shown here well-known double-circuit heat exchanger. (It is clear that inside circulation circuit of this heat exchanger must be assembled with the tank 1 in order to create a closed loop, while its outside open circuit must be connected to a source of respective process liquid and equipped with at least one dispenser).

Thermal power of each separate heater 2, total amount of these heaters and their total thermal power must be established depending on –

installed capacity of the tank (thermal receiver) 1 together with circulation circuit capacity of the heat consumer,

time of validity of night tariff relating to selected energy carrier (because this time is equal to maximal permissible time of heating of liquid heat carrier reserve during each diurnal cycle), and

assurance factor, which may be selected, as a rule, in the range 1,5–3,0 (or more) in view of minimal admissible time of coming the heat supply system into operation and probability of heaters' failure.

It is obvious also that the proposed heat supply system may be equipped with available well-known controlling means.

The described heat supply system operates as follows.

At first, selected liquid heat carrier must be poured into the tank (thermal receiver) 1 up to set level that may be controlled by the regulator 15. During this process the locking and regulating devices 6 and 7 are closed. Further –

the hoses 10 (if they are used) may be usually flattened (i.e. moved away by the drivers 11 in directions those are shown on Fig.1 by opposite arrays having dashed tail-lines, and/or

the locking and regulating device 13 on the tubular passageway 12 and the three-way cock 14 (if these components are used) must be fully opened,

the circulation pump 4 must be switched on,

the locking and regulating devices 6 and 7 must be smoothly opened, and

selected liquid heat carrier must be poured up to charging of all circulation circuit (including circulation capacity of the heat consumer) and stabilization of said carrier's level within the tank (thermal receiver) 1.

At the time of the heat supply system pouring, air must be removed from this system by

any suitable well-known means.

Two basic variants interaction of the tank (thermal receiver) 1 with any heat consumer are possible.

First variant provides for separate accumulation and consumption of heat. It is typical for temperature starting of the heat supply system and for such cases when said system supplies heat to respective consumer during day time only.

During accumulation of heat within the tank (thermal receiver) 1 preferably all operable heaters 2 must be switched on up to maximum power, while the locking and regulating devices 6 and 7 are closed and circulation pump 4 is switched off. It is clear that at the moment of full heat charging of the thermal receiver 1 all mass of liquid heat carrier being within said receiver must be practically synthermal as a result of convective heat transfer between upper and near-bottom strata of said carrier.

During consumption of accumulated heat all heater 2 are switched off, while locking and regulating devices 6 and 7 are at least partially opened and circulation pump 4 is switched on. It is clear that temperature balance would be violated, as heat storage in the thermal receiver 1 would be exhausting.

Second variant provides for concurrent thermal recharge of the tank (thermal receiver) 1 and consumption of heat (preferably for the purpose of continuous hot-liquid heating, as it is normal at night for each heating season).

In this variant, at least one or some heaters 2 and the circulation pump 4 must operate at the same time, and the locking and regulating devices 6 and 7 are at least partially opened all the time. It is clear that temperature of upper stratum of liquid heat carrier within the tank (thermal receiver) 1 at this operating mode exceeds temperature of near-bottom stratum of said carrier, and that differential temperature increases during day time.

Flexible regulation of temperature and consumption of liquid heat carrier at the input into arbitrary heat consumer, as heat storage in a thermal receiver 1 would be exhausting, may be provide in different ways depending on structure and amount of used adjustable mixers of relatively hot liquid heat carrier taking off from the tank (thermal receiver) 1 and relatively cold liquid heat carrier taking off from the return pipe duct 5.

In first simplest case, such regulation may be provided on basis of heat carrier's temperature indications, which are measured with sensors 8 and 9, using the hoses 10 and the locking and regulating devices 6 and 7 only. Respectively, in the beginning of heat consumption the hose 10 at the input into the feed pipe duct 3 must be bent and pulled down into extreme lower position, and the hose 10 at the output from the return pipe duct 5 must be straightened and also pulled down into extreme lower position. Further, as temperature within the feed pipe duct 3 would be decreased, the hose 10 at the input into this pipe duct 3 must be straightened step-by-step, while hose 10 at the output from the return pipe duct 5 must be bent and pulled up step-by-step too. Sometimes both hoses 10 may be bent in such a way that their butt-ends will be placed oppositely practically "line-on-line", as it is shown on Fig.1. In the

beginning of this process, consumption of the recirculating liquid heat carrier must be established by the locking and regulating devices 6 and 7 at minimal permissible level, and further must be increasing as temperature within the feed pipe duct 3 would be decreasing.

Temperature-sensor 17 (if it placed in near-bottom liquid heat carrier's stratum) allows more precisely defining residual heat in the tank (thermal receiver) 1 and adjusting of the hoses' 10 relative placement and the locking and regulating devices' 6 and 7 open flow areas.

In second simplest case, flexible regulation of temperature and consumption of liquid heat carrier at the input into heat consumer may be provided by the passageway 12 and the locking and regulating devices 6, 7 and 13 only on basis of the temperature-sensing devices' 8 and 9 indications. Respectively, at first must be opened the locking and regulating devices 6, 7 only. Then, taking into account desired temperature in feed pipe duct 3, open flow areas of these devices 6 and 7 and the locking and regulating device 13 on the passageway 12 must regulate additionally in order to optimize consumption of liquid heat carrier recirculating through tank (thermal receiver) 1.

Shown on the Fig.2 the direct passageway 12, which has bent downstream output upper end placed within the feed pipe duct 3, facilitates ejection of relatively hot liquid heat carrier from the tank (thermal receiver) 1.

Shown on the Fig.3 the direct passageway 12, which has bent upstream input lower end placed within the return pipe duct 5, facilitates cross-flow of relatively cold liquid heat carrier from the pipe duct 5 into the feed pipe duct 3.

Shown on the Fig.4 the bow-shaped passageway 12 facilitates, at one time, ejection of relatively hot liquid heat carrier from the tank (thermal receiver) 1 and cross-flow of relatively cold liquid heat carrier from the return pipe duct 5 into the feed pipe duct 3.

Use of the three-way cock 14 and temperature-sensor 17 facilitates such optimization additionally.

Use of both described above circuits for makeup of any heat consumer by only such amount of relatively hot liquid heat carrier, which is substantively need to keeping of desired temperature, increases ability of flexible regulation of the heat supply system even greater.

Industrial Applicability

The proposed heat supply system based on at least one liquid thermal receiver may be easy made from available in the market materials and deliverable components. It is serviceable even at manual control.

Practical use of such system ensures reliable flexible regulation of temperature and consumption of relatively hot liquid heat carrier at the input into arbitrary heat consumer, as heat storage in a thermal receiver would be exhausting.

CLAIMS

1. A heat supply system based on at least one thermal receiver; the system has:

at least one flow-through heat-insulated tank which contains liquid heat carrier and serves as thermal receiver,

at least one heater of mentioned heat carrier connected to said tank,

a feed pipe duct having input end, which is connected to upper part of said tank, and output end, which is meant for connection to the input of a heat consumer,

a circulation pump that is built-in between said tank and said output end of said feed pipe duct,

a return pipe duct having input end, which is meant for connection to the output of said heat consumer, and output end, which is connected to the near-bottom part of said tank,

locking and regulating devices, which are arranged respectively at the input in said feed pipe duct from said tank and at the output from said return pipe duct into said tank,

at least two temperature sensing elements for measuring of liquid heat carrier's temperature, which are arranged respectively within upper part of said tank and on said feed pipe duct before the input into said circulation pump or after the output from it, and

at least single-circuit adjustable mixer of relatively hot liquid heat carrier taking off from said tank and relatively cold liquid heat carrier taking off from said return pipe duct.

2. The system according to claim 1 wherein the single-circuit adjustable mixer is equipped with placed within said tank hoses those are connected respectively, on the one hand, to the feed pipe duct's input end and to the return pipe duct's output end and, on the other hand, to controllable drivers for their closing in or moving away.

3. The system according to claim 1 wherein the single-circuit adjustable mixer has tubular passageway that is placed between the feed pipe duct's input end and the return pipe duct's output end, and is equipped with locking and regulating device.

4. The system according to claim 3 wherein said passageway is made as direct tube section that is transversely connected to said ends of the feed and return pipe ducts.

5. The system according to claim 4 wherein a three-way cock is fixed in bifurcation zone of said output end of the return pipe duct and said passageway.

6. The system according to claim 3 wherein said passageway is made as direct tube section that is obliquely connected to said ends of the feed and return pipe ducts.

7. The system according to claim 3 wherein said passageway is made as bow-shaped tube section, input and output ends of which are placed within said ends of the feed and return pipe ducts and directed downstream and upstream respectively.

8. The system according to claim 1 wherein said adjustable mixer is equipped with two circuits for mixing of relatively hot liquid heat carrier taking off from said tank and relatively cold liquid heat carrier taking off from said return pipe duct, namely:

first said circuit, which has placed within said tank flexible hoses those are connected respectively, on the one hand, to the feed pipe duct's input end and to the return pipe duct's

output end and, on the other hand, to controllable drivers for their closing in or moving away, and

second said circuit, which has tubular passageway between the feed pipe duct's input end and the return pipe duct's output end, and this passageway is equipped with locking and regulating device.

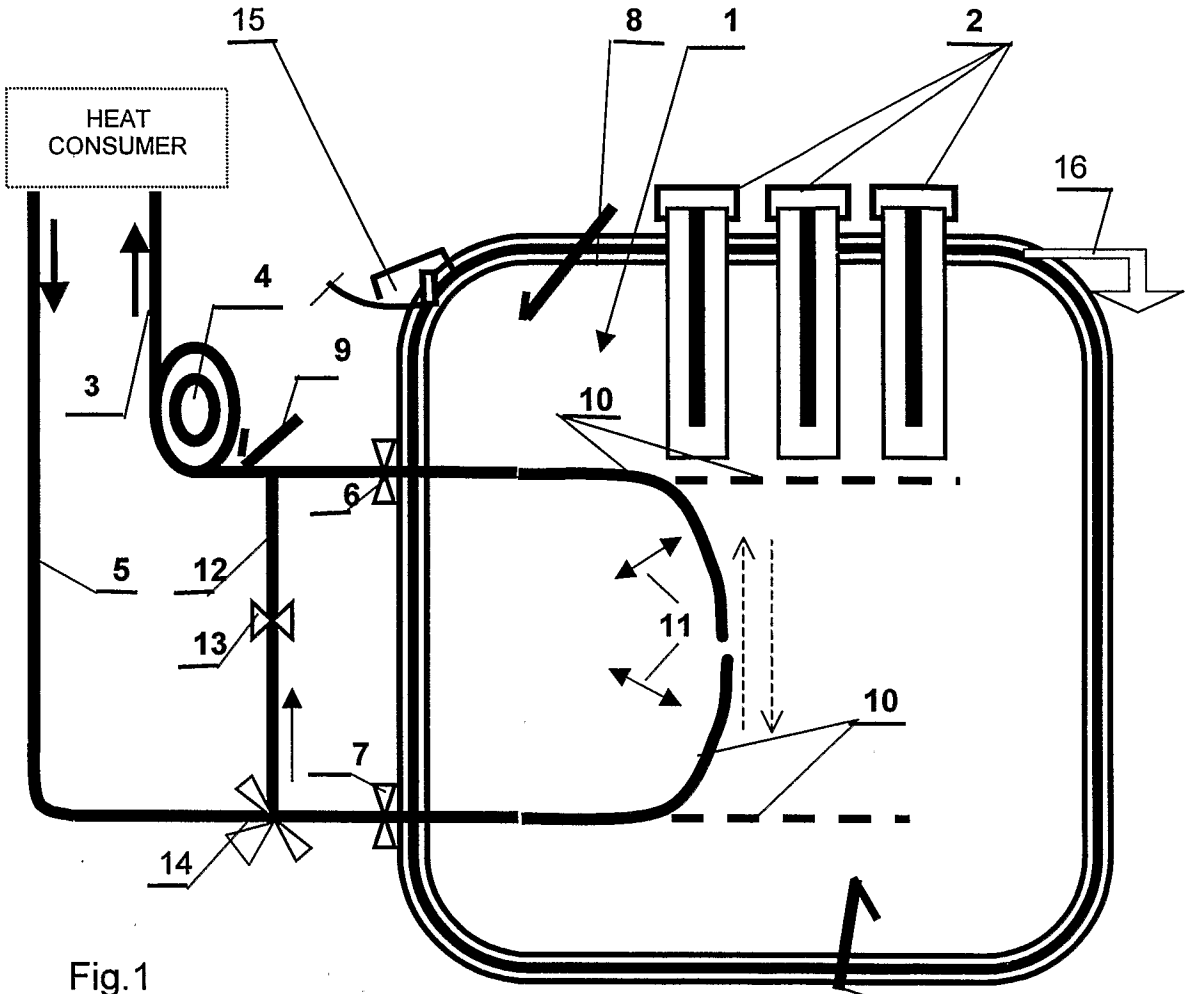


Fig.1

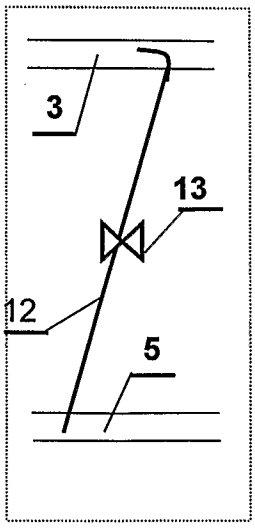


Fig.2

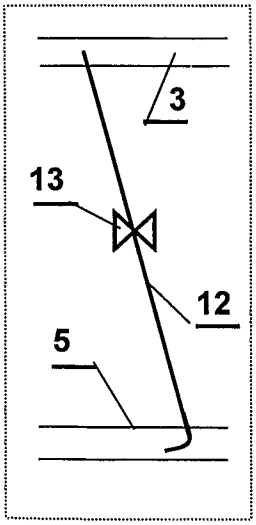


Fig.3

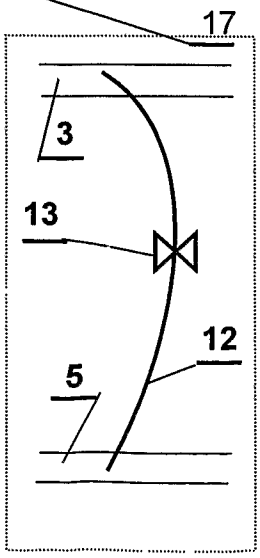


Fig.4