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(54) Title: GEOTHERMAL HEAT EXCHANGER DEVICE

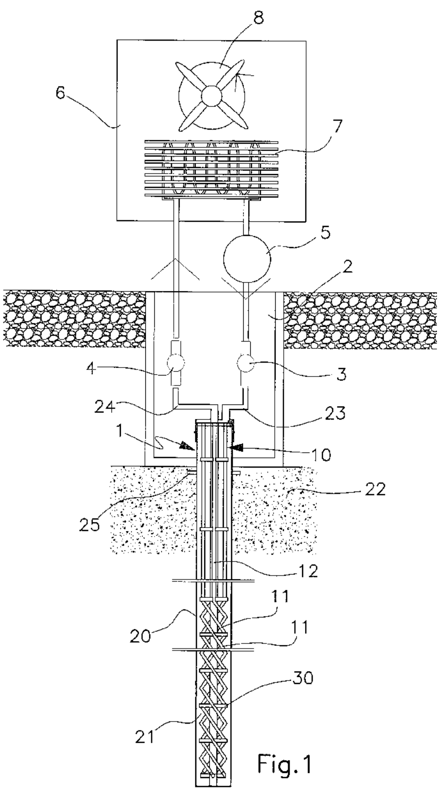

Fig.1

(57) Abstract: The geothermal heat exchanger device comprises a geothermal probe (10) having low enthalpy suitable to be inserted in vertical position in the ground and provided with at least one inlet piping (11) and one outlet piping (12) for the circulation of a heat exchange fluid provided with regulation means (40) which allow to regulate the heat exchange capacity. The exchanger device comprises an external pipe (20) of thermal conductive material, closed at the opposite ends, suitable to be inserted in a drilling made in the ground, and shaping a thermal chamber (21) which axially carries in its inside said geothermal probe (10). The thermal chamber (21) is suitable to be filled with an interchangeable fluid, for varying the overall thermal impedance of the exchanger device.

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Description

GEOTHERMAL HEAT EXCHANGER DEVICE

Technical Field

[01] The present invention relates to a geothermal heat exchanger device having low enthalpy, in particular provided for being used in air-conditioning systems.

Background Art

[02] It has been known that air-conditioning systems which exploit geothermal energy are used as an alternative for traditional fuel powered systems. Such systems can be generally divided in depth plants, provided with geothermal probes placed beyond a depth of 50 meters, and surface plants, provided with geothermal probes placed within a depth of 20 meters.

[03] The main difference between the cited different technologies consists in the fact that the depth plants must operate in almost constant thermodynamic conditions during the year, by exploiting specific heat sources together with the high thermal capacity of the ground, which acts as heat storage. Vice versa, the surface plants exploit the natural temperature variation of the first layers of the ground, combining the thermal capacity of the ground, which acts as a storage, and the heat transmission speed in the ground, which allows to have a working temperature being lower in summer and higher in winter. Therefore, it is possible to extract heat from the ground, for the winter heating, and to release heat extracted from rooms to the ground for the refrigeration of such rooms in summer months.

[04] Therefore, geothermal devices have been designed provided with one or more geothermal probes inserted in suitable drillings made in the ground and connected with a conventional air-conditioning plant by means of a heat exchanger. More in particular, it has been known the use of geothermal probes having low enthalpy suitable to be inserted in vertical position in the ground and provided with at least one inlet piping and with one outlet piping for the circulation of a heat exchange fluid, for example water.

[05] Patent application EP 1 978 314 discloses for example a geothermal probe able to be inserted in a drilling made in the ground and comprising at least one first inlet piping and at least one second outlet piping connected with the first inlet piping for the circulation of the fluid suitable for the heat exchange with the environment; the geothermal probe comprises an external pipe which encloses said inlet piping and outlet piping and which is filled at least partially with a thermal conductive material. Such heat conductive material is a mix comprising a solid granular material and a thermal conductive liquid.

[06] Geothermal probes being substantially of the same type are illustrated in EP 1 486 741 and US201 1/0272054.

[07] Nevertheless, known solutions do not fully satisfy the cost and efficiency exigencies of users, independently from their shape. As a matter of facts, such geothermal probes differ

only in shape and filling materials for the space in which inlet and outlet pipes are enclosed, therefore the functioning of their heat exchange surface, that is of the thermal impedance, is passive. In particular, known geothermal probes do not allow, once installed, any season or environment adjustment, according to the different kinds of ground or of its variation in the course of time. In fact, the geometrical shape and the specific technical features of the probes determine their thermodynamic characteristics. For example, it is possible to increase, in developing step, the dissipative capacity or the absorbent capacity, but not both, to optimize the functioning during both summer and winter. In particular, known geothermal probes do not allow to edit in active and automatic way their heat exchange capacity, that is the thermal impedance, for example adapting to climatic zones having great thermal gradients between summer and winter, preventing drift phenomena or possibly restoring existing thermal drifts.

[08] In addition, known solutions do not easily allow the user to run the periodic maintenance operations of the already installed probes, nor the replacement or the full or partial recovery of the same probes at the end of their life.

Disclosure

[09] The task of the present invention is that of solving the aforementioned problems, devising a geothermal heat exchanger device having low enthalpy which allows to obtain a high efficiency level in any season and climatic zone.

[10] Within such task, it is a further scope of the present invention that of providing a geothermal heat exchanger device which enables an optimal adjustment to the ground characteristics.

[11] A further scope of the present invention is that of providing a geothermal heat exchanger device easy to install and maintain.

[12] A further scope of the present invention is that of providing a geothermal heat exchanger device having a simple installing and functioning, provided with a surely reliable functioning, a versatile use as well as relative economic cost.

[13] A further scope of the present invention is that of providing a geothermal heat exchanger device easy to adapt to any type of thermal pump currently existing on the market.

[14] The cited scopes are attained, according to the present invention, by the geothermal heat exchanger device having low enthalpy according to claim 1.

[15] The geothermal heat exchanger device comprises a geothermal probe having low enthalpy provided with at least one inlet piping and at least one outlet piping for the circulation of a heat exchange fluid; an external pipe of thermal conductive material, suitable to be inserted in a drilling made in the ground and shaping a thermal chamber, which axially carries in its inside said geothermal probe and is suitable to be filled with a

heat exchange medium; regulation means of the exchange surface of said inlet and/or outlet piping, which allow to vary the heat exchange capacity.

[16] Preferably, said regulation means for the exchange surface of said inlet and/or outlet piping comprises at least one electro valve associated with at least one of said inlet and/or outlet piping.

[17] Preferably, said regulation means comprise a plurality of electro valves respectively arranged next to the inlet of a plurality of pipes which constitute said inlet piping.

[18] Said electro valves are suitable to regulate the flow of the heat exchange fluid inside each single pipe which composes the exchange pipe bundle or to exclude completely some pipes of the same pipe bundle, actively modifying the total exchange surface of the geothermal probe.

[19] Suitably, the geothermal heat exchanger device comprises control means for the said regulation means.

[20] Said control means for the regulation means are suitable to control the opening of each electro valve, thus regulating the flow rate of each inlet and/or outlet pipe, by varying the active heat exchange surface, that is the thermal impedance of the ground of the geothermal probe.

[21] Suitably, said thermal chamber is suitable to be filled with a heat exchange medium which can be changed for varying the total thermal impedance of the exchanger device.

[22] Said interchangeable heat exchange medium can be water in summer and sand dispersed in water in winter.

[23] Preferably, said outlet piping of the geothermal probe is made of heat conductive material having a thermal conductivity higher that the thermal conductivity of the material used for said at least one inlet piping.

[24] Preferably, said outlet piping is suitable to be the supporting structure of said geothermal probe.

[25] Preferably, said inlet piping comprises a plurality of pipes of plastic material, wound in spiral around said outlet piping.

[26] Preferably, said outlet piping and said external pipe are made of steel.

[27] The present invention concerns as well a method of operating a geothermal heat exchanger device, comprising a geothermal probe with low enthalpy provided with at least one inlet piping and one outlet piping for the circulation of a heat exchange fluid, inserted in an external pipe of heat conductive material, suitable to be inserted in a drilling made in the ground and shaping a thermal chamber suitable to be filled with a heat exchange medium, the method providing to vary the heat exchange capacity of said inlet and/or outlet piping through regulation means of the exchange surface of the same inlet and/or outlet piping.

[28] Said operating method provides to control the said regulation means of the exchange surface of the inlet and/or outlet piping through automatic control means.

Description of Drawings

[29] Details of the invention shall be more apparent from the detailed description of a preferred embodiment of the geothermal heat exchanger device according to the invention, illustrated for indicative purposes in the attached drawings, wherein:

[30] figure 1 shows a schematic view in axial cross section of the geothermal heat exchanger device according to the invention;

[31] figure 2 shows a lateral view of a portion of the geothermal heat exchanger device according to the invention;

[32] figure 3 and 4 show, in the aforesaid schematic axial cross section view, magnified details of the geothermal heat exchanger device according to the invention;

[33] figures 5 and 6 show a lateral view and a plant view of further magnified details of the geothermal heat exchanger device according to the invention;

[34] figure 7 shows a schematic view in axial cross section of a different embodiment of the geothermal heat exchanger device according to the invention;

[35] figure 8 shows, in the afore said schematic axial cross section view, a magnified detail of the geothermal heat exchanger device of figure 7.

Best Mode

[36] With particular reference to such figures, the geothermal heat exchanger device having low enthalpy is indicated for better clarity in its entirety with 1.

[37] The geothermal exchanger device 1 comprises a tubular heat exchanger or geothermal probe 10 having low enthalpy, suitable to be inserted in vertical position in the ground and provided with at least one inlet piping 11 and one outlet piping 12 for the circulation of a suitable heat exchange fluid. The geothermal probe 10 is suitable to be axially inserted inside an external pipe 20 inserted in a drilling made in the ground. The external pipe 20 is made of a heat conductive material, resistant to chemical aggression, and is in particular made of varnished steel or stainless steel.

[38] The external pipe 20 is suitably closed at its opposite ends so as to shape, in use, a thermal chamber 21 suitable to be filled with a fluid medium, for example water, sand or bentonite dispersed in water. Suitably, according to the present invention, such fluid medium can be changed for passively varying the overall thermal impedance of the exchanger device. In particular, such fluid medium can be periodically changed, according to the season's climatic variations.

[39] The inlet piping of the geothermal probe 10 is preferably made of a plurality of elements, in practice constituted by pipes 11 of plastic material, for example polyethylene of the type known as Pex-A or a multi-layer one for example of the type Pex-Al-Pex. In the illustrated

case, four inlet pipes 11 are provided, wound in coaxial spirals around the raising outlet piping 12, as it is better described in the following. Obviously, it is possible to provide that the pipe bundle made by the inlet pipes 11 comprises a different number of elements, for example six or eight, so as to vary the maximal exchangeable thermal power of each probe; or it is possible to provide a single inlet pipe. It is possible as well to provide that the inlet pipes 11 do not wind in spiral around the raising outlet piping 12, but instead that they extend in linear way along such outlet piping 12. It is further possible to provide the use of fins on the pipe bundles to increase the exchange surface with the thermal fluid. It is further possible to provide that the inlet piping is the one raising, around which one or more outlet pipes are wound in coaxial spirals.

[40] The outlet piping of the geothermal probe 10 is made, according to the present invention, by an internal rising pipe 12 of thermal conductive material, in particular of varnished and/or galvanized steel or stainless steel, suitably closed at its opposite ends. In particular, the outlet piping 12 in made of a material having higher thermal conductivity than the plastic material used for making the inlet pipes 11, in order to keep the thermal flow exchanged for linear unity of the probe constant, thus counter-balancing the decrease of the exchange surface due to the reduction of the number of pipes used for the outlet piping and, at the same time, keeping a low loss of overall pressure drop of the piping system, which, consequently, does not need particularly powerful recirculation pumps. Obviously, it is possible to provide that the outlet piping as well is made of a plurality of elements or pipes.

[41] Preferably, the rising pipe 12 is made by a plurality of tubular tracts axially associated. Such tubular tracts are firmly constrained to one another through sleeves which screw on grooved or flanged end portions of the same tubular tracts.

[42] The rising pipe 12 is interiorly closed by a cap 14 provided, in angularly spaced positions, with a plurality of connection members 15 for the inlet pipes 11 (see figure 3). Obviously, the number of connection means 15 is equal to the number of the inlet pipes 11. The cap 14 is provided with a grooved or flanged portion for the connection with the sleeve of the tubular end tract of the internal pipe 12.

[43] Furthermore, the rising pipe 12 is closed superiorly through a head 16 which is constrained to the top tubular tract of the same rising pipe 12 (see figure 4). The head 16 shapes a mixing chamber 17 provided in its lower part with suitable joint members 18 for the inlet pipes 11, among which the exchange fluid, fed by the heat exchanger or by the thermal pump of the plant, is divided. Furthermore, the head 16 carries axially integral a sleeve 19, protruding above and below the same head 16, for connecting the outlet piping 12.

[44] It is to be observed that the rising pipe 12 is suitable to be the support structure of the geothermal probe 10. The inlet pipes 11 are suitably constrained to such support structure through a series of spacing members 30 mounted, regularly spaced, on the rising pipe 12. The spacing members 30 are preferably made by a circular crown peripherally shaping couples of prongs 31, of substantially semi-annular shape, suitable to define the hooking housing for a respective inlet pipe 11 (see figures 5 and 6). The spacing members 30 are made for example by moulding of plastic material, in particular Pvc or the like.

[45] The installation and the functioning of the geothermal heat exchanger device according to the present invention are described in the following. Firstly, a drilling of suitable depth is made in the ground; in such drilling the external pipe 20 is inserted, suitably closed on the bottom by a cap, for example through continuous welding; the depth of such drilling can be limited for example to 24 meters. The upper opening of the external pipe 20 is instead open, for being accessible at a well 2 made at the top of the drilling.

[46] Suitably, the external pipe 20 is provided at its upper end with a spacing member 25 suitable to be drowned in a cast of concrete at the end of the installation step of the same external pipe, in order to discharge and absorb possible buoyancy of the ground.

[47] The external pipe 20 shapes a thermal chamber 21 which is suitably filled with a suitable heat exchange medium, for example water, snow, bentonite dispersed in water, air and the like. It is to be observed that according to the medium used in the thermal chamber 21 the thermal impedance of the exchanger changes.

[48] Inside the thermal chamber 21 the thermal probe 10 is progressively inserted. It is to be observed that the installing of the geothermal probe 10 is very easy thanks to the modular structure of the same geothermal probe, which allows to operate with pre-assembled modules. In particular, a first modular element is made by the lower tract of the internal pipe 12 closed at the lower end through the cap 14 at which the inlet pipes 11 are connected; the pipes 11 are possibly pre-shaped. The further tracts are connected in series with such first tract of the internal pipe 12 in modular manner to create the support structure in which the inlet pipes 11 are constrained by means of the spacing members 30. As such modular elements are mounted, the tubular exchanger is lowered in the thermal chamber 21, allowing to restore conditions of maximum ease of operation until reaching the expected length of the tubular exchanger.

[49] For completion, the internal pipe 12 is closed at its upper end by the head 16. It is to note that the head 16 also serves, in use, as upper closure member for the external pipe 20, as well as support for the internal tubular exchanger, which therefore may, at any time, be completely extracted easily by lifting the head 16.

[50] The joint members 17 of the head 16 are connected through respective pipes 23, 24 with an inlet manifold 3 and an outlet manifold 4 of the heat exchange fluid. This fluid is

circulated by a pump 5, in known way, in the circuit which goes through a heat pump 6 of the air conditioning plant. In the illustrated case, the heat pump 6 provides a water/air radiator 7 with air suction fan 8, but it is possible to provide the use of geothermal heat exchanger devices with any type of heat pump currently existing on the market, for example, air/air or air/water or water/water pumps.

[51] Figures 7 and 8 show a different embodiment of the geothermal heat exchanger device in which the geothermal probe is provided with regulation means 40 for the exchange surface of the pipe bundle, such as to obtain in an active way a variation of the thermal impedance.

[52] Such regulation means for the exchange surface are controlled by a suitable control circuit 41. The control circuit 41 can be placed inside or outside the heat pump 6.

[53] The regulation means 40 for the exchange surface are preferably made by electro valves arranged respectively next to the inlet of one or more pipes of the inlet pipe bundle. The electro valves 40 are suitable to regulate the flow of the heat exchange fluid inside each single pipe which composes the exchange pipe bundle or to exclude completely some pipes of the same pipe bundle, thus actively modifying the total exchange surface of the probe.

[54] The control circuit 41 connected with the electro valves 40 of the inlet and/or outlet pipes controls the opening of each single electro valve, thus regulating the flow rate of each single inlet and/or outlet pipe, varying the active heat exchange surface that is the thermal impedance of the ground of each single probe.

[55] The heat exchanger device according to the invention attains the scope of reaching a high efficiency level in any season. Such result is obtained thanks to the inventive idea of being able to vary in the course of the life of the geothermal probe both the thermal impedance of the same geothermal probe in passive way, that is the capacity of releasing or intercepting heat from the ground, and the thermodynamic condition of the ground, that is the thermal impedance in which the probe works through the control of the active exchange surface.

[56] The use of water in summer and of sand dispersed in water in winter as exchange medium in the thermal chamber is an example of use with passive regulation of the thermal impedance of the probe. The use of water in summer allows, thanks to its high convective heat exchange coefficient, to unbalance the ratio between thermodynamic ground and probe to ease the thermal flow from the probe to the ground. The use of sand dispersed in water in winter instead allows the transmission of heat mainly by conduction, like the surrounding ground, instead of by convection; in this case therefore the thermodynamic ratio provides that the favourite thermodynamic flow is inverted, thus making prevail the effect of heat storage of the ground. The sand dispersed in water is

taken away by pumping water in the thermal chamber and bringing in suspension the sand which is then dredged up through pumping. The process cleans the thermal chamber from the sand and replaces it with water. The opposite process is obtained by simply pouring the dissolved sand inside the thermal chamber and making water overflow.

[57] In case of occurring of thermal drifts of the ground, both in heating and cooling, due to a substantial unbalance in use between winter and summer (for example, in case of different climates, different user requirements or particular geothermal conditions of the ground) it is possible to easily intervene on the thermal chamber in order to recover the drift phenomena themselves or to improve in general the operating conditions of the ground, for example in a passive way by washing the thermal chamber with cold water or snow or ice during the winter period, or by replacing one or more probes with probes consisting of a lesser or greater number of inlet and/or outlet pipes, in case of drifts in heating, otherwise by flushing hot atmospheric air during the summer period, in case of drifts in cooling, or by replacing one or more probes with probes consisting of a lesser or greater number of inlet and/or outlet pipes; in an active way by regulating, through the control circuit, the electro valves connected with one or more pipes of each inlet and/or outlet pipe of each probe for controlling the heat exchange surface of the ground, that is the thermal impedance.

[58] The probe according to the present invention ensures the control of the efficiency of different types of heat pumps that can be connected to it, according to the peak value of demand.

[59] As an example, in case of installation in temperate climate zones with a substantial balance of thermal energy demand in heating and air conditioning throughout the year, if the geothermal plant is of new installation or the control circuit does not detect thermal drift phenomena, that is the temperature of the ground after a complete heating/cooling cycle meets the initial conditions, four elements probes are installed with parallel wiring on a heat pump. The control circuit manages, in this case, the probes plant homogeneously distributing the thermal power required by the pump in the entire plant. By such mode, the control circuit opens and closes in each probe the same number of elements, for example by keeping two elements in function in each probe in the autumn and spring periods and then opening them all in the summer and winter climatic peaks. In this way, each element can always work in the best conditions of heat flow while homogeneously distributing the thermal power all over the geothermal plant.

[60] Otherwise, if local drift phenomena occur, that is concerning only part of the geothermal plant, or distributed drift phenomena, that is regarding homogeneously the whole geothermal plant, differently from what happens in traditional geothermal probes, the control circuit starts to automatically manage the plant in not distributed mode. If, for

example, a homogeneous drift in heating is detected, that is, at the end of a heating/cooling cycle, the efficiency of the heat pump is lower than the one detected in the previous year, in the following heating cycle in which the heat pump absorbs heat from the ground, the control circuit periodically discharges the maximum thermal power on each probe, locally intensifying the cooling process of the ground until bringing it back to the optimal operating conditions. In this way, a homogeneous drift is reduced to a local drift.

[61] In case of local drift, differently from the traditional passive probes, the control circuit performs the same not distributed management of thermal power exchanged by focusing on individual probes affected by drift and controlling in a distributed way the probes which operate in optimal working conditions of the ground. In this way, a drift is fully recovered, bringing the geothermal plant back to the optimal working conditions.

[62] In case of installation in temperate climates with moderate unbalance of demand between thermal energy in heating and air conditioning throughout the year, within a ratio between 2/3 and 1/3, if the geothermal plant is of new construction or the control circuit does not detect phenomena of thermal drift, six elements probes are installed with parallel wiring on the heat pump.

[63] For example, if the geothermal plant is installed in a warm temperate climate in which the balance of the annual heat demand is 2/3 in air conditioning and 1/3 in heating, the control circuit, unlike the traditional passive probes, manages in a distributed way the thermal power exchanged by the geothermal plant in all probes, while maintaining four elements working in the period corresponding to the increase of conditioning demand, that is of the heating of the ground, and six elements working in half of probes of the geothermal plant in the period corresponding to the heating demand, that is of the cooling of the ground, cyclically changing every year the portion of the geothermal plant in use. In this way, the control system is able to reduce the thermal drift to only half of the geothermal plant, exchanging periodically each year the portion of the plant that is affected, preventing distributed drifts and therefore keeping constant the average operating conditions of efficiency of the heat pump even under conditions of unbalanced thermal demand.

[64] If, in this case, a homogeneous drift in heating is detected, that is at the end of a heating/ air conditioning cycle the efficiency of the heat pump is lower than the one detected in the previous year, in the following heating cycle in which the heat pump absorbs heat from the ground, the control circuit, unlike the traditional passive probes, periodically discharges the maximum thermal power on each probe of the portion of the plant concerned, locally intensifying the cooling process of the ground until bringing it back to the optimal working conditions. In this way, a homogeneous drift is reduced to a local drift. In case of local drift, the control circuit performs the same not distributed management of the thermal power exchanged on the portion of the geothermal plant concerned, focusing on individual

probes affected by drift and managing in a distributed manner probes that work in optimal operating conditions of the ground. In this way, the drift is fully recovered bringing all the geothermal plant to optimal working conditions.

[65] Finally, in case of installation in hot climatic zones with thermal energy demand only for air conditioning during the year, the plant is also sized for the production of hot water and six elements probes are installed. The control circuit manages the geothermal plant with power distributed to three active elements for air conditioning and, cyclically on all the probes of the plant, with power concentrated on a single probe with six active elements for the production of sanitary hot water. In case of occurrence of drifts in heating of the ground due to a low demand for sanitary hot water, the control circuit, unlike the traditional passive probes, automatically regulates the number of active elements in the conditioning step, with an alarm informing of the need to increase the number of probes in order to better distribute the load in each, thereby acting as self-diagnosis for the entire plant.

[66] The device described for indicative purpose is susceptible of numerous modifications and variants according to the different exigencies.

[67] In practice, the embodiment of the invention, the materials used, as well as the shape and dimensions, may vary depending on the requirements.

[68] Should the technical characteristics mentioned in each claim be followed by reference signs, such reference signs were included strictly with the aim of enhancing the understanding the claims and hence they shall not be deemed restrictive in any manner whatsoever on the scope of each element identified for exemplifying purposes by such reference signs.

Claims

1. Geothermal heat exchanger device, comprising a geothermal probe (10) having low enthalpy suitable to be inserted in vertical position in the ground and provided with at least one inlet piping (11) and one outlet piping (12) for the circulation of a heat exchange fluid; an external pipe (20) made of thermal conductive material, closed at the opposite ends, suitable to be inserted in a drilling made in the ground, and shaping a thermal chamber (21) axially carrying in its inside said geothermal probe (10) and suitable to be filled with a heat exchange medium, **characterized in that** it comprises regulation means (40) of the exchange surface of said inlet and/or outlet piping (11, 12), for varying the heat exchange capacity, and control means (41) of said regulation means (40).
2. Device according to claim 1, **characterized in that** said thermal chamber (21) is suitable to be filled with a heat exchange medium, which can be changed for varying the overall thermal impedance of the exchanger.
3. Device according to claim 1 or 2, **characterized in that** said regulation means (40) comprise at least one electro valve arranged at least one inlet and/or outlet piping (11, 12).
4. Device according to claim 1 or 3, **characterized in that** said inlet and/or outlet piping (11, 12) comprise a plurality of pipes.
5. Device according to claim 4, **characterized in that** said regulation means (40) comprise a plurality of electro valves arranged respectively at said plurality of pipes (11, 12).
6. Device according to claim 4 or 5, **characterized in that** said plurality of pipes (11) is wound in spiral around a rising piping (12).
7. Device according to claim 6, **characterized in that** said rising piping (12) is suitable to be the support structure of the geothermal probe (10), a plurality of inlet and/or outlet pipes (11) being constrained to said support structure.
8. Device according to claim 6 or 7, **characterized in that** said rising piping (12) is made of a plurality of tubular tracts axially associated with one another.
9. Device according to claim 7 or 8, **characterized in that** said rising piping (12) is interiorly closed through a cap (14) provided, in angularly spaced positions, with a plurality of connection means (15) for respective inlet and/or outlet pipes (11).
10. Device according to claim 7 or 9, **characterized in that** said rising piping (12) is superiorly closed by a head (16) shaping a mixing chamber (17) provided in its lower part with joint members (18) for respective inlet and/or outlet pipes (11).
11. Device according to claim 10, **characterized in that** said head (16) is suitable to act, in use, as upper closure member for said external pipe (20).
12. Method of operating a geothermal exchanger device, said device comprising a geothermal probe (10) having low enthalpy provided with at least one inlet piping (11) and at least one

outlet piping (12) for the circulation of a heat exchanger fluid, inserted in an external pipe (20) of heat conductive material, suitable to be inserted in a drilling made in the ground and shaping a thermal chamber (21) suitable to be filled with a heat exchange medium, **characterized in that** it provides to vary the thermal exchange capacity of said inlet and/or outlet piping (11, 12) through regulation means (40) of the exchange surface of the same inlet and/or outlet piping (11, 12).

13. Method according to claim 12, **characterized in that,** it provides to control said regulation means (40) through automatic control means (41).

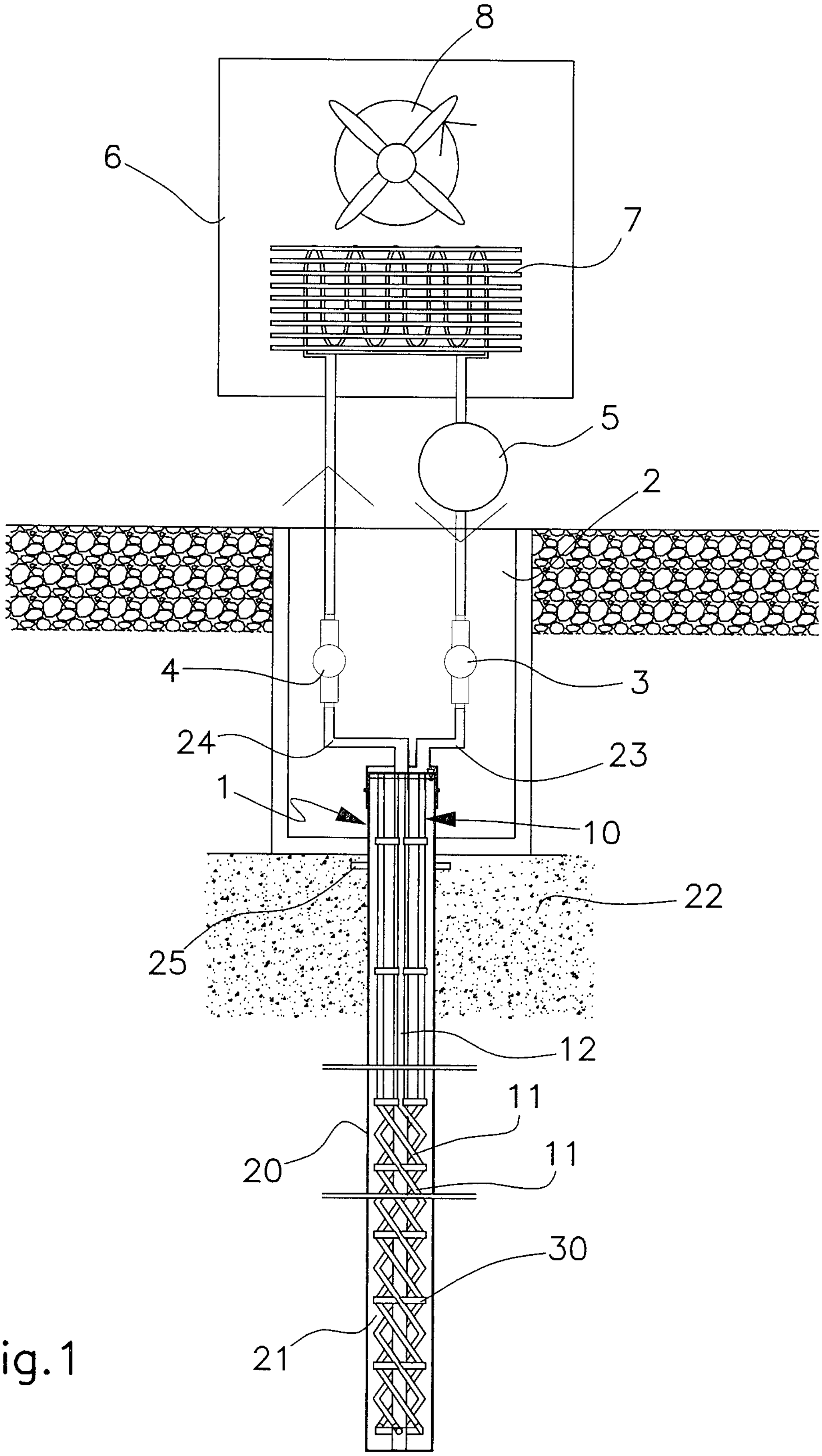


Fig.1

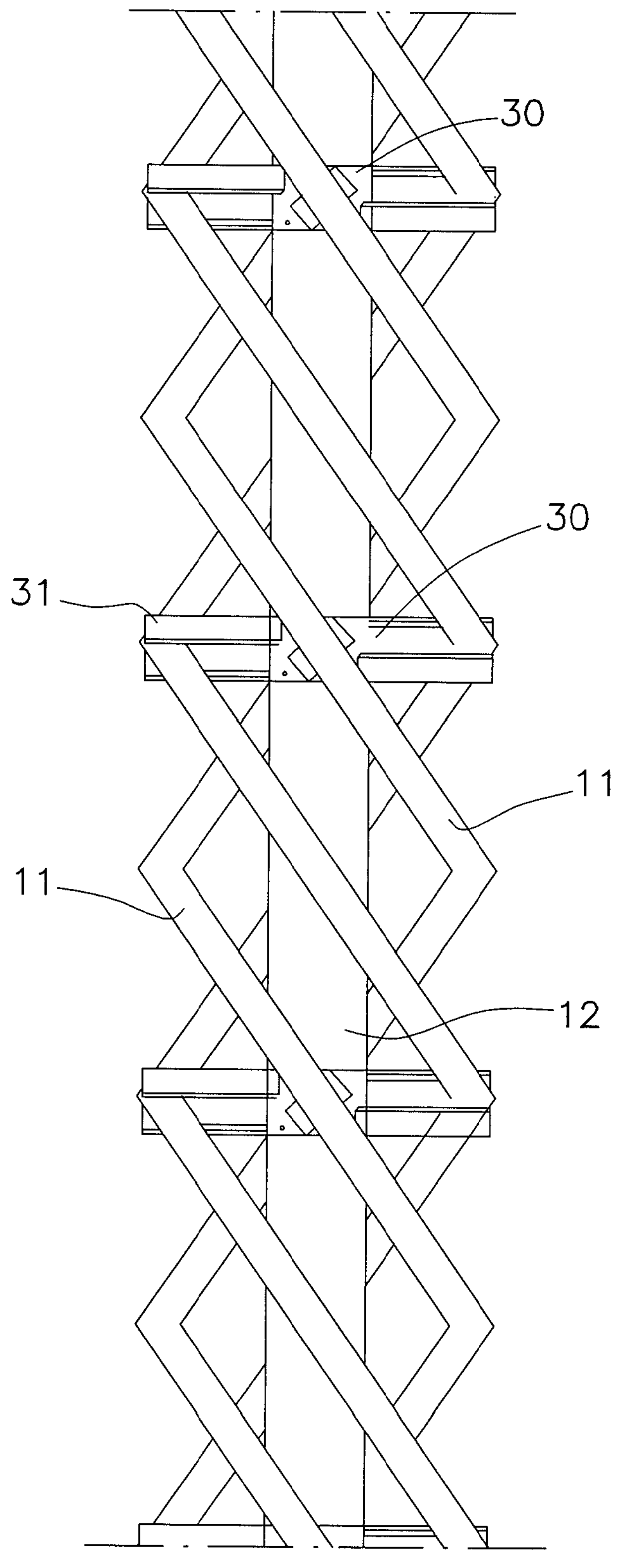
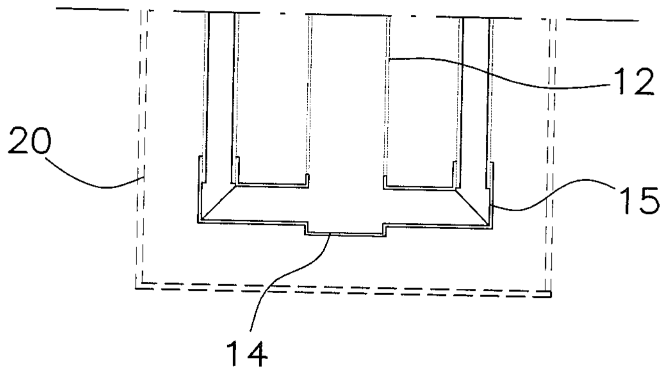


Fig.2

Fig.3



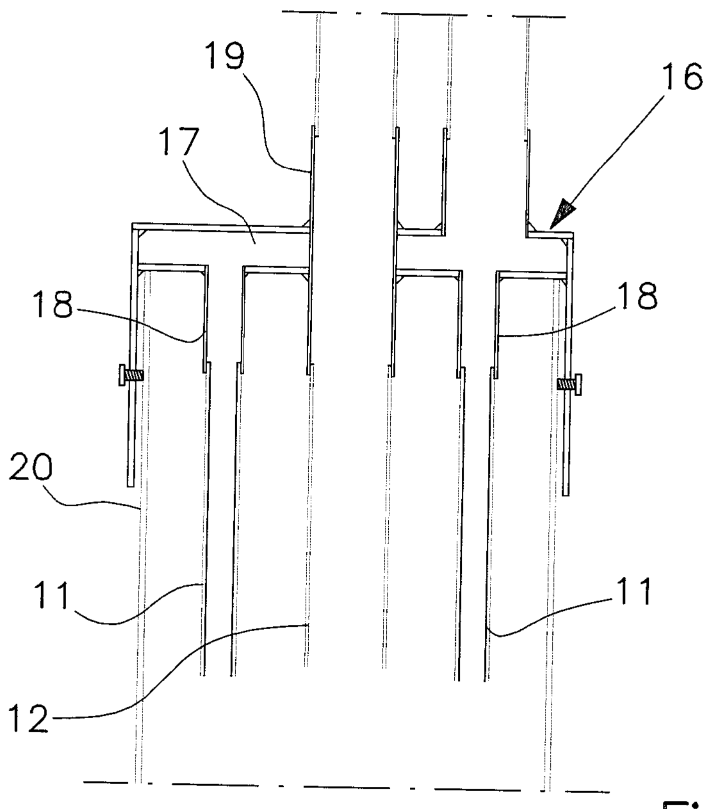


Fig.4

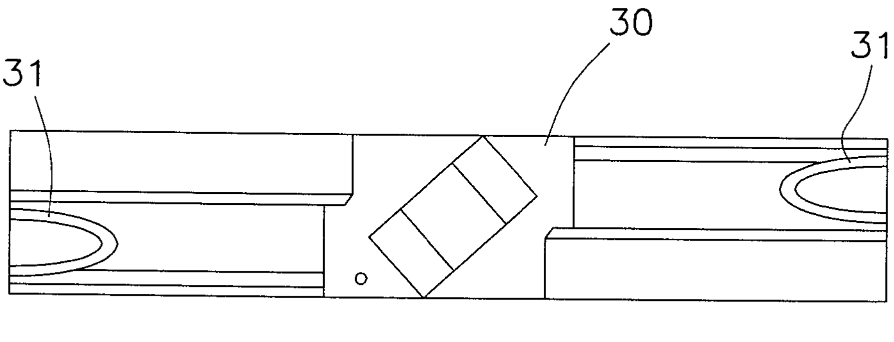


Fig.5

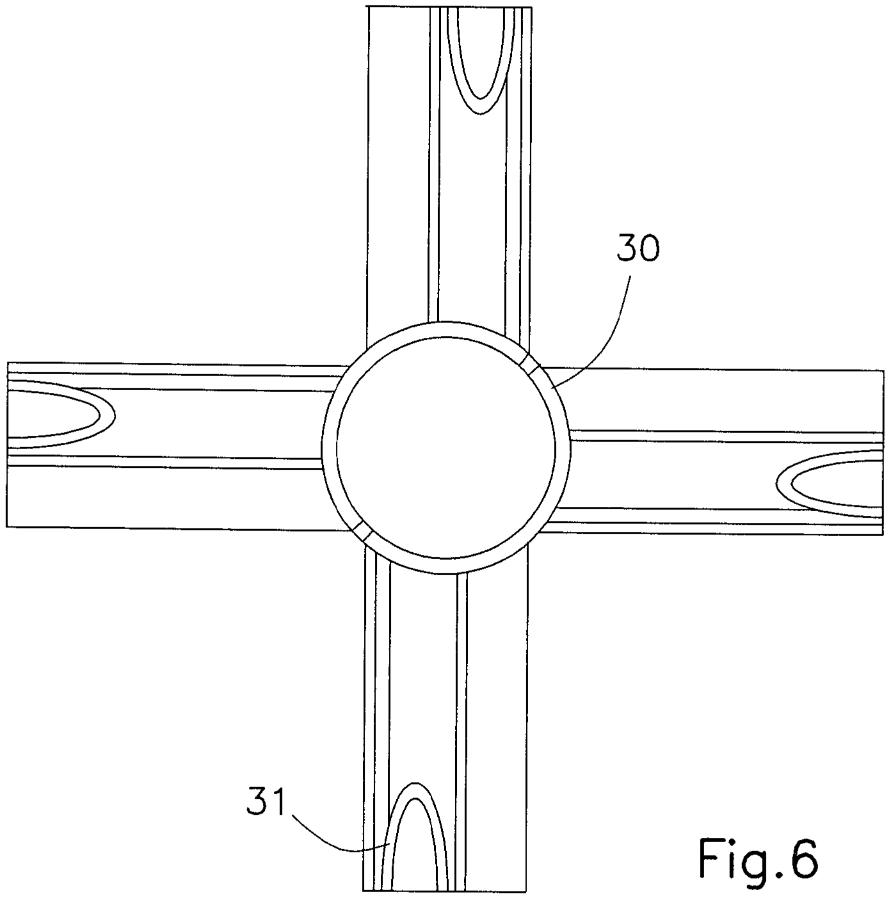


Fig.6

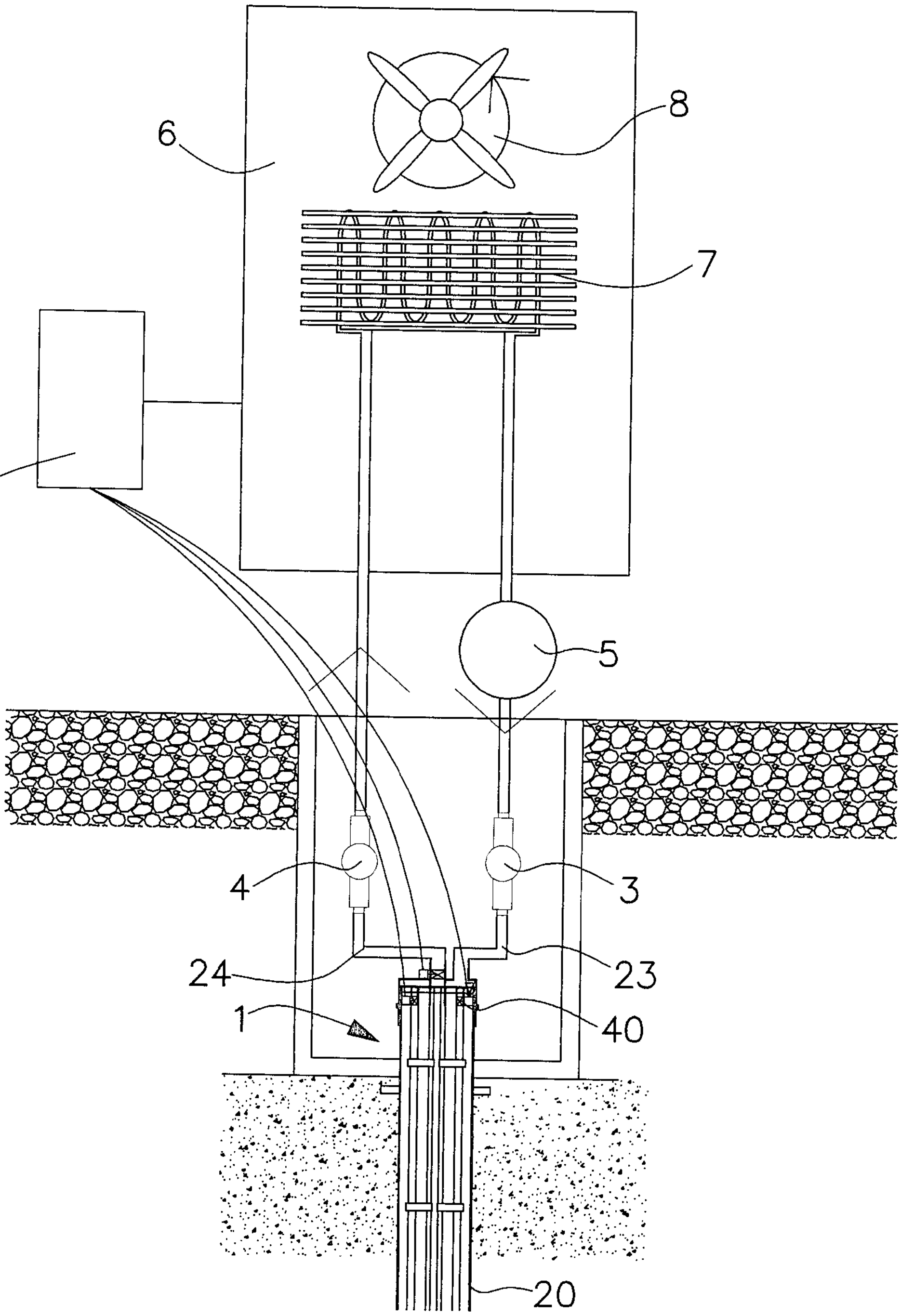


Fig.7

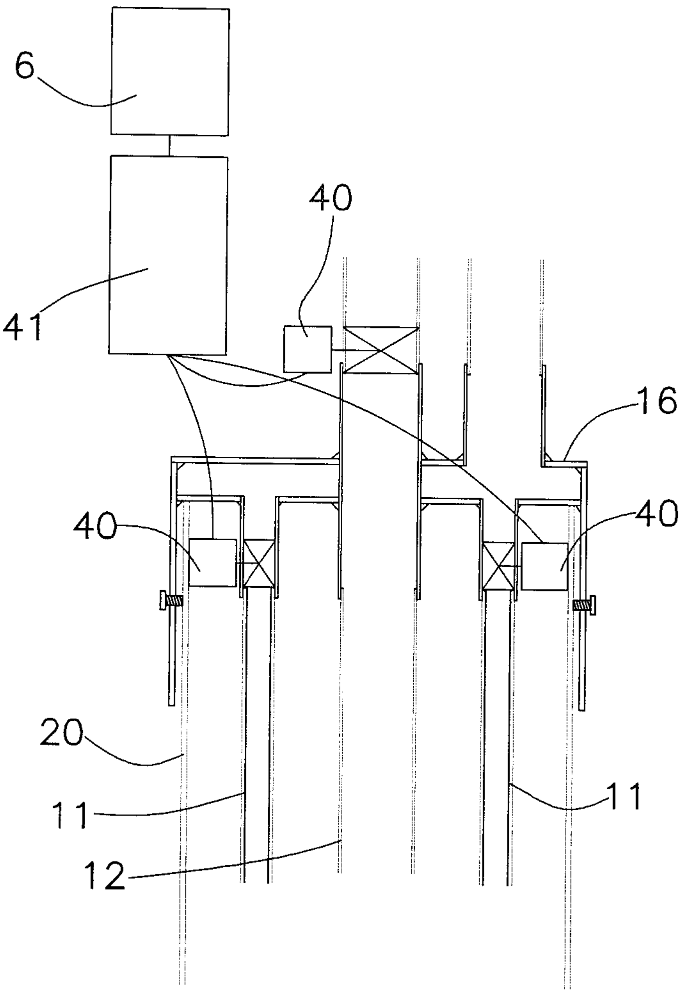


Fig.8

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/060280

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24J3/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2011/100587 A1 (YANG TAI-HER [TW]) 5 May 2011 (2011-05-05) paragraph [0098] - paragraphs [0103], [0127]; figures	1-6, 12, 13 7-11
Y	EP 1 978 314 A1 (IRIDE S R L [IT]) 8 October 2008 (2008-10-08) paragraph [0026] - paragraph [0034]; figures 3-8	7-11
X	FR 2 802 623 A1 (DEMERCASTEL DIDIER [FR]) 22 June 2001 (2001-06-22) page 14, line 16 - page 15, line 36 page 9, line 29 - page 12, line 29; figures 1,2,12-14	1-5,12, 13

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
28 February 2014	10/03/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Mootz, Frank

INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 1 486 741 A1 (TIROLER ROEHREN & METALLWERK [AT] ; AMANN ARMIN ING [AT]) 15 December 2004 (2004-12-15) paragraph [0059] - paragraph [0068] ; figures 3a-d paragraphs [0016] , [0083] - paragraph [0087] ; figures 5a, b -----	1,12
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International application No
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