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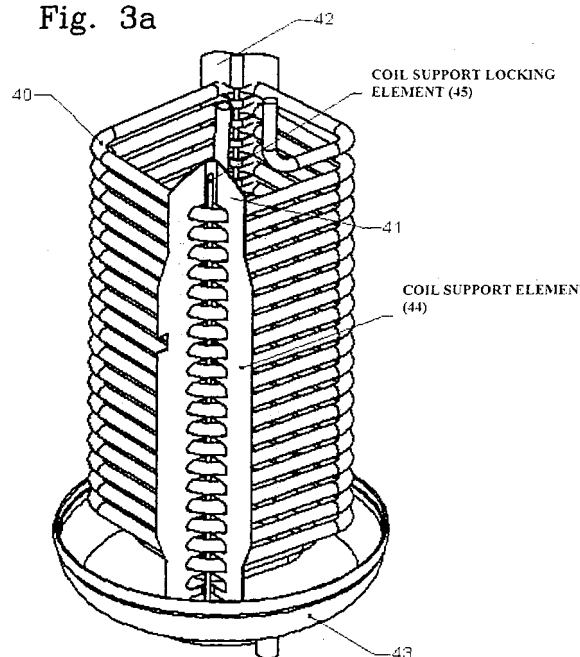
Remarks:

This application was filed on 17-06-2008 as a divisional application to the application mentioned under INID code 62.

(54) **Heat exchanger arrangement**

(57) The present invention relates to a coil support device for supporting a tubular coil in a water container, wherein said coil support device consists of a coil support element and an elongated coil support locking element, wherein said coil support element consists of an elongated structure having a plurality of substantially transversal cut-outs, each adapted for receiving a portion of a respective turn of said tubular coil. The said coil support device is arranged to be applied to said coil such that an elongated space is formed between said coil and said coil support element, and said elongated coil support locking device is arranged to, from one end of the coil support element, be inserted into said space formed between the coil and the coil support element so as to, in use, lock said coil support element to the coil. The present invention also relates to a heat exchange arrangement.

Fig. 3a



Description

Field of the invention

[0001] The present invention relates to heating systems, and in particular to a coil support device according to the preamble of claim 1.

[0002] The present invention also relates to a heat exchanger arrangement comprising a coil support device according to the preamble of claim 8.

Background of the invention

[0003] Today, there are a large number of heating systems for heating living houses.

[0004] These heating systems may consist of, e.g. oil-fired boilers, bioenergy boilers, which e.g. are intended for firing with chips or pellets, and heat pumps.

[0005] The heating systems often comprise a water heater, which, in principle, consists of a water container in which hot water is heated and stored to enable a momentary consumption of water that is larger than what the heating system momentarily can produce.

[0006] In the case of water heaters wherein heating is provided directly through electricity, the hot water may be heated during the night to enable a large hot water consumption during the day. In this kind of water heating, the water in the water heater may, in principle, be heated to an arbitrary temperature, which enables consumption of a large number of litres of ready-mixed hot water when the water heater is fully heated.

[0007] Regarding heat pumps, on the other hand, water heating is performed more often. Further, heating of the hot water in the water heater, the so called secondary water or hot water, is performed by the so called primary water, heated by the heat pump loop. As the available water heating temperature is limited by the temperature to which the heat pump is capable of heating the primary water, there is a limitation in the temperature to which the secondary water may be heated.

[0008] The water heating method often used today involves use of a double-walled water container, wherein the clean water is contained in the inner container, and is heated by hot water in the double-wall through the container wall.

[0009] A problem when using this kind of water heating is that heat pumps with high output power, e.g. more than 6 kW, tends to, during heating of hot water, and in particular during summer operation, turn off and on a number of times during heating, charging, of the hot water, which results in poor usage of the heat pump.

Summary of the invention

[0010] The object of the present invention is to provide a system for heating water that solves the above mentioned problem.

[0011] This object is achieved by a coil support device

according to claim 1 and a heat exchanger arrangement according to claim 8.

[0012] The coil support device is for supporting a tubular coil in a water container, wherein said coil support device consists of a coil support element and an elongated coil support locking element, wherein said coil support element consists of an elongated structure having a plurality of substantially transversal cut-outs, each adapted for receiving a portion of a respective turn of said tubular coil, wherein said coil support device is arranged to be applied to said coil such that an elongated space is formed between said coil and said coil support element, characterised in that said elongated coil support locking device is arranged to, from one end of the coil support element, be inserted into said space formed between the coil and the coil support element so as to, in use, lock said coil support element to the coil.

[0013] This has the advantage that the tubular coil may be assembled in the container in a manufacturing plant and then transported to an installation location without having to risk the coil collapsing and becoming damaged, which otherwise could be the case, e.g. if the tubular coil is made from copper. A further advantage is that the tubular coil may easily be positioned in an optimal way in the container, both regarding the position relative to the container wall and the positioning of the individual turns of the coil.

[0014] The heat exchanger arrangement includes a water container having an inlet for supplying water to be heated and an outlet for discharging heated water. The heat exchanger arrangement includes a tubular coil arranged in said water container, wherein said tubular coil includes an inlet for receiving hot fluid and an outlet for discharging said hot fluid after passage through the coil, wherein the coil is made from a material admitting heat from the hot fluid to be emitted to water in the container when hot fluid is passing through the coil, and includes a coil support device for keeping the tubular coil in position.

[0015] The outlet of the coil may be arranged in the lower end of the tubular coil.

[0016] This has the advantage that by conveying the hot water through the tubular coil instead of through a double-wall, a heat transfer surface which is considerably larger than the wall surface may be obtained, which increases the heat transfer capability of the heat exchanger and thereby allows that more heat may be transferred to the water in the container. Further, the tubular coil solution has the advantage that a considerably higher hot water velocity may be achieved as compared to what is possible when using the double-wall solution, which further increases heat transfer. Even further, the solution according to the present invention allows that the heat transferring surface may be positioned more freely than when using a double-wall, which has the advantage that a larger temperature gradient may be achieved in the container.

[0017] The system can further comprise means for

heating the hot fluid using a heat pump, wherein the hot fluid is circulated through the container using a circulation pump, and wherein the system comprises means for controlling the circulation pump continuously or in relation to predetermined start and stop conditions.

[0018] For example, the circulation pump may be controlled such that the circulation pump is turned on at a first predetermined cooling medium condensation pressure, and turned off at a second predetermined cooling medium condensation pressure, which is lower than said first cooling medium condensation pressure. Alternatively, the circulation pump may be controlled such that the cooling medium condensation pressure is kept at a predetermined cooling medium condensation pressure. This has the advantage that the ability of the heat exchanger arrangement to heat water may be varied in relation to various demands. For example, an uncontrolled circulation pump may have as result that a slightly smaller amount of ready-mixed water may be drawn from a fully heated water container, however with the hot water production having been accomplished at lower cost since the heat pump efficiency has been high. Controlling the circulation pump towards a certain working point, on the other hand, may allow a higher temperature in the water container, which in turn has as result that a consumer of large amounts of water may achieve a larger amount of ready-mixed hot water (ready-mixed hot water means the total volume of the hot water in the container and the volume of the cold water that the hot water is mixed together with) but at a higher cost due to lower efficiency.

[0019] The pitch of the tubular coil may be evenly distributed over its length, or, alternatively, the pitch of the tubular coil may vary over its length. For example, the pitch may be lower in the top and bottom as compared to the pitch in the middle of the coil. This has the advantage that the water transferring surface may be adapted to achieve a best possible temperature stratification in the container.

[0020] The heat exchanger arrangement may further comprise a double-wall, which may be used as an accumulator container, e.g. for defrosting water. This has the advantage that if the heat pump uses outside air as heat source, the volume in the double-wall may be used as defrosting container for defrosting an air heat exchanger, on demand or at regular intervals.

Brief description of the drawings

[0021] In figs. 1a and 1b is generally shown a heat pump.

[0022] In fig. 2 is shown a preferred embodiment of the present invention.

[0023] In figs. 3a and 3b are shown a solution to keep the tubular coil in position.

Detailed description of preferred embodiments of the invention

[0024] In fig. 1 is shown a heat pump 10 installed in a real estate such as a private house. The heat pump is provided with a control computer 12, which controls and monitors various functions in the heat pump. Such functions may be, e.g. setting and/or monitoring operating temperatures of the heat pump compressor, indoor and outdoor temperatures, heating function settings, room temperature control depending on time-of-day or holiday absence etc. A user may communicate with the control computer 12 via a display 29 and keypad 29 arranged on the heat pump. The heat pump 10 further comprises a heat pump circuit 20 and a water container 11 having an inlet 13 in the bottom part of the container for supplying water to be heated and an outlet 14 in the upper part of the container for discharging heated water.

[0025] The heat pump circuit 20 comprises a circulating cooling medium, refrigerant, wherein liquid cooling medium absorbs heat from a heat source such as heat loop in rock 22, having a temperature of about -5° - $+5^{\circ}$ and is evaporated in an evaporator. The evaporation temperature may be, e.g. -3° . The gaseous cooling medium is then compressed using a compressor 23 to a higher pressure, which, due to the smaller volume of the gas, results in an increased gas temperature. The compressed, hot gas then delivers its heat via a condenser 24 and sub-cooler 25 to the so called primary water, or radiator water 26. The sub-cooler has as result that more heat may be extracted, which consequently yields a more economic heat pump. The pressure of the, at this stage liquid, cooling medium is then considerably lowered in an expansion valve 27, whereupon the temperature of the cooling medium is rapidly lowered, whereupon the cooling medium again absorbs heat from the heat loop 22. The heat loop may also absorb heat from earth, air and/or water.

[0026] The primary water is then alternately used for heating hot water or the estates radiator and/or under-floor heating system. The efficiency of the heat pump is controlled by the temperature of the cooling medium when it reaches the condenser. The lower the temperature, i.e. the lower the pressure, the higher efficiency. When heating the primary water to, e.g. 35° using a 10kW heat pump, the coefficient of performance, COP, of the heat pump, i.e. the ratio of delivered power and supplied power, may be 4,4; at 50° it may be 3,3 and at 60° it may be 2,7.

[0027] Accordingly, the heat pump can not heat the primary water to an arbitrary high temperature, which leads to restrictions in the temperature to which the secondary water, hot water, may be heated by the primary water.

[0028] In fig. 1 is shown the method for heating the secondary water that is commonly used today. The water container 11 is double-walled with an outer wall 15 surrounding the container 11. The primary water is, by

means of a valve, alternately circulated through the estate's heating system (not shown) and the volume 16 between the container 11 and the wall 15. When the hot primary water passes through the volume 16, the water in the container 11 is heated through the container wall surface 17. When the primary water reaches the bottom of the double-wall it is led by means of outlet 18 back towards the heat pump portion for reheating.

[0029] However, a problem with this solution is that the primary water, when brought back to the heat pump portion 20, still may have such high temperature, due to poor heat transfer through the container wall, that the heat pump, in turn, may turn off as the cooling medium can not deliver its heat. This, in turn, has as result that the water in the container in some instances is not heated quickly enough, which may result in the hot water running out, in particular for a large consumer such as a family with more than one child, even though, in reality, there exists capacity for further heating. Frequent heat pump turn-off also leads to a low effective running time. Thereby the heat pump capacity is not used to the extent that otherwise would be possible.

[0030] In fig.2 is shown a heat exchanger arrangement according to the present invention, which allows a larger heat transfer to the water in the container and also larger hot water consumption. Instead of having a double-wall, a tubular coil 31, extending substantially through the entire portion of the water container 30 that is filled with water, is arranged in the water container 30. The primary water, heated by the heat pump portion, is let into the tubular coil from above and circulates through the coil, which is ended by an outlet in the container bottom, after which the primary water is recirculated to the heat pump portion for reheating prior to circulating the coil again. The tubular coil has the advantage that, as compared to the container wall, a considerably larger heat transfer surface is obtained, which results in transfer of a larger amount of energy during passage through the coil. This further leads to a lower temperature of the primary water after passage through the coil, as compared to the solution in fig. 1, which, in turn, means that a larger amount of energy may be absorbed from the heat pump cooling medium, and hence the heat pump need not turn off as often. Thereby, the water in the water container may be heated to the desired temperature faster (become fully charged) and may thus in a shorter period of time than before again allow hot water consumption following a previous large hot water consumption. In the figure, the coil is shown as having an essentially square section, this section, however, may, of course, also be circular, triangular or of any other polygon shape. As can be seen in the figure, the tubular coil and the water container are coaxially aligned in this example.

[0031] Since the coil extends through all or substantially all of the water carrying portion of the container, a greater temperature gradient as compared to the double-wall solution is achieved. I.e., even if the total energy contained in the container is the same, the temperature

difference between the top and bottom will be greater using the tubular coil, which results in a higher temperature in the upper part as compared to using a double-wall. In heat pump applications, each additional degree of higher temperature in the hot water is important since this means that a larger amount of ready-mixed water with a temperature suitable for consumption can be obtained. The present invention thus facilitates the often present regulations regarding how much hot water a water heater must be able to deliver during a continuous discharge, and then again at a new discharge after a certain amount of time, e.g. one hour.

[0032] In an example of a heat pump according to the invention, a top temperature 5° higher than when using a double-wall solution is obtained. Further, recharging is much quicker since the heat pump does not turn off in the same manner as when using the double-wall.

[0033] As compared to the double-wall solution the present invention further has the advantage that the weight of the total appliance is lighter and the heat pump is thus easier to transport and install.

[0034] In an alternative embodiment of the present invention the double-wall may be kept. If, for example, the heat pump uses outdoor air as heat source, a defrosting container containing hot water is normally required, wherein the hot water is circulated through an air heat exchanger having a flange battery to defrost ice precipitated on the flange battery. This defrosting container normally constitutes a separate unit, positioned next to the heat pump. The present invention, however, allows that the freed volume in the double-wall is used as a defrosting container. Water that has been cooled during heating of the flange battery may then be reheated by the hot water through the wall of the water container, and then be shunted to the flange battery when necessary. The limited ability of the wall to transfer heat has as result that the temperature of the hot water is only slightly affected. The invention thus has the advantage that the extra container is unnecessary, with following savings in cost and space.

[0035] The water is circulated through the tubular coil using a circulation pump. Normally, no control of the circulation pump is performed, the water is circulated continuously. In order to further improve the ability of the heat pump to deliver larger amounts of hot water, a control of the circulation pump may be performed. For example, a very simple control principle may be used, wherein the circulation pump is started when the condensation pressure in the heat pump has reached, e.g. 25,5 bar, which means that the cooling medium has a high temperature and that the primary water thus will be heated to a high temperature when the circulation starts. When the condensation pressure then has dropped, e.g. to 20 bar, due to heat transfer to the primary water the circulation pump is turned off until the condensation pressure again has risen to 25,5 bar. Accordingly, this control method is very simple and may be implemented in a simple manner. The advantage of this control method is that

even more hot water may be drawn from the container, in particular when using hot water of higher temperatures, such as 50° hot water. This control method also results in an even greater temperature difference in the container, and thereby higher top temperature. The disadvantage of this control is that the COP of the heat pump is lower than when using an uncontrolled circulation pump due to the higher condensation temperature.

[0036] Another alternative regulation possibility is to turn on the circulation pump during a certain fraction of the time, e.g. 1 second every 4 seconds.

[0037] In order to further increase the possibility to draw large amounts of hot water a continuous control of the circulation pump may be applied. At continuous control, the working point of the heat pump compressor may be kept about a predetermined point, e.g. 26 bar, which allows that an even larger volume of high temperature hot water maybe drawn, which may be advantageous for large families or at occasions with guests staying overnight. The lower COP factor, however, raises the costs for heating.

[0038] The circulation pump may advantageously be variable-speed controlled to enable an accurate and continuous control.

[0039] The above mentioned circulation pump start and stop pressures merely constitutes an example, and should be chosen lower than the condensation pressure at which the heat pump turns off.

[0040] The water container may also be provided with a sensor in the top of the water container in order to allow display of a real water temperature. This sensor may also be used in control of hot water production. For example, the heat pump may turn off when the top temperature has reached a certain temperature. This has the advantage that a customer may choose at which temperature the heat pump turns off. If the household is not a large consumer of hot water, maybe 45° or 50° is enough to provide the household with a sufficient amount of ready-mixed water from the water in the water container. The sensor may also be used to start the heat pump when the top temperature falls below a certain value, e.g. when the top temperature has fallen due to hot water consumption or heat transfer by radiation, e.g. when the container has been left unused for some time.

[0041] In fig. 3a is shown a solution to keep the tubular coil in position. In order to avoid that the coil collapses during transport, due to shakings, knocks etc., which may occur if the coil is produced, e.g., by copper, a coil support device may be used to keep the coil in position. In the figure is shown two diametrically opposed coil support devices 41, 42 that are used to support a coil in a container 43.

[0042] The coil support devices 41, 42 each consists of two separate parts wherein one 44 constitutes the coil support element and the other part 45 constitutes a coil support locking element.

[0043] In fig. 3b is shown the portions 44 and 45 more in detail. The coil supports are preferably made from ther-

moplastic such as polyethylene or polyoximethylene and consist of, e.g. a 2 mm thick plate with cut-outs 46 for the coil support. During assembling, the coil support is bent approximately 90 degrees using a tool and is applied onto the corner of the coil. A coil support locking element in the shape of a stiff rod is inserted into the space arisen between the coil and the coil support from one end. In fig. 3a, the coil support is shown both in a bent shape and in a planar shape. The coil support may be arranged such that it remains in a bent shape after bending, but may also be arranged such that when the tool releases the coil support this may, as much as possible, tend to again become straight, i.e. until the coil support locking element is stopped by the coil and thereby prohibits the coil support from fully straightening out.

[0044] The coil support locking element consists of, e.g., a round bar made from polyethylene or polyoxymethylene. For a heat exchanger intended for a living house heat pump of ordinary size, the locking element may have a diameter of about 8 mm and be about 900 mm in length.

[0045] Two coil supports are mounted in this manner on each coil and in two opposite corners of the coil. In order to reduce the number of parts both coil supports may be identical, but shaped such that a compensation for the pitch of the coil is accomplished by turning one support upside down. During transport of the heat exchanger, the lower portions of the coil support rests on the bottom portion of the container and, in this manner, keeps the coil in position and prohibits it from collapsing during transport. The coil support also ensures that a correct positioning of the coil is maintained during the heat exchanger lifetime. In an alternative embodiment the coil support may be completely flat but shaped such that it still may be applied on to a corner of the coil. In this example, the corner of the coil may, e.g., be relatively sharp, as may be the case, e.g. when an axial section of the coil is triangular, quadrangular, pentagonal or of another polygon shape.

[0046] Further, in the above description water has been used as heat transfer medium. Instead of water, of course, some other liquid may be used, or fluids such as gas or gas/liquid mixtures.

Claims

1. Coil support device for supporting a tubular coil in a water container, wherein said coil support device consists of a coil support element and an elongated coil support locking element, wherein said coil support element consists of an elongated structure having a plurality of substantially transversal cut-outs, each adapted for receiving a portion of a respective turn of said tubular coil, wherein said coil support device is arranged to be applied to said coil such that an elongated space is formed between said coil and said coil support element, **characterised in that**

said elongated coil support locking device is arranged to, from one end of the coil support element, be inserted into said space formed between the coil and the coil support element so as to, in use, lock said coil support element to the coil.

2. Coil support device according to claim 1, **characterised in that** said coil support element is arranged to be folded/bended using a tool in the longitudinal direction during assembling before/at application of the coil support element on said coil, wherein the coil support element further is arranged such that it tends to straighten out at tool release of the coil support. 10
3. Coil support device according to claim 1 or 2, **characterised in that** the coil support element is an elongated sheet having a substantially L, Y or V shaped cross section. 15
4. Coil support device according to any of the claims 1-3, **characterised in that** the coil support comprises cut-outs for substantially each turn of the coil. 20
5. Coil support device according to any of the claims 1-4, **characterised in that** the coil support may be turned upside down for use on the diametrically opposed side for compensation of the pitch of the coil. 25
6. Coil support device according to any of the claims 1-5, **characterised in that** the recesses are angled for adaption to the pitch of the coil. 30
7. Coil support device according to any of the claims 1-6, **characterised in that** the coil support is made from thermoplastic such as polyethylene or polyoximethylen. 35
8. Heat exchanger arrangement for use with a heat pump, an oil burner or the like, wherein the heat exchanger arrangement includes: 40
 - a water container having an inlet for supplying water to be heated and an outlet for discharging heated water, wherein the heat exchanger arrangement further includes: 45
 - a tubular coil arranged in said water container, wherein said tubular coil includes an inlet for receiving hot fluid and an outlet for discharging said hot fluid after passage through the coil, wherein the coil is made from a material admitting heat from the hot fluid to be emitted to water in the container when hot fluid is passing through the coil, **characterised in that** the arrangement includes a coil support device according to any of the claims 1-7. 50
9. Heat exchanger arrangement according to claim 8, wherein said tubular coil extends substantially 55

through the water carrying height of the water container.

10. Heat exchanger arrangement according to claim 8, **characterised in that** the outlet of the tubular coil is arranged in the lower end of the tubular coil.
11. Heat exchanger arrangement according to any of claims 8-10, **characterised in that** the pitch of the tubular coil is evenly distributed over its length.
12. Heat exchanger arrangement according to any of claims 8-10, **characterised in that** the pitch of the tubular coil varies over its length.
13. Heat exchanger arrangement according to any of the claims 8-12 **characterised in that** the cross section of the tubular coil is round, triangular, quadrangular, pentagonal or of other polygonal shape.
14. Heat exchanger arrangement according to any of the claims 8-13, **characterised in that** the tubular coil and the water container is coaxially aligned.
15. Heat exchanger arrangement according to any of the claims 8-14, **characterised in that** said hot fluid consists of hot water.

Fig. 1a

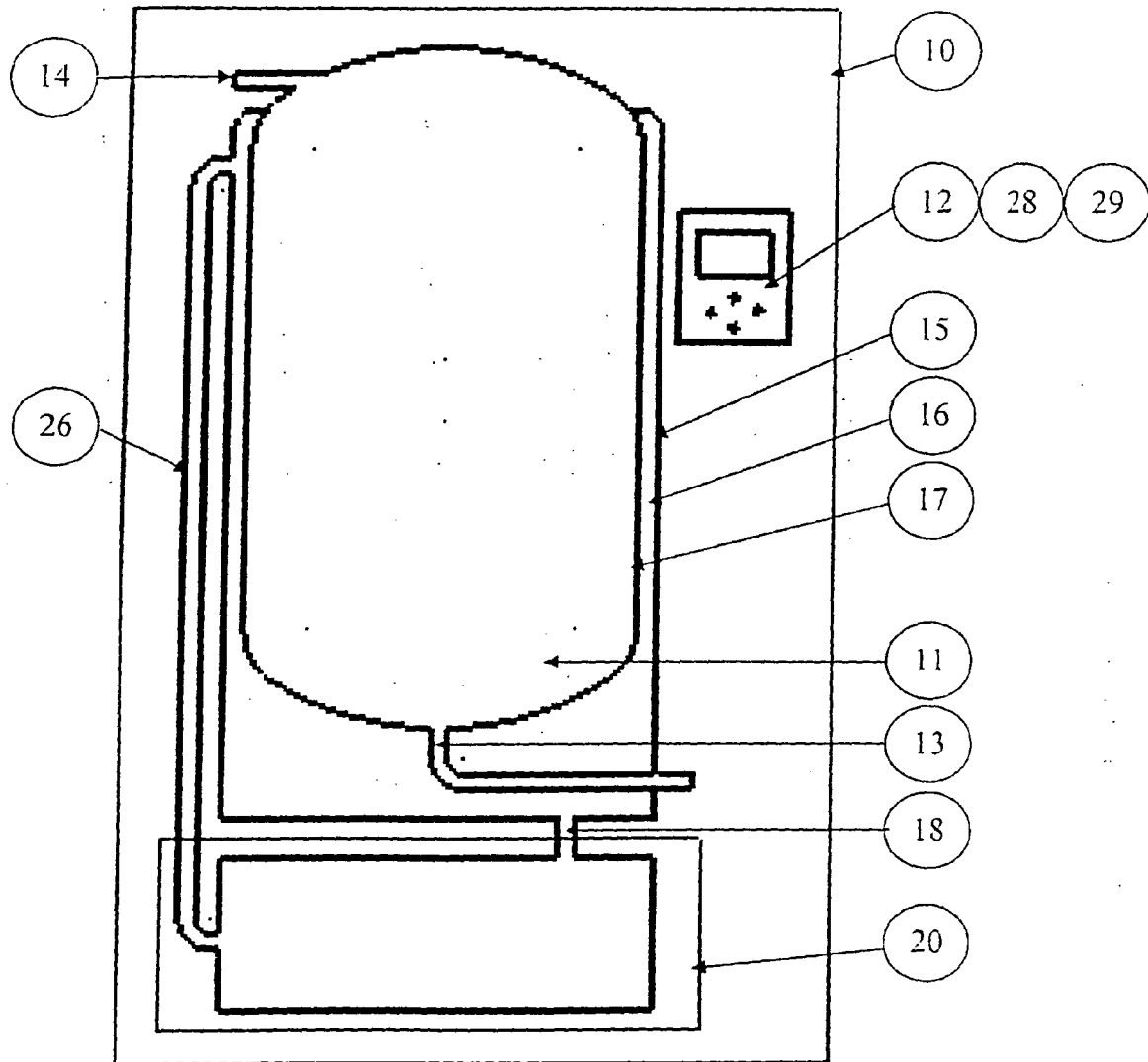


Fig. 1b

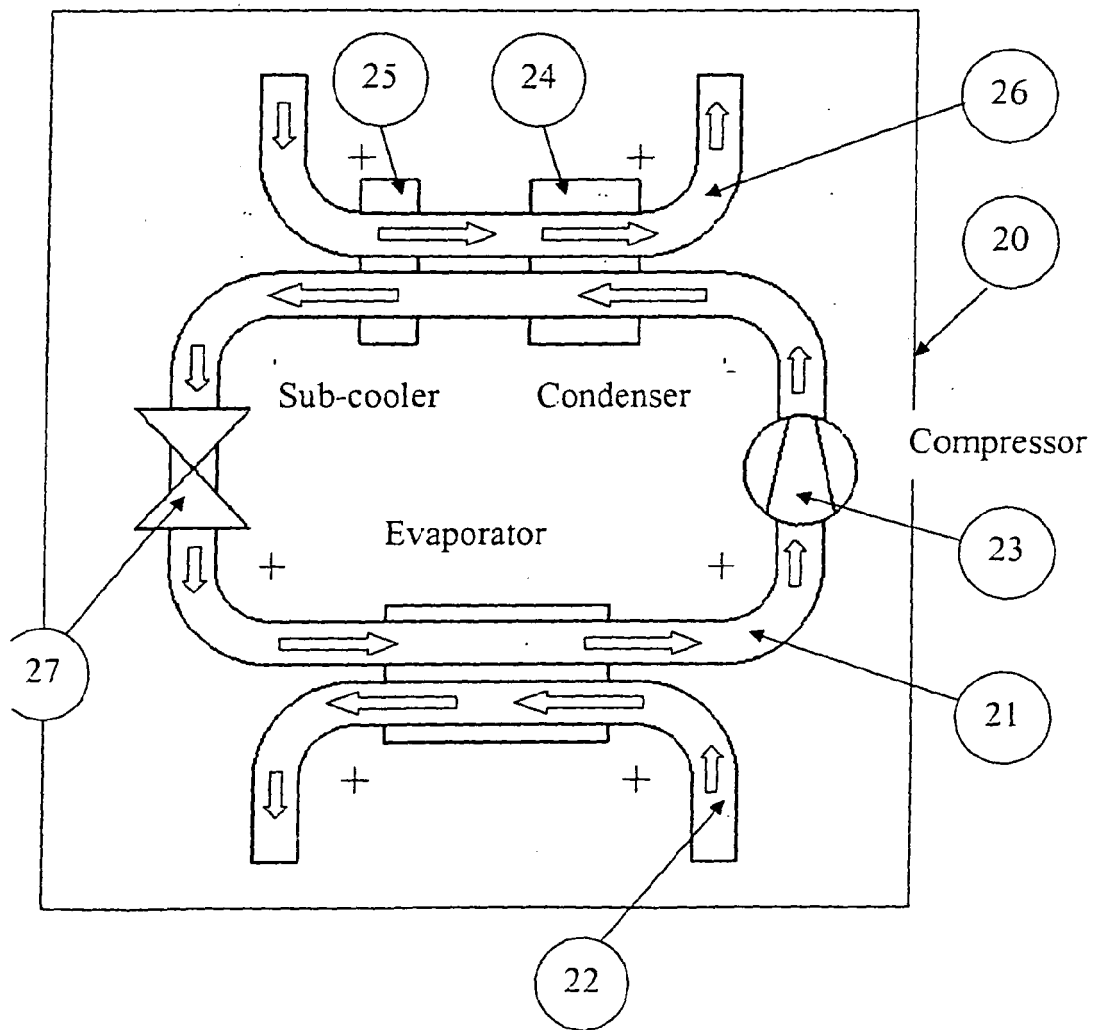


Fig. 2

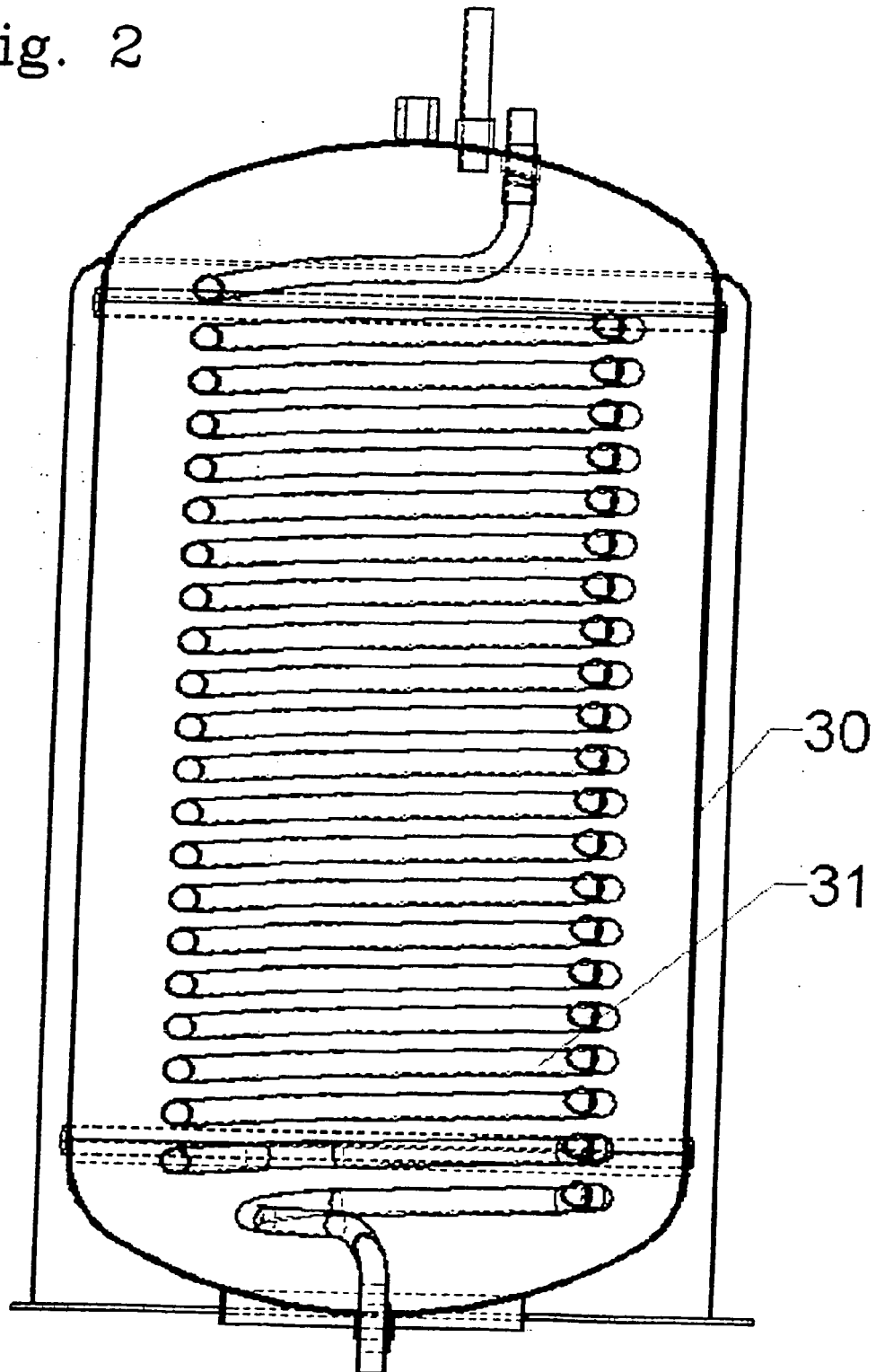


Fig. 3a

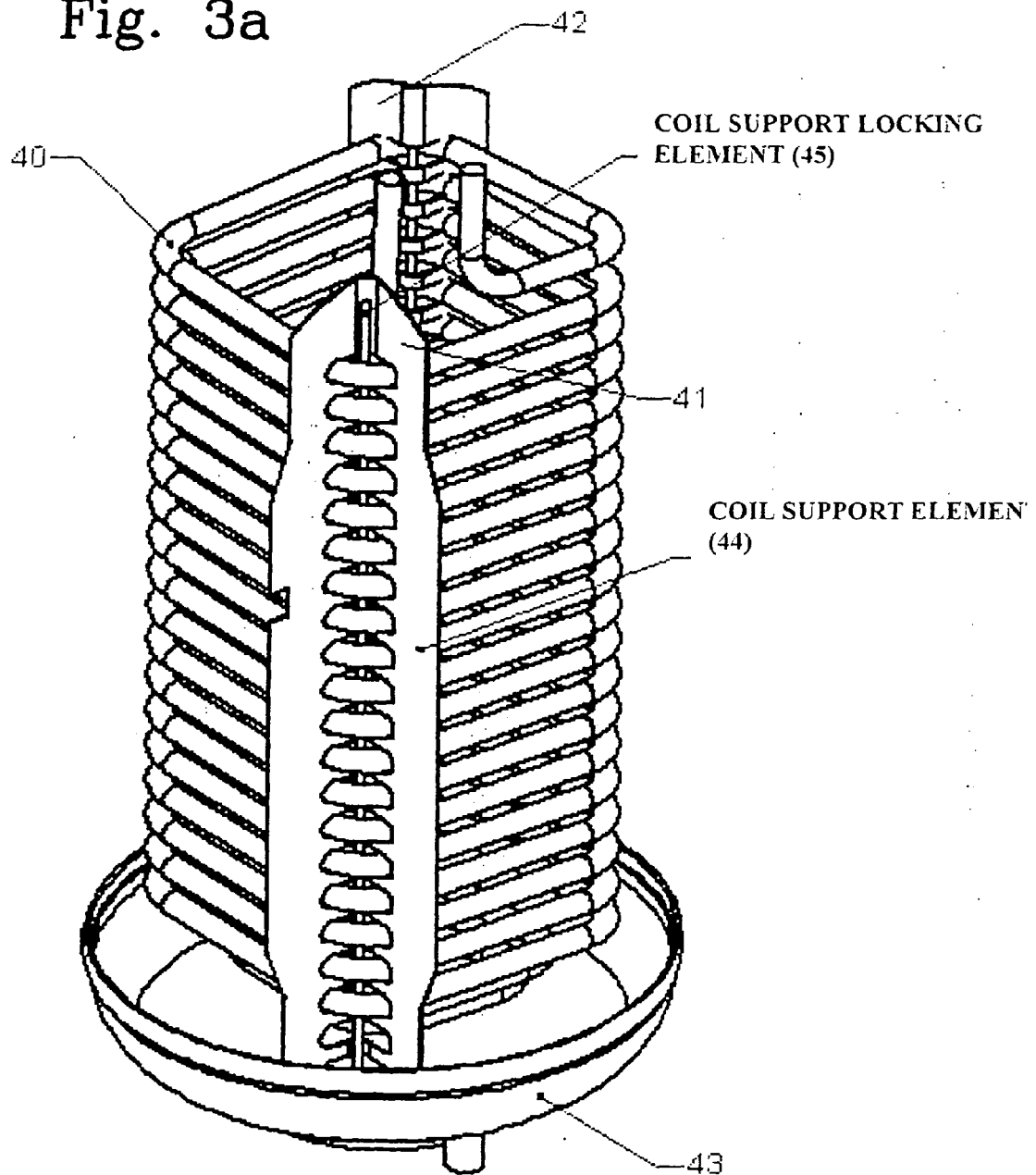
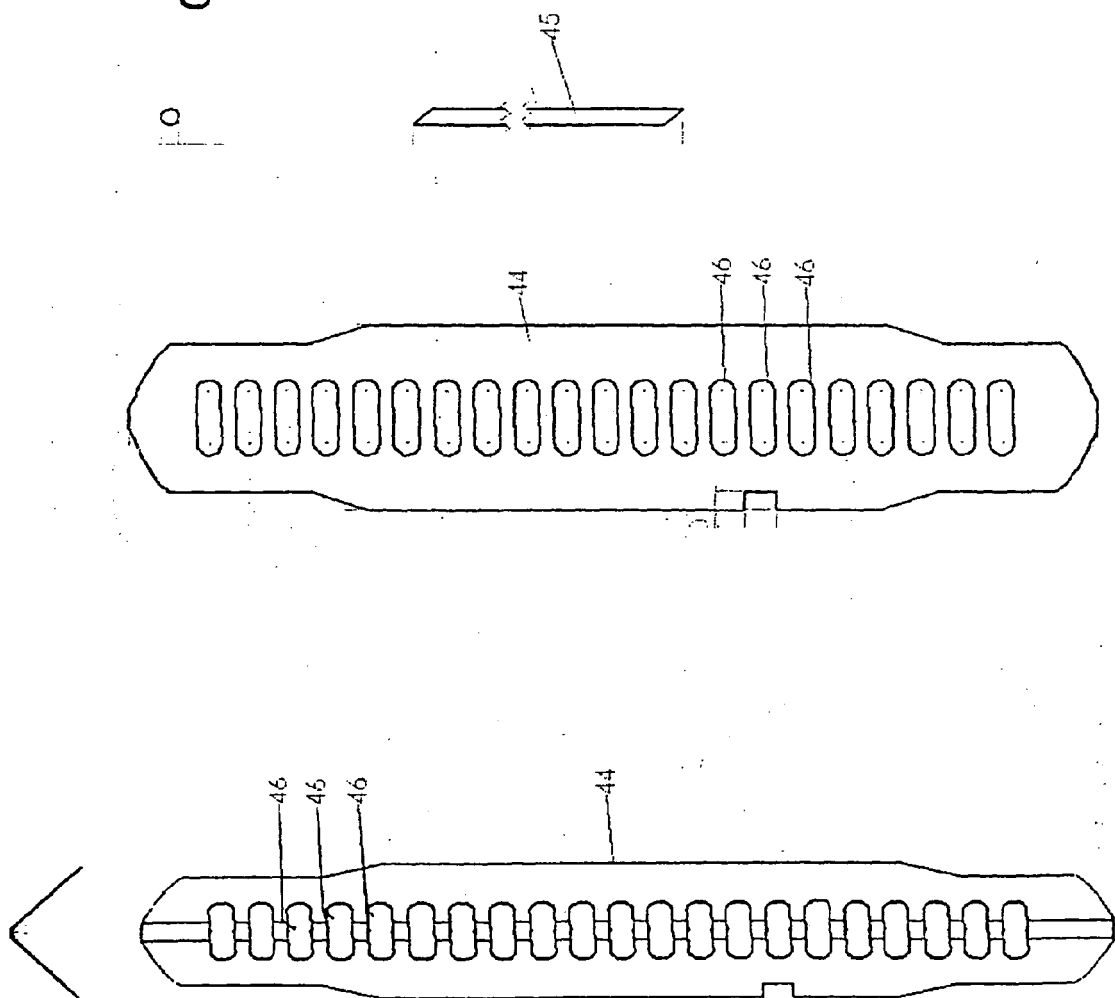


Fig. 3b





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 01 0942

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Place of search Munich		Date of completion of the search 4 September 2008	Examiner Mellado Ramirez, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 08 01 0942

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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