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CA 2632275 A1 2007/07/12

(21) 2 632 275

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2006/11/10
(87) Date publication PCT/PCT Publication Date: 2007/07/12
(85) Entrée phase nationale/National Entry: 2008/05/26
(86) N° demande PCT/PCT Application No.: FI 2006/050488
(87) N° publication PCT/PCT Publication No.: 2007/077293
(30) Priorité/Priority: 2005/12/30 (FI20055718)

(51) Cl.Int./Int.Cl. *F28D 7/02* (2006.01), *F01K 25/08* (2006.01)

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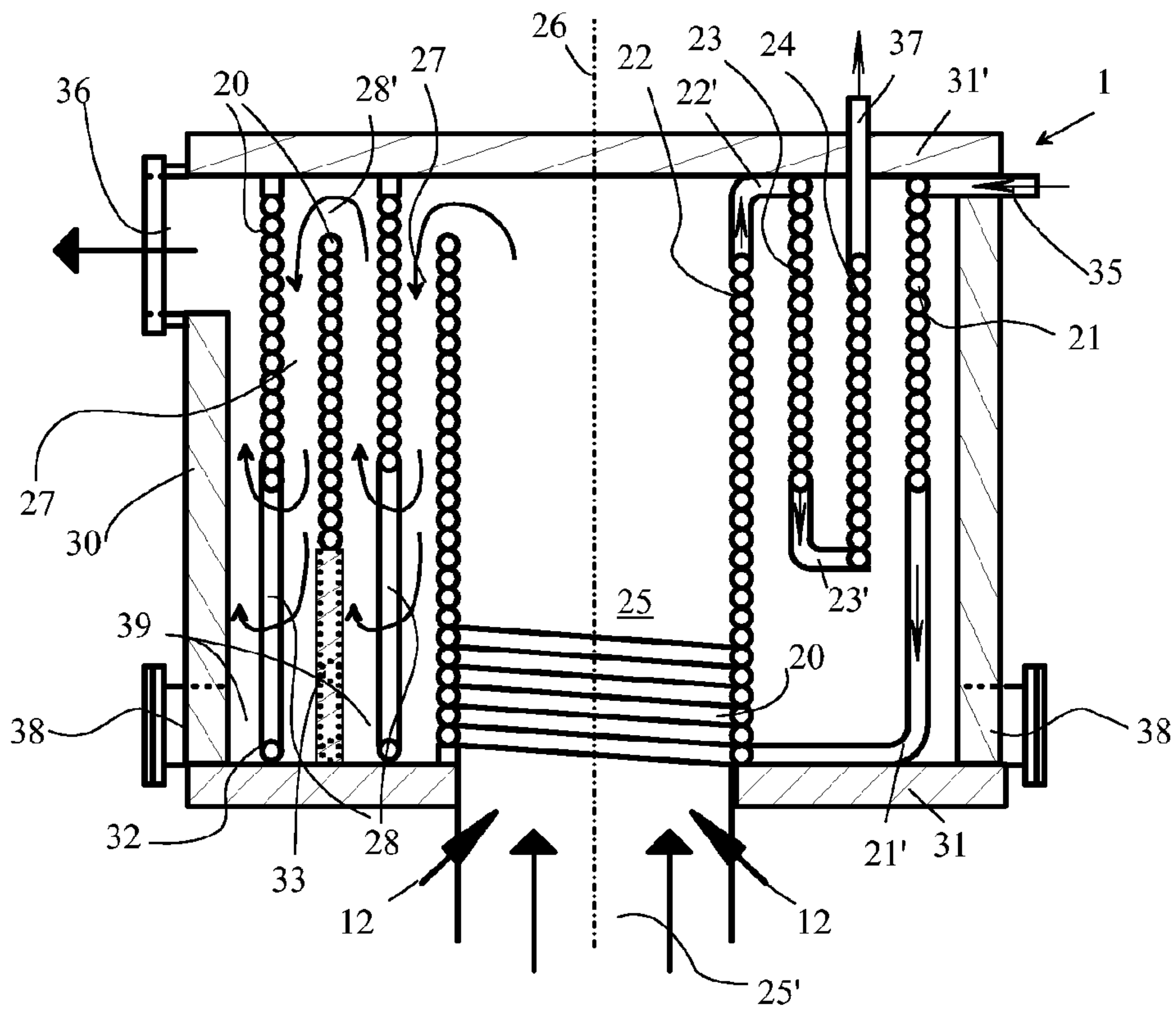
(54) Titre : PROCEDE DE CHAUFFAGE ET / OU D'EVAPORATION D'UN MILIEU ORGANIQUE ET UNITE D'ECHANGEUR DE CHALEUR DESTINEE A RECUPERER DE LA CHALEUR A PARTIR D'UN ECOULEMENT DE GAZ CHAUD

(54) Title: METHOD OF HEATING AND/OR EVAPORATING AN ORGANIC MEDIUM AND A HEAT EXCHANGER UNIT FOR RECOVERING HEAT FROM A HOT GAS FLOW



(57) Abrégé/Abstract:
A heat exchanger unit for recovering heat from a hot gas flow to a medium flow, which heat exchanger comprises an enclosure structure (30, 31, 31'), a gas flow inlet (25'), in which the gas is adapted to flow in a substantially vertical direction, and a gas flow

(57) Abrégé(suite)/Abstract(continued):
outlet (36), in which heat exchanger unit the enclosure structure encompasses several heat exchangers (21, 22, 23, 24) provided with an essentially gas-tight wall and arranged at least partially within each other with respect to the longitudinal axis (26) of the enclosure structure so that the gas flow is arranged to pass every time in a space, which is formed of two within each other arranged heat exchangers. The enclosure structure comprises a bottom section (31'), against which the heat exchangers are mainly supported by means of a support arrangement (32), and the support arrangement comprises an opening surface (28) in at least one of the heat exchangers for allowing the through-flow of the gas from one side of the heat exchanger to the other side thereof. The invention also relates to a method, in which heat is transferred to the first heat exchanger (21) in the flow direction of the organic medium to cool the gas flow to its final temperature.

CA 02632275 2008-05-26

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 July 2007 (12.07.2007)

PCT

(10) International Publication Number
WO 2007/077293 A1

(51) International Patent Classification:
F28D 7/02 (2006.01) *F01K 25/08* (2006.01)

(21) International Application Number: PCT/FI2006/050488

(22) International Filing Date: 10 November 2006 (10.11.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20055718 30 December 2005 (30.12.2005) FI

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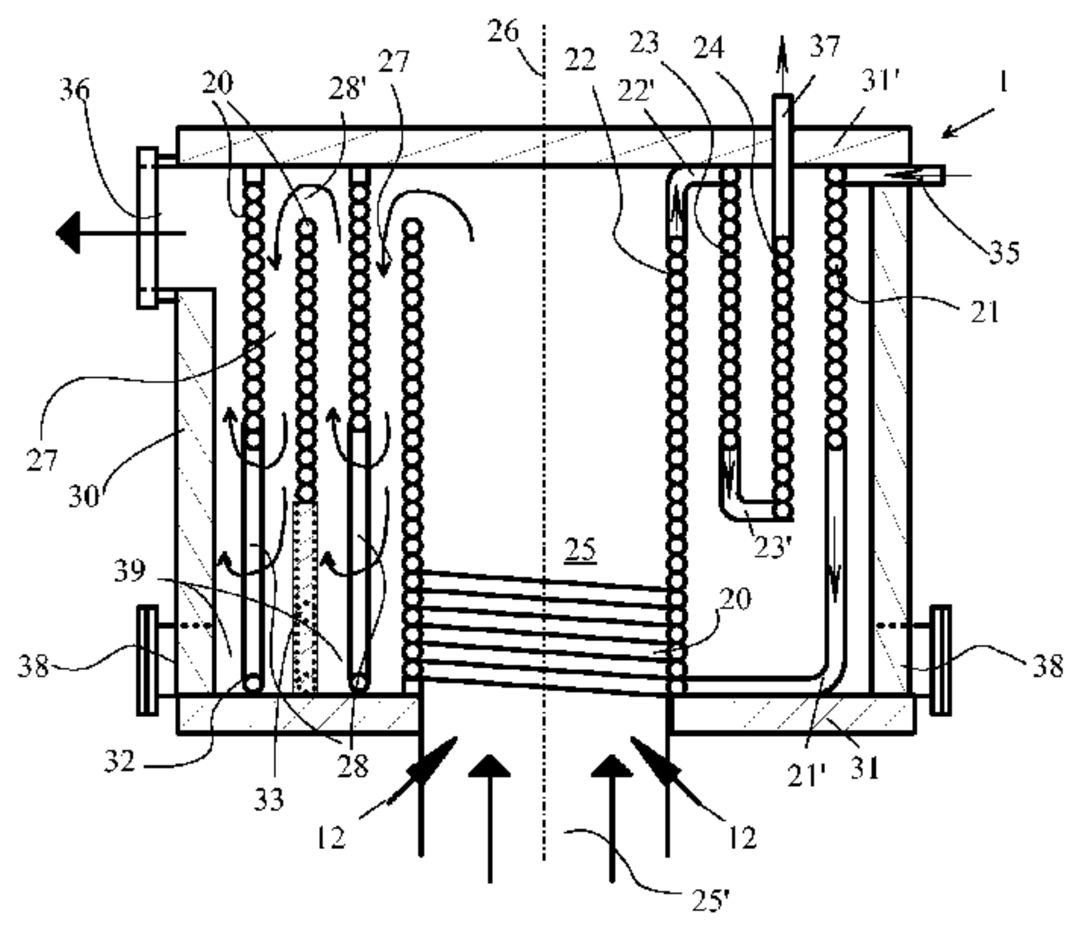
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** METHOD OF HEATING AND/OR EVAPORATING AN ORGANIC MEDIUM AND A HEAT EXCHANGER UNIT FOR RECOVERING HEAT FROM A HOT GAS FLOW



(57) **Abstract:** A heat exchanger unit for recovering heat from a hot gas flow to a medium flow, which heat exchanger comprises an enclosure structure (30, 31, 31'), a gas flow inlet (25'), in which the gas is adapted to flow in a substantially vertical direction, and a gas flow outlet (36), in which heat exchanger unit the enclosure structure encompasses several heat exchangers (21, 22, 23, 24) provided with an essentially gas-tight wall and arranged at least partially within each other with respect to the longitudinal axis (26) of the enclosure structure so that the gas flow is arranged to pass every time in a space, which is formed of two within each other arranged heat exchangers. The enclosure structure comprises a bottom section (31'), against which the heat exchangers are mainly supported by means of a support arrangement (32), and the support arrangement comprises an opening surface (28) in at least one of the heat exchangers for allowing the through-flow of the gas from one side of the heat exchanger to the other side thereof. The invention also relates to a method, in which heat is transferred to the first heat exchanger (21) in the flow direction of the organic medium to cool the gas flow to its final temperature.

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METHOD OF HEATING AND/OR EVAPORATING AN ORGANIC MEDIUM AND A HEAT EXCHANGER UNIT FOR RECOVERING HEAT FROM A HOT GAS FLOW

The invention refers to a method according to claim 1 of heating and/or evaporating an organic medium by conducting heat from a hot gas flow to the organic medium, in which method the organic medium is led through several successive heat exchangers, which are located in the gas flow, and the gas flow is cooled from an initial temperature to a final temperature.

The invention also refers to a heat exchanger unit according to claim 6 for recovering heat from a hot gas flow to a medium flow, which heat exchanger unit comprises an enclosure structure, a gas flow inlet, in which the gas is adapted to flow in a substantially vertical direction, and a gas flow outlet, in which heat exchanger unit the enclosure structure encompasses several heat exchangers provided with an essentially gas-tight wall and arranged at least partially within each other with respect to the longitudinal axis of the enclosure structure so that the gas flow is arranged to pass respectively in an annular space, which is formed of two within each other arranged heat exchangers.

Especially the invention relates to an evaporator for an organic medium and a method of evaporating and/or heating an organic medium.

One application for the invention is the Rankine process based on an organic circulation medium, i.e. the ORC process (ORC = Organic Rankine Cycle). In the ORC process a suitable organic medium, for instance toluene, isobutane or isopenthane, is used as a circulation medium instead of water. The ORC process is particularly applicable on a relatively low temperature level, whereby waste heat released even at a low temperature may be utilised.

In the ORC process an intermediate hot oil circuit is often used between hot flue gases and a vaporisable medium. When an intermediate hot oil circuit is used, heat is transferred from the flue gas to the hot oil in a separate thermal oil vessel, from which the heated liquid hot oil is pumped to an evaporator for an organic circulation medium, in which the heat is transferred further from the liquid hot oil to the organic circulation medium. By maintaining a sufficiently strong hot oil flow in the intermediate hot oil circuit it is possible to prevent overheating of both the hot oil and the organic circulation medium. This solution, however, is complicated and expensive, includes an extra temperature difference due to the hot oil circuit, and especially the pumping of hot oil is a significant operating cost.

The publication FI 86464 discloses, on a principle level, an ORC power station, in which the evaporator for an organic medium is in direct heat transfer connection with hot gas. The problem involved in the evaporation of the organic medium directly by hot gas, especially by the boiler's flue gases or the like, which reacts slowly to power adjustment, is how to avoid both the excessive heating of the evaporator material and the overheating of the organic medium, which would lead to chemical changes in the substance, such as cracking of hydrocarbons, especially in transient situations. In such a case the overheating of the organic medium, in particular, would bring about detrimental changes in its flowing and heat transfer properties.

A purpose of the invention is to provide a method of heating and/or evaporating an organic medium minimising the problems related to prior art. Especially a purpose of the invention is to provide a method of heating and/or evaporating an organic medium, by which the overheating of the organic medium can be avoided. A purpose of the invention is also to provide a heat exchanger unit, which is suitable for evaporating and/or heating an organic medium by hot gas, especially by flue gas from combustion of biomass.

The objects of the invention are mainly achieved as disclosed in the appended claims 1 and 6, and more closely as explained in the other claims.

In the method according to the invention of heating and/or evaporating an organic medium by conducting heat from a hot gas flow to the organic medium, the organic medium is led through several successive heat exchangers, which are located in the gas flow, and the gas flow is cooled from an initial temperature to a final temperature. The method is characterised in that heat is transferred to a first heat exchanger in the flow direction of the organic medium while cooling the gas flow to its final temperature. By this method the overheating of the organic medium and the first heat exchanger is avoided.

Further in the method, heat is transferred to a second heat exchanger to start the cooling of the gas flow from its initial temperature, whereby the organic medium flows first through the first heat exchanger and then through the second heat exchanger.

The heat exchanger unit according to the invention for recovering heat from a hot gas flow to a medium flow comprises an enclosure structure, a gas flow inlet, in which the gas is adapted to flow in a substantially vertical direction, and a gas flow outlet, in which heat exchanger unit the enclosure structure encompasses several heat exchangers provided with an essentially gas-tight wall and arranged at least partially within each other with respect to the longitudinal axis of the enclosure structure so that the gas flow is arranged to pass respectively in a space, which is formed of two within each other arranged heat exchangers. The invention is characterised by the enclosure structure comprising a bottom section, against which the heat exchangers are mainly supported by means of a support arrangement, and the support arrangement comprising an opening surface in at least one of the heat exchangers for allowing the through-flow of the gas from first side of the heat exchanger to a second side thereof.

The support arrangement of the heat exchangers is made of a cooled structure, in which the medium flow of the heat exchanger is adapted to flow. Preferably, the heat exchangers are pipe spiral heat exchangers and the cooled structure of the support arrangement comprises an take-off shaped as a flow elbow formed of a pipe spiral. By means of the take-off an opening surface is formed and arranged to extend to a distance from the inner surface of the bottom section of the enclosure structure, whereby an ash space is formed in the area above the bottom section extending from the inner surface of the bottom section to the lower edge of the opening surface.

The size of the ash space is so large that it also acts as a service space, through which required reparations can be performed as well. Then, the size of the space is such that a serviceman has enough room to work therein. There must be several openings, typically e.g. four, to form the opening surface as well as corresponding outer service doors/ash pit doors.

The opening surface in each heat exchanger is defined so that the total of the cross-sectional surfaces of individual (radial) openings is larger than the cross-sectional flow area of the heat exchanger's annular space (space between the heat exchangers arranged within each other), whereby the pressure loss of the gas flow in the openings is smaller than or equal with the pressure loss in the annular space between the heat exchangers within each other. The ratio between the height and the radial width of the ash space is larger than 1 and the ash settled in the ash space during operation will normally not be re-entrained with the gas.

The heat exchanger unit comprises preferably several ash removal conduits that can be opened to the ash space. An ash removal conduit comprises a substantially gas-tight channel penetrating gas-tightly the support arrangement of the heat exchanger, whereby it does not in normal use disturb the flowing of the gas in the heat exchanger unit.

The heat exchanger unit is arranged to heat and/or evaporate an organic medium, whereby the last one of the heat exchangers arranged within each other is adapted to be the first heat exchanger in the medium flow and the first one of the heat exchangers arranged within each other is adapted to be the second heat exchanger in the medium flow.

Quite a number of advantages are achieved by the present invention:

-In the evaporator according to the invention heat is transferred from the hot flue gases directly to the medium flow, whereby no separate thermal oil vessel is required. Consequently, also the structures and components included in the intermediate thermal oil circuit, such as pipelines, vessels as well as safety and security systems, are eliminated and the apparatus will thus be simpler and less expensive.

-The efficiency of heat transfer is improved, since the temperature difference between the flue gas and the medium flow is larger than that between the gas and the thermal oil, when using an intermediate thermal oil circuit, and the gas is discharged from the evaporator at a lower temperature, which decreases the flue gas loss.

-The operating efficiency is improved, as no separate hot oil pumps are required, which reduces the pumping costs. Also the heat losses of the intermediate thermal oil circuit are eliminated.

-The heat exchanger unit according to the invention is more reliable, as there are fewer components prone to failure.

-The space required by the heat exchanger unit according to the invention is smaller in comparison with an evaporator for an intermediate thermal oil circuit, which enables the compact structure formed by the furnace and the evaporator.

In the following, the invention is explained by way of example with reference to the appended schematic drawings, in which

- Figure 1 is a schematic view of the application of the method according to the invention in conjunction with combustion of biomass;

- Figure 2 shows a heat exchanger unit according to the invention;

- Figures 3 and 4 show a detail in the heat exchanger unit according to Fig. 2;

- Figure 5 shows a detail in one embodiment of the heat exchangers in the heat exchanger unit according to the invention;

- Figure 6 shows the section A-A of Fig. 5; and

- Figure 7 is a diagram of the temperature and the relative heat flow of one application of the method according to the invention.

With reference to one flow diagram of the ORC process shown schematically in Fig. 1 a heat exchanger unit 1 produces superheated vapour for a turbine 5, which drives a high speed generator 4, which is connected to an electric network 2 by means of a frequency converter 3. Of the organic mediums applicable at the moment toluene is particularly suitable to be used as an organic medium in conjunction with the present invention. Since a biomass fuel boiler is an important target of application of the invention, hot gas or a gas flow can also be referred to as flue gas in the following. From the turbine 5 the toluene vapour is led to a recuperator 6, in which a liquid toluene to be introduced to the heat exchanger unit 1 is preheated by the toluene vapour. On the other hand, the task of the recuperator 6 is to eliminate the superheat in the vapour coming from the turbine, as toluene vapour is characterised by still being superheated after the expansion in the turbine. From the recuperator the toluene vapour is introduced into a condenser 7, in which it is condensed to form a liquid, and in which also the rest of the superheat is eliminated in case the vapour is still superheated after the recuperator. Next, the liquid toluene is introduced into a condensation tank 8, from which it is led further at raised pressure via a pre-feed pump 9 and a feed pump 10 to the recuperator 6. In the recuperator 6 the toluene vapour heats the liquid toluene and thereafter it is fed to the heat exchanger unit 1, in which the toluene is further heated, evaporated and the vapour is superheated. The heat exchanger unit 1 is arranged directly into a hot gas flow 11, which in this application is flue gas from combustion of biomass, and the heat exchanger unit is therefore connected with a biomass boiler 13.

The structure of the heat exchanger unit itself according to the invention is described in more detail in the other figures, but in the biomass combustion application the space of the heat exchanger that first encounters the gas of the heat exchanger unit acts also partially as an afterburner, whereby the plant comprises feed members 12 to bring air (or oxygenous gas) to the hot gas just prior to or simultaneously with it being introduced into the heat exchanger unit 1. Fig. 1 also shows the heat exchanger unit 1 according to the invention, in which heat is transferred to the first heat exchanger in the flow direction of the organic medium thus cooling the gas flow to its final temperature.

In Figs. 2 - 6 mutually corresponding reference numbers are used for the sake of clarity and in the following the indications of the reference numbers refer to Figs. 2 - 6 case by case. Fig. 2 shows one embodiment of the heat exchanger unit 1 according to the invention. Fig. 2 shows the cross-section of the heat exchanger unit in such a manner that the left side, in the figure, of a longitudinal axis 26 represents mainly the support of the heat exchangers and the flow arrangement on the gas side and the right side, in the figure, shows the interconnection of the heat exchangers. The heat exchanger unit comprises heat exchangers 21, 22, 23 24 arranged within each other and formed of pipe spirals 20. The heat exchangers are preferably symmetrical with respect to the cross-section of the longitudinal axis, and as pipe spirals mainly cylindrical. The type of the heat exchanger unit is according to the invention a once-through evaporator. The organic medium is arranged to flow in the piping of the heat exchangers and the gas outside the pipes of the heat exchangers.

Fig. 2 shows a heat exchanger unit, which is formed within an enclosure structure consisting of an outer shell 30, a cover section 31' and a bottom section 31. The heat exchanger unit comprises a gas flow inlet 25', which is parallel with the heat exchanger unit's longitudinal axis 26 and located in the middle of the heat exchanger unit. The innermost heat exchanger 22 with respect to the longitudinal axis 26 of the heat exchanger unit forms an after-burning space 25, which is located above the actual furnace of the boiler 13 (Fig. 1). In the after-burning space 25, the after-burning of the flue gas and the solid matter particles therein coming form the furnace takes place, and therefore there are feed members 12 arranged in the after-burning space 25 for bringing air (or oxygenous gas) into the hot gas. From the after-burning space 25 the flue gases are led into annular channels formed between the heat exchangers 21 - 24 arranged within each other parallel with the longitudinal axis. In the after-burning space 25 the heat is transferred to the heat exchanger 22 mainly as thermal radiation, whereas thereafter, in the less hot sections in the gas flow direction, convective heat exchange is dominant. By the structure described above the disadvantages entailed in the fouling effect of the flue gas is minimised and on the other hand, an adequate heat transfer in the various parts of the heat exchanger unit is provided on the flue gas side. The gas flow is guided in the channels formed by the heat exchangers within each other so that the main direction is from the centre part toward the outer sections, alternately up and down. Preferably, every second heat exchanger 21, 23 comprises an opening surface 28 in its lower part, which opening surface enables the gas to flow from first side of said heat exchanger to the second side thereof, i.e. to move radially closer to the outer section. The gas flow in said opening surface is sufficiently weak to prevent the ash on the bottom of the ash spaces from being entrained to any substantial extent back to the gas flow. The support consists of cooled support structures formed of pipes and flow elbows so that the flue gas may pass between them from the channel formed of pipe spirals 20 to the next channel in the direction of the radius of the heat exchanger unit. The organic medium flowing in the pipes and flow elbows forming the structure is used for cooling the support structure. In practise, this can be accomplished and the opening surface formed so that the heat exchanger is supported against the bottom section 31 of the enclosure structure of the heat exchanger unit by means of a heat exchange pipe or pipes by arranging an take-off as a u-shaped flow elbow in the pipe located in the lower section. This is shown also in Figs. 5 and 6. On the other hand, these structures also make it possible to form routes required by the cleaning of the heat exchange surfaces and gas flues between the pipe spirals 20 as well as the ash spaces 39 below them.

Between the heat exchangers provided with an opening surface there is a heat exchanger, which instead comprises an opening surface 28' at the end of the cover part 31' of the enclosure structure, i.e. above itself. This kind of a heat exchanger is made substantially gas-tight in its lower part, for instance by means of a refractory lining or brick-laying, which is though, preferably, a cooled structure. The flue gases are discharged from the heat exchanger unit via a gas outlet 36, which in the embodiment of Fig. 1 is located on the outer rim of the unit.

The mutual flow connection between the organic medium and the flue gas is according to the invention arranged as follows. Generally, the heat exchanger unit is an intermediate form of a counter flow heat exchanger and a parallel flow heat exchanger, since the directions of the flue gas flows outside (two annular spaces) the medium (in a spiral pipe) to be heated are opposite.

The organic medium is first led via a conduit 35 to the first heat exchanger 21, in which the organic medium is heated by hot flue gas thus cooling the gas flow to its final temperature. The liquid organic medium coming to the heat exchanger unit is led to the less hot part on the flue gas side. In this section, the organic medium flows mainly counter-currently with respect to the gas so as to make the heat exchange surface as small as possible. By this arrangement the overheating problems of the organic medium and also of the heat exchanger 21, which could otherwise occur e.g. in transient situations, are avoided. The first heat exchanger 21, which is then the outermost of the heat exchangers arranged within each other, is connected to the second heat exchanger 22 by a connecting pipe 21', which interconnects these two (Fig. 2) at their lower parts. The second heat exchanger is the innermost of the heat exchangers arranged within each other. The second heat exchanger 22 is further connected to the third heat exchanger 23 via a connecting pipe 22'. Preferably, the third heat exchanger 23 acts primarily as an evaporator. It is further connected to the fourth heat exchanger 24 via a connecting pipe 23', in which exchanger the superheating of the vapour takes place. In the heat exchanger unit all the rest of the heat exchangers are arranged radially in the space between the first and the second heat exchanger, symmetrically with respect to the longitudinal axis 26.

In order to avoid overheating of the organic medium and the material of the heat exchangers the superheated vapour is discharged from the section on the flue gas side, in which the flue gas is not at its hottest. The vapour is primarily superheated by the fourth heat exchanger 24, which is located between the innermost 22 and the outermost 21 of the heat exchangers arranged within each other. The fourth heat exchanger 24 is provided with an outlet 37 for the organic medium in the upper part of the pipe spiral 20. Then, especially in transient situations, such as during decreasing of power, in spite of the changes in the mass flows of the gas and the organic medium, the final temperature of the vapour of the organic medium is not allowed to rise too high. By this arrangement the size of the required heat exchange surface can be reduced, as the average temperature difference between the flue gas and the organic medium is then bigger than in a situation, when the whole heat exchanger unit is of parallel flow type.

The lower parts of the outer shell 30 of the heat exchanger unit and the structures 28, 33 guiding the flue gas flow are provided with ash removal doors 38, which are used for cleaning the flue gas side of the heat exchanger unit. The lower parts of the pipe spirals 20 form in the vertical direction a radially staggered structure so that also the cleaning of the channels formed by the inner pipe spirals is possible via the ash removal doors 38, which act as ash removal conduits. This is shown in more detail in Figs. 3 and 4. In the embodiment shown in Fig. 3 the ash removal door is provided with a substantially gas-tight channel 38', which extends to the innermost ash space 39. Fig. 4 shows an embodiment, in which a door 38", which can be opened and closed, is arranged in conjunction with the structures guiding the flue gas flow of the heat exchanger 24 for cleaning the ash space. The ash removal doors are located so as to make it possible to perform the cleaning efficiently.

Cleaning is required in the heat exchanger unit both in operation and during shutdowns. The cleaning in operation is performed automatically by dropping the fouling collected on the heat exchange surfaces and other parts of the gas flues on the flue gas side, to the lower parts of the flue gas side by using a cleaning method appropriate for the situation. The ash spaces 39 are formed of the structures in the lower parts of the flue gas side, into which spaces collected fouling can be discharged in the cleaning during a shutdown via the above-mentioned ash removal doors 38. The ash space is formed in the lower part of the structures 28, 33 guiding the flue gas flow so that the opening surface 28 in the vicinity of the bottom section 31 of the heat exchanger unit extends from the bottom section at least so that the total cross-sectional flow surface of the openings corresponds to the cross-sectional flow area between the pipe spirals.

Figs. 5 and 6 show an advantageous pipe structure, in which the supporting of the heat exchangers 21 - 24 and the cooling of the structures 28, 33 guiding the flue gas flow is provided according to the invention. In the lower parts of the pipe spirals of the heat exchangers 21 - 24 there is a u-shaped part 32 arranged to extend downwards from the lower surface of the spiral, which u-shaped part acts as a cooling and supporting structure for the heat exchangers.

Fig. 7 illustrates the method according to the invention of heating and/or evaporating an organic medium, by way of example, by toluene. In the figure the vertical axis represents the temperature T and the horizontal axis the relative heat flow q of the gas. Graph 71 illustrates how the temperature of the gas acting as a heat source falls from the situation, in which the relative heat flow is 100 %, down to the value 0 %, in other words when cooling the gas from the initial temperature (q=100 %) to the final temperature (q=0 %). Graph 72 illustrates the temperature of the toluene and its development, when it passes through several successive heat exchangers. The numerical values given for the temperatures in the following are values in one specific case, which are presented here only for facilitating the understanding of the invention. The organic medium, toluene in this case, is brought to the first heat exchanger 21 at a temperature of 156 ºC, which in this example corresponds to the final temperature of 350 ºC of the exiting gas. Toluene is heated in the first heat exchanger 21 to a temperature of 196 ℃, while the temperature of the incoming gas is 475 ℃. This is performed mainly by heat transfer of counterflow type, whereby the surface area of the heat exchanger required for the heating is minimised. Next, the toluene is heated further in the second heat exchanger 22 to a temperature of 300 ℃, but now the heat source is the gas, which starts the cooling of the gas flow from its initial temperature, in this case 1100 ℃, and cools the gas down to a temperature of 755 ℃. Here, the heat exchanger is primarily a parallel flow heat exchanger. Subsequently, the toluene is introduced into the evaporator section, which consists mainly of the third heat exchanger 23. The evaporation lowers the gas temperature to 570 ℃. In the fourth heat exchanger 24 the vapour is superheated, in this example to a temperature of 326 ℃, whereby the temperature of the flue gas is 475 ℃, i.e. it is in the state, in which the heat transfer by the first heat exchanger starts.

By the method according to the invention the required total heat exchange surface can be made substantially smaller than by a parallel flow heat exchanger alone.

The invention is not limited to the shown embodiments, but several variations are conceivable within the scope of the appended claims. For instance, the pipe spiral may, deviating from the embodiments shown in the figures, be made of a pair of pipes or of several adjacent pipes instead of one pipe.

CLAIMS

1. A method of heating and/or evaporating an organic medium by conducting heat from a hot gas flow to the organic medium, in which method the organic medium is led through several successive heat exchangers (21, 22, 23, 24), which are located in the gas flow, and the gas flow is cooled from an initial temperature to a final temperature, and in which method heat is transferred to the first heat exchanger (21) in the flow direction of the organic medium to cool the gas flow to its final temperature, **characterised** in that heat is transferred to the second heat exchanger (22) to start the cooling of the gas flow from its initial temperature.

2. A method according to claim 1, **characterised** in that the organic medium flows first through the first (21) and thereafter through the second heat exchanger (22).

3. A method according to claim 1, **characterised** in that the last heat exchanger (24) operates primarily according to the parallel flow principle.

4. A method according to claim 3, **characterised** in that all the heat exchangers after the first heat exchanger (21) operate mainly as parallel flow heat exchangers.

5. A heat exchanger unit for recovering heat from a hot gas flow to a medium flow, which heat exchanger comprises an enclosure structure (30, 31, 31'), a gas flow inlet (25'), in which the gas is adapted to flow in a substantially vertical direction, and a gas flow outlet (36), in which heat exchanger unit the enclosure structure encompasses several heat exchangers (21, 22, 23, 24) provided with an essentially gas-tight wall and arranged at least partially within each other with respect to the longitudinal axis (26) of the enclosure structure so that the gas flow is arranged to pass every time in a space formed of two within each other arranged heat exchangers, **characterised** in that the enclosure structure comprises a bottom section (31'), against which the heat exchangers are mainly supported by means of a support arrangement (32), and that the support arrangement comprises an opening

surface (28) in at least one of the heat exchangers for allowing the through-flow of the gas from first side of the heat exchanger to the second side thereof.

6. A heat exchanger unit according to claim 5, **characterised** in that the support arrangement is made of a cooled structure (32), in which the medium flow of the heat exchanger is adapted to flow.

7. A heat exchanger unit according to claim 6, **characterised** in that the heat exchangers are pipe spiral heat exchangers (20) and that the cooled structure of the support arrangement comprises an take-off shaped as a flow elbow formed of a pipe spiral.

8. A heat exchanger unit according to claim 5, **characterised** in that the opening surface (28) is arranged to extend to a distance from the inner surface of the bottom section of the enclosure structure, whereby an ash space (39) is formed in the area above the bottom section extending from the inner surface of the bottom section to the lower edge of the opening surface.

9. A heat exchanger unit according to claim 8, **characterised** in that the total of the cross-sectional areas of the individual openings forming the opening surface is larger than the total cross-sectional area of the annular space.

10. A heat exchanger unit according to claim 8, **characterised** in that the heat exchanger unit comprises several ash removal conduits (38) that can be opened to the ash space (39).

11. A heat exchanger unit according to claim 10, **characterised** in that an ash removal conduit (38) comprises a substantially gas-tight channel penetrating gas-tightly the support arrangement of the heat exchanger.

12. A heat exchanger unit according anyone of claims 5 - 8, which is adapted to heat and/or evaporate an organic medium, **characterised** in that the last one of the heat exchangers arranged within each other is arranged to be the first heat exchanger (21) in the medium flow and the first one of the heat exchangers arranged within each other is arranged to be the second heat exchanger (22) in the medium flow.

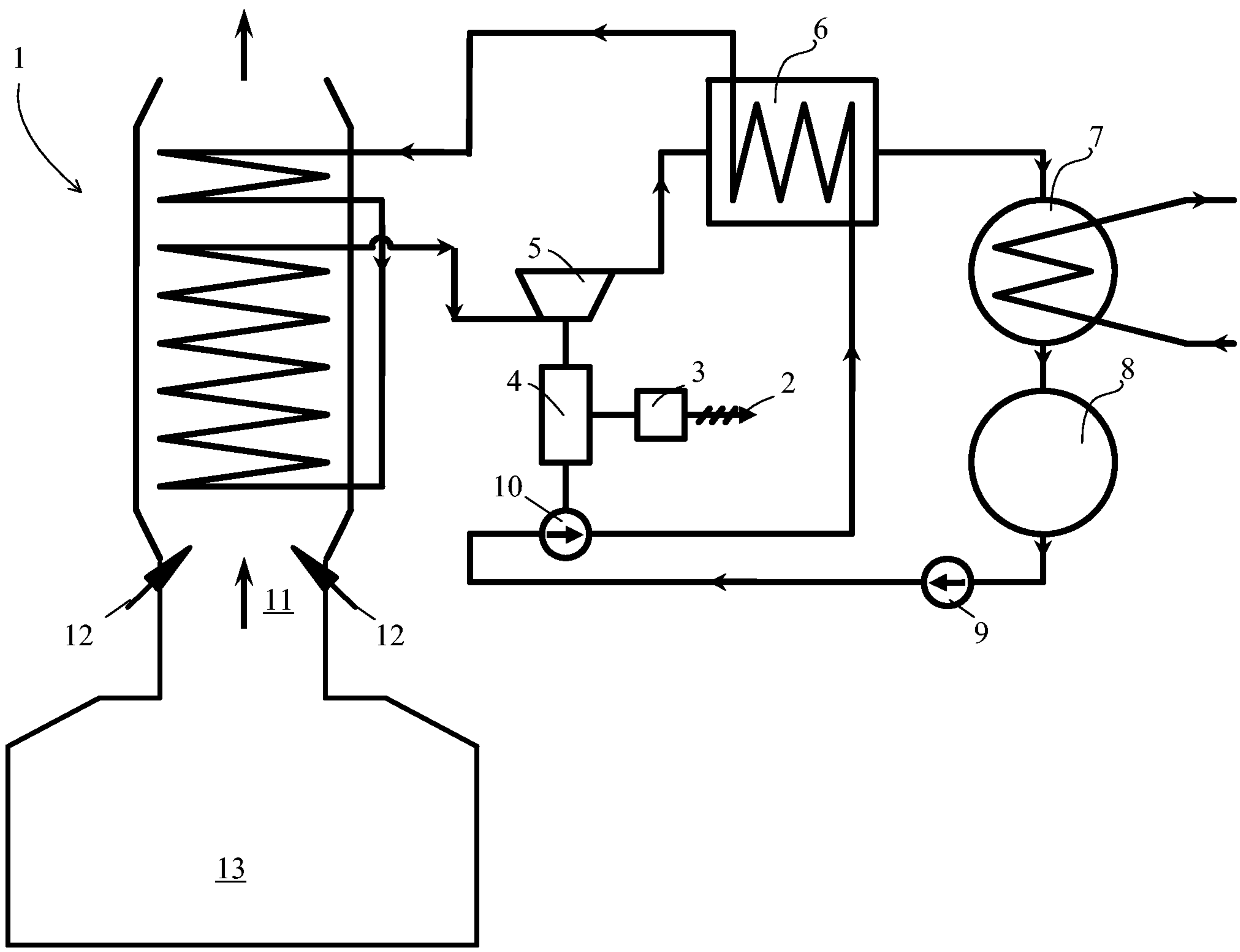


Fig. 1

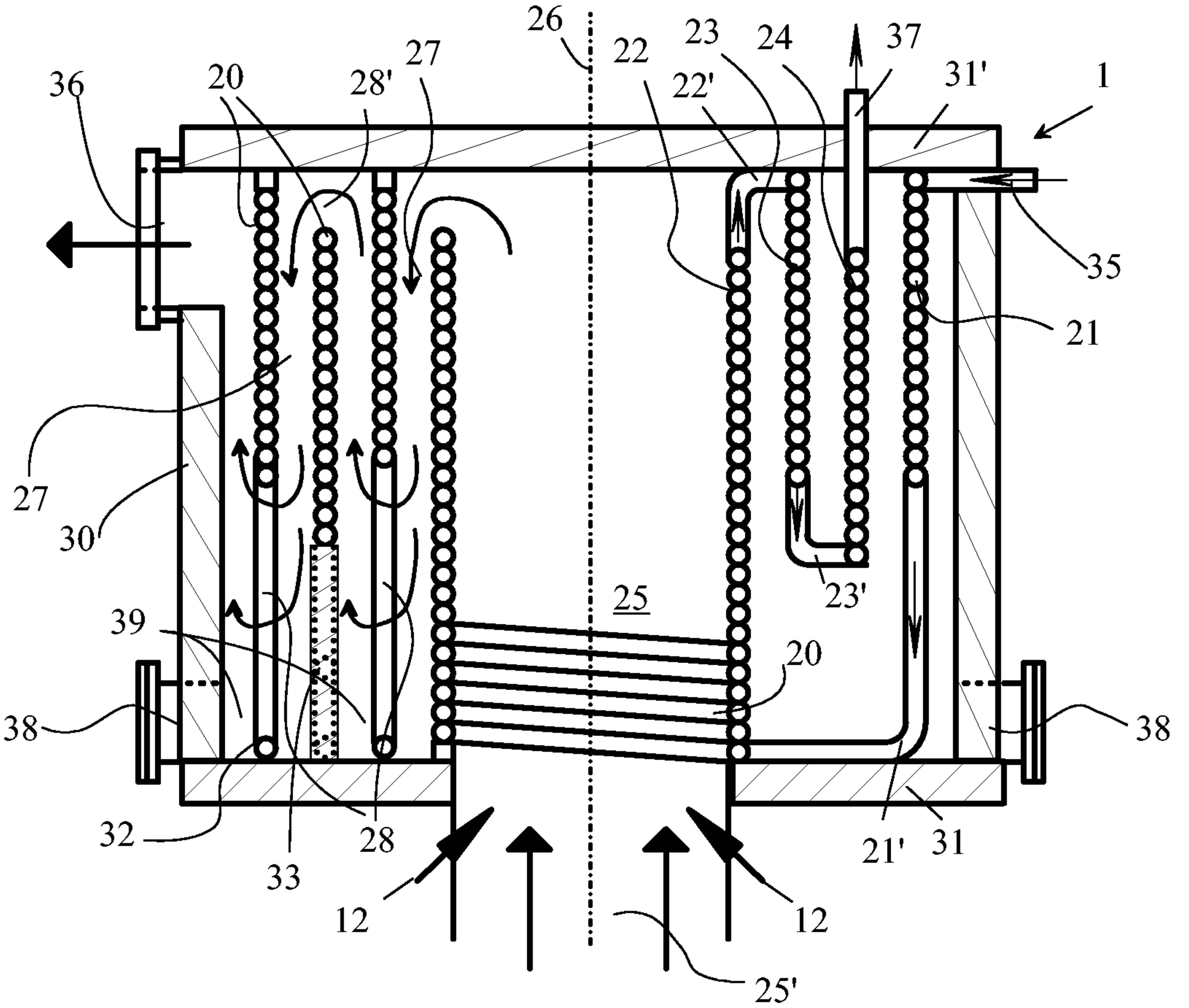
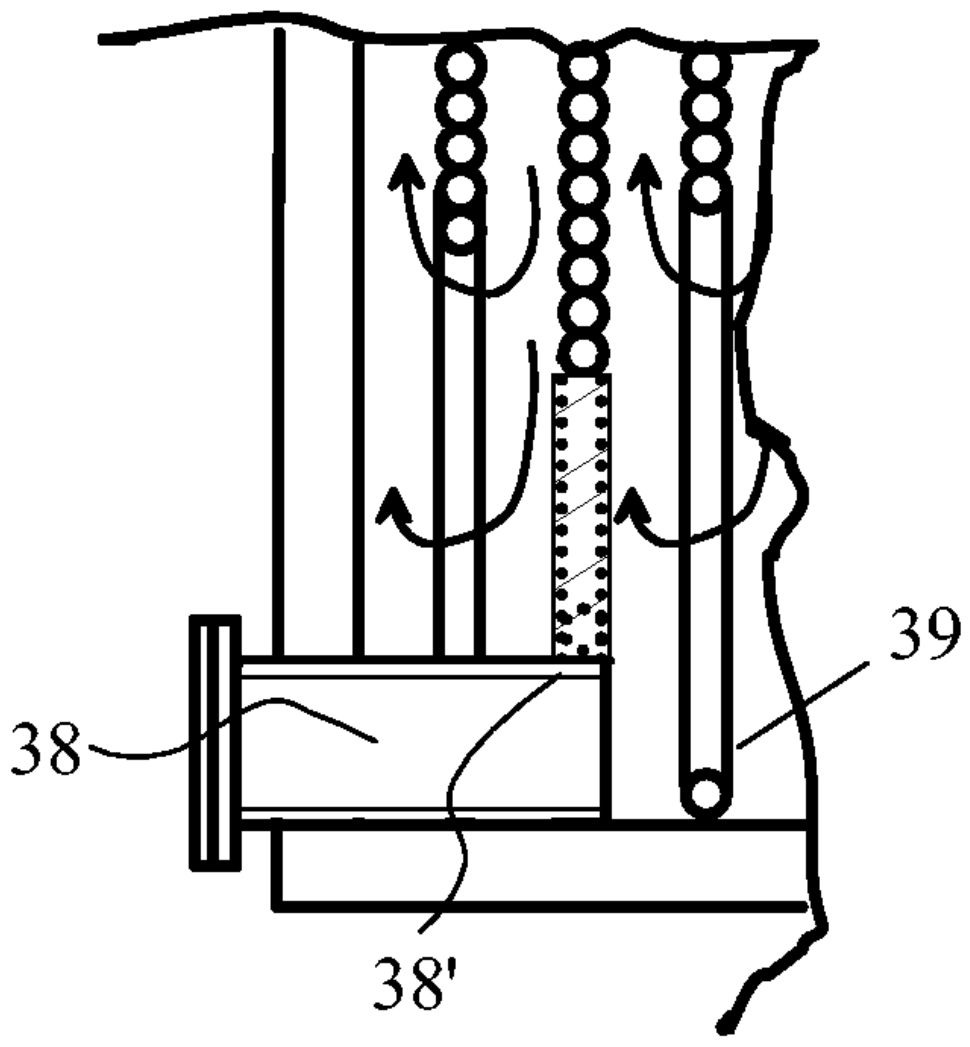


Fig. 2



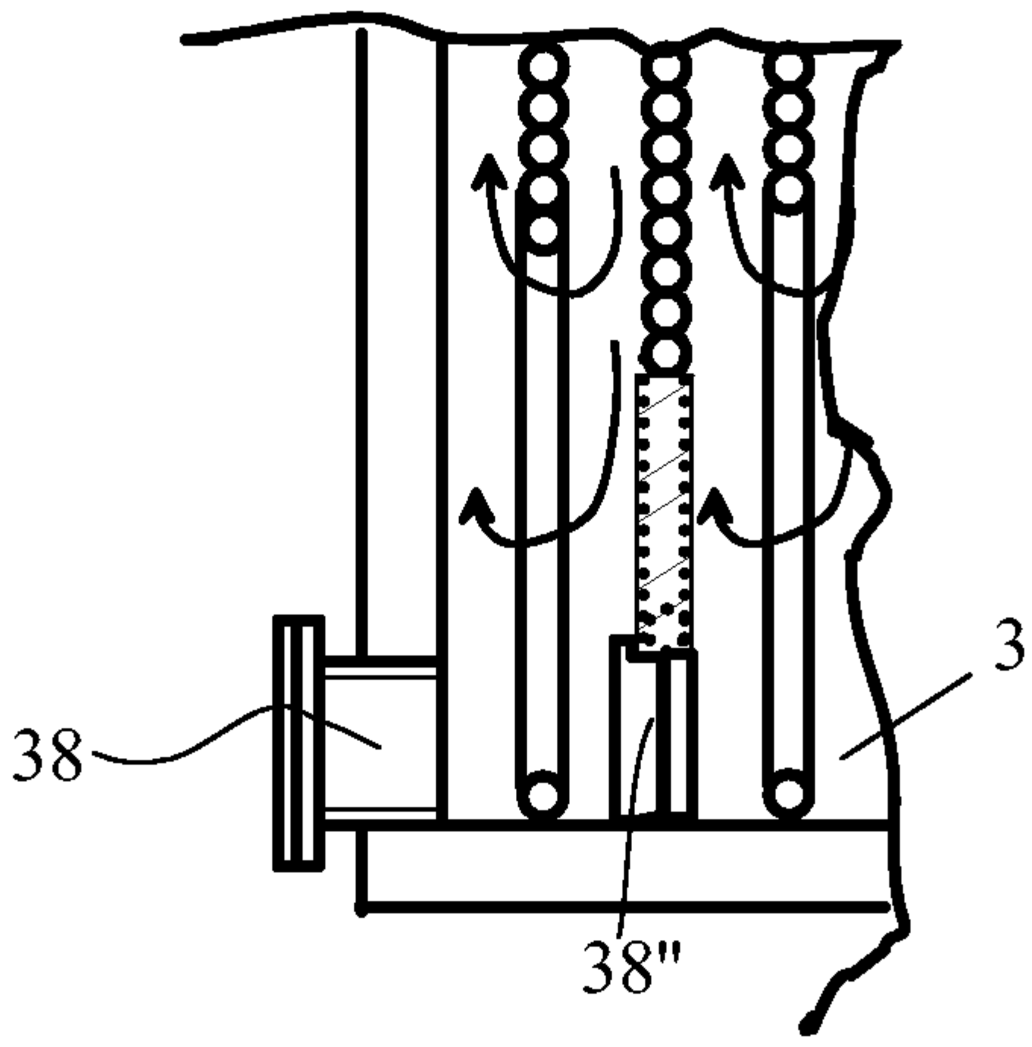


Fig. 3

Fig. 4

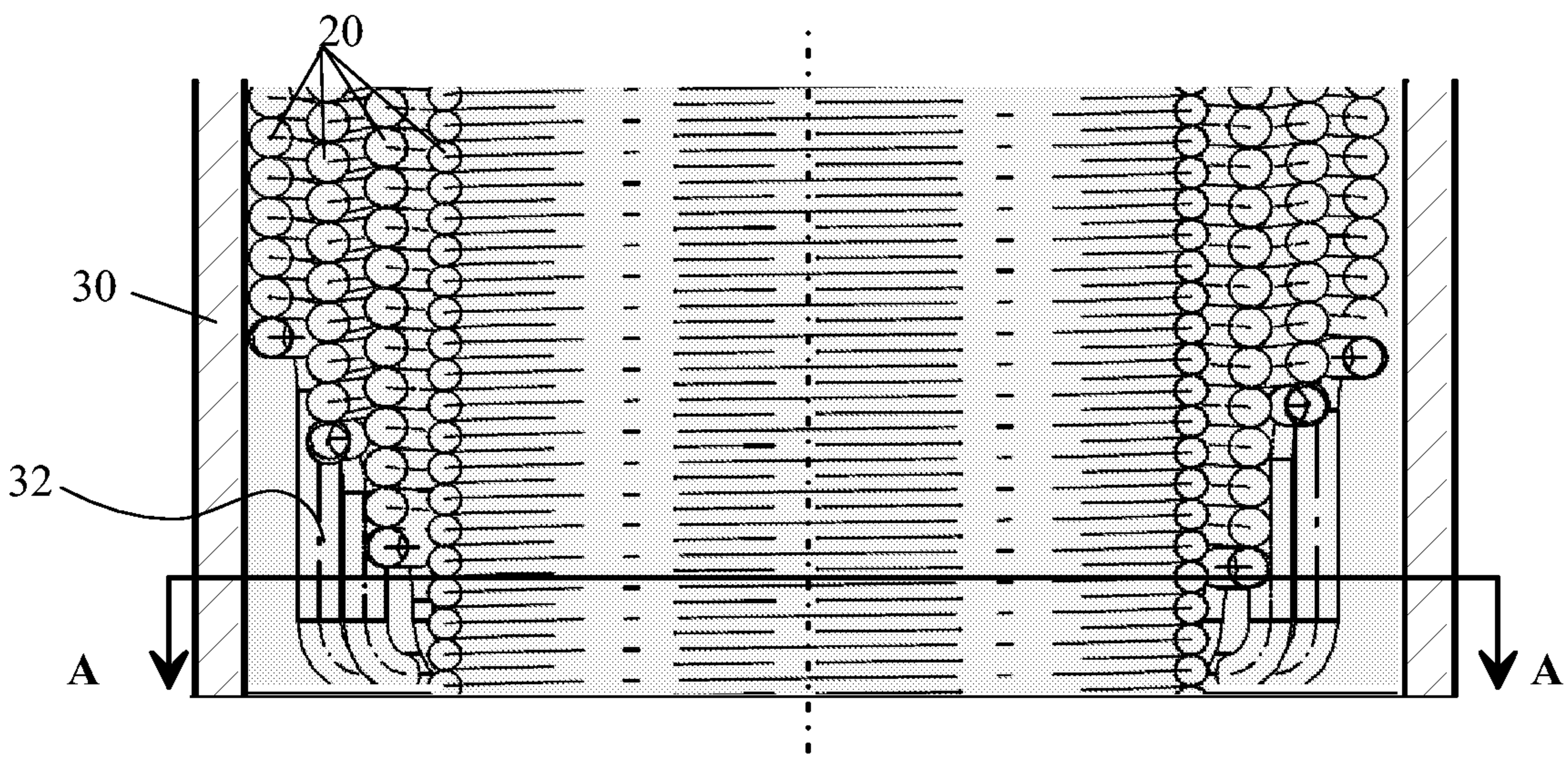


Fig. 5

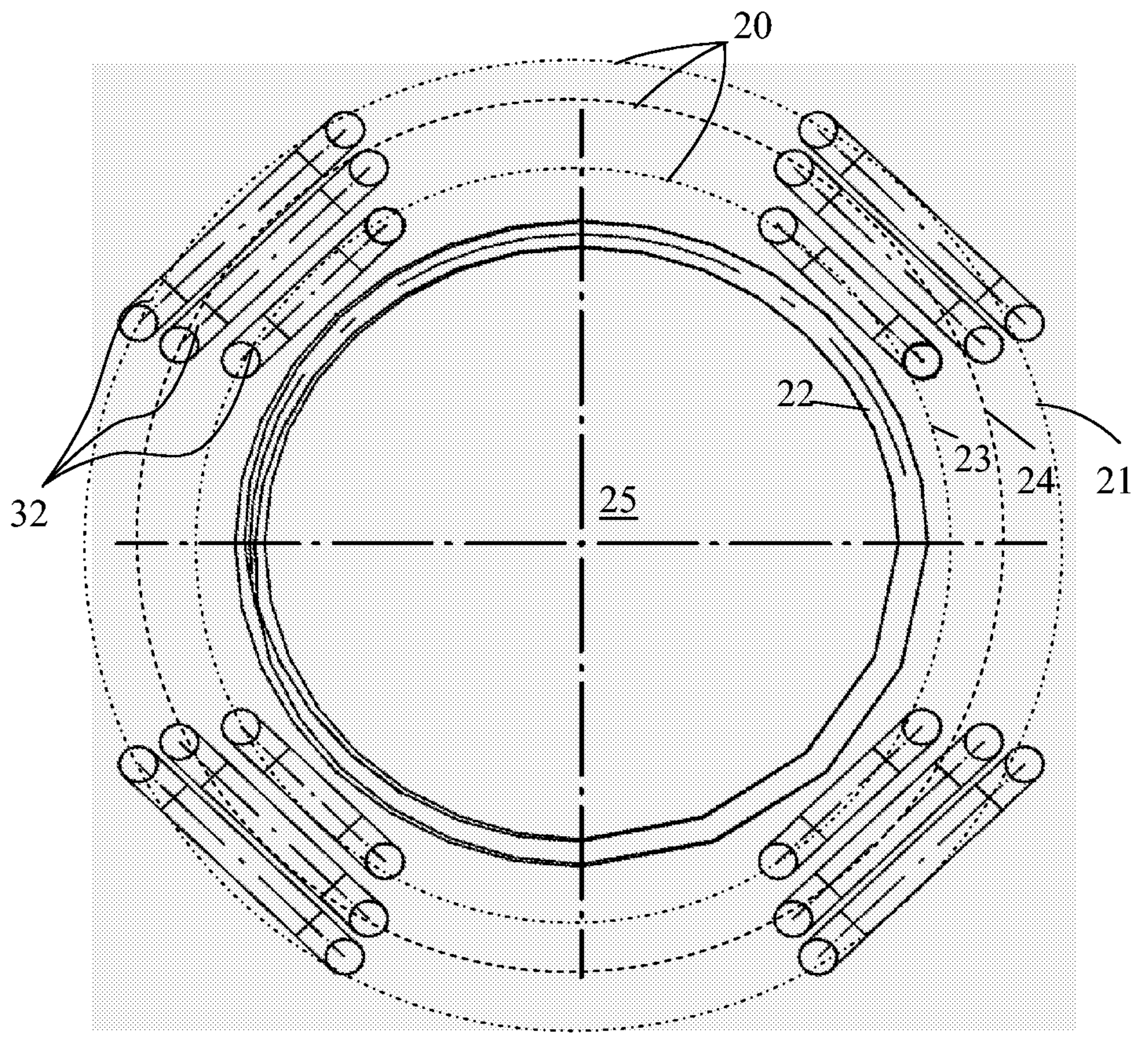
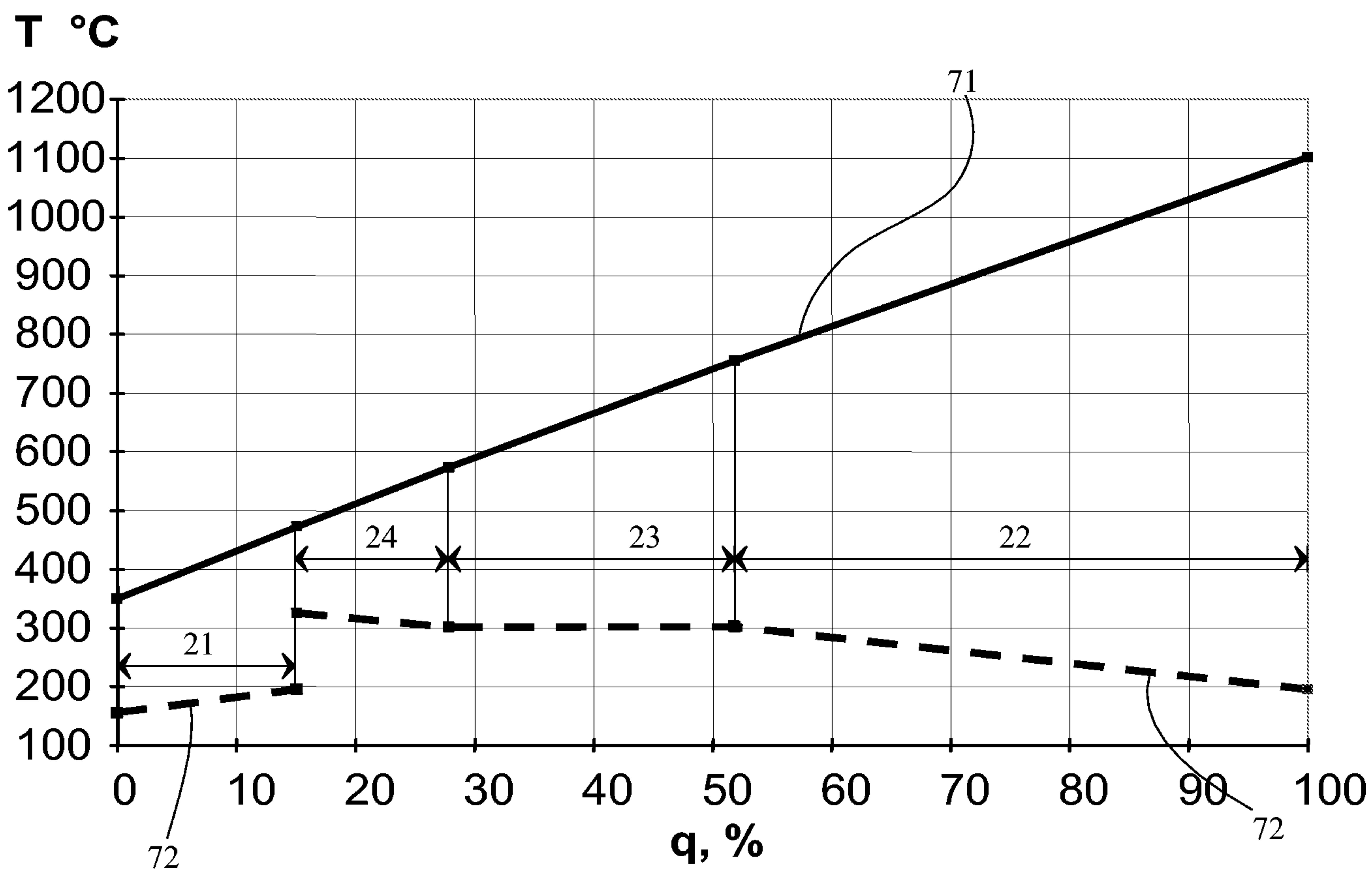


Fig. 6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1000
900
800
700
600
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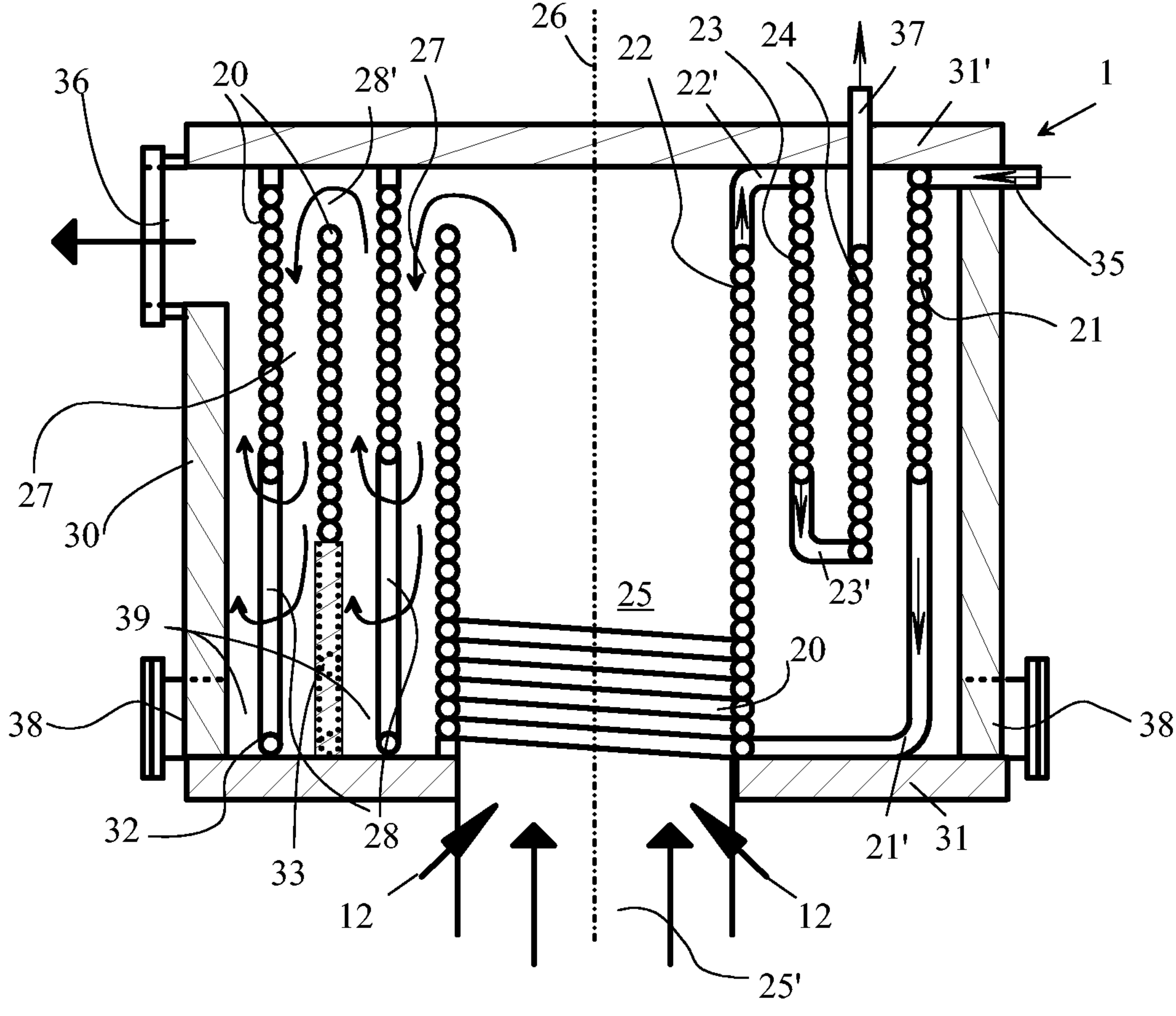
400
300
200
100
0
10
20
30
40
50
60
70
80
90
100
q, %
71
72
72
21
24
23
22

Fig. 7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28'
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