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MODULAR GEOTHERMAL ENERGY CENTER

(57)

The invention relates to a modular geothermal energy center that will find application in thermal engineering, and in particular will serve to provide heating and cooling power in newly constructed or existing buildings. The modular geothermal energy center includes a main container (1) in which at least one geothermal heat pump (2) is installed, having a condensing and an evaporating part. The evaporating part of each geothermal heat pump (2) is connected through boreholes to geothermal sources, while the condenser part of the geo-

thermal heat pump (2) can be connected to a heating and cooling installation, as well as to a hot water supply installation. The modular geothermal energy center has a heat-transferring fluids managing unit (5), including electronically controlled three-way valves, and one or more additional modules (7, 12, 13) with equipment for hot water supply and indoor installation for heating and cooling. All operation modes of the modular geothermal energy center are controlled by a power supply and control panel (21).

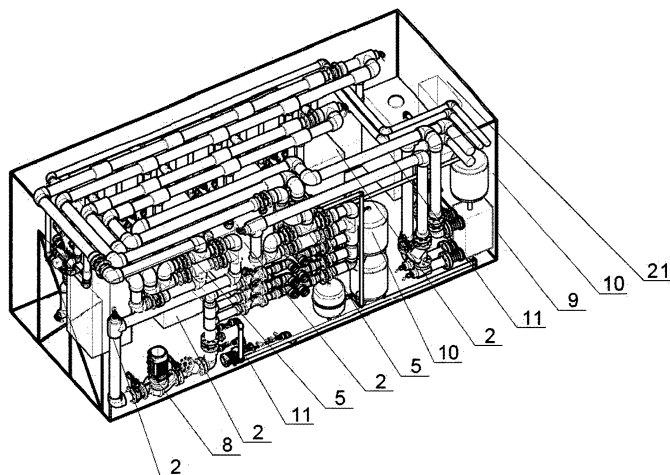


Fig. 1

Description

TECHNICAL FIELD

[0001] The invention relates to a modular geothermal energy center that will find application in thermal engineering, and in particular will serve to provide heating and cooling power in newly constructed or existing buildings.

BACKGROUND ART

[0002] With the modern requirements for reduction of fossil fuels consumption and to improve the energy efficiency of air conditioning systems, the demand for technologies and systems utilizing renewable energy sources has increased significantly. Such a renewable source of energy is the earth's crust having practically inexhaustible internal heat potential from the earth's bowels. The heat pumps use the most efficient technology to convert low-potential heat into heat with suitable parameters for powering heating and cooling systems. Using this technology, 75 to 82% of the provided heat comes from the earth's field, while 18 to 25% is brought into the system as electrical energy. Geothermal heat pumps use low-potential energy from the earth's crust and produce hot water for heating in winter and hot water for domestic needs all year round by transforming low-potential energy extracted from the earth into high-potential energy. In the transitional seasons, the heat pumps provide passive cooling through the ground field, and on the hottest days the cooling is active using the refrigeration cycle. With active cooling, the heat of condensation can be used to generate domestic hot water.

[0003] From EP2597379 one such heat pump system is known, disclosing a modular geothermal energy center comprising a container in which a geothermal heat pump having a condensing and an evaporating part is installed. The condensing part of the geothermal heat pump can be connected to the cooling installation, as well as to a domestic hot water installation. Hydraulically connected to the evaporating part of the geothermal heat pump is a pump unit for heat-transferring fluid, located in the container and including at least one electronically controlled circulation pump. This electronically controlled pump must have high-pressure because it is necessary to provide water pumping from a well (open system), which requires a high pressure to overcome the static pressure of the water column and a high energy consumption of the pump. With the known heat pump system, no other modes of operation are provided, except the mode of supplying heat to the air conditioning system and the mode of domestic hot water production. Furthermore, the technical solution known from EP2597379 works either in one mode or in the other, not providing for the simultaneous supply of cooling to the air conditioning system and heat to produce domestic hot water. The known heat pump system requires high energy consumption in both

modes of operation, as it uses a high-pressure pump and fans, which are energy intensive. Using the container space for an air chamber when working through air/water heat exchangers means that the air temperature in the container space will always be approximately equal to the outside temperature, which is detrimental to the equipment at extremely low and extremely high outside temperatures.

10 DISCLOSURE OF INVENTION

[0004] The object of the present invention is to create an improved, efficient and compact geothermal heat pump system, which is a modular energy center, providing the opportunity to maximize the utilization of given natural resources through optimal management of operating modes, while ensuring that the modular center is also easy to operate and maintain at minimal operating costs.

[0005] The object is solved by providing a modular geothermal energy center, including a main container in which at least one geothermal heat pump having an evaporating and a condensing part is installed. The evaporating part of the geothermal heat pump is connected by pipes with an intermediate heat-transferring fluid to a geothermal circulation unit, which geothermal circulation unit is installed in the main container. The geothermal circulation unit includes at least one electronically controlled circulation pump which circulation pump is connected by pipes with a low-potential source fluid to at least one tube heat exchanger located in at least one geothermal well. Said tube heat exchanger is a main source of low potential fluid for the geothermal heat pump. The condensing part of the geothermal heat pump is connected by pipes to a heating and cooling installation as well as to a domestic hot water installation.

[0006] According to the present invention, the evaporating part of the geothermal heat pump through an evaporating part connecting unit is connected by pipes with a cooling fluid to a heat-transferring fluids managing unit. The heat-transferring fluids managing unit through a condensing part connecting unit is connected by pipes with a heating fluid to the condensing part of the geothermal heat pump. The evaporating part connecting unit, the condensing part connecting unit and the heat-transferring fluids managing unit are installed in the main container. The condensing part connecting unit is further connected by pipes with a heating fluid to a hot water distribution unit. The hot water distribution unit is installed in the main container and is configured to direct the heating fluid via three-way valves to said domestic hot water installation or to the heat-transferring fluids managing unit. The heat-transferring fluids managing unit is connected by pipes with an intermediate heat transfer fluid to the geothermal circulation unit and the heat-transferring fluids managing unit is connected by pipes with a heating or cooling fluid to a plate heat exchanger. The plate heat exchanger is also installed in the main con-

tainer and is configured for connecting to said heating and cooling installation. After each of said geothermal well(s) and after the heat-transferring fluids managing unit, respectively before the geothermal circulation unit and before the plate heat exchanger, are connected by pipes safety units. The safety units are installed in the main container and each safety unit includes one or more closed expansion vessels with safety valves. In the main container are further installed a heat-transferring fluids refilling station, connected to the geothermal circulation unit, as well as a power supply and control panel.

[0007] In one embodiment of the modular geothermal energy center, according to the invention, the hot water distribution unit is connected by pipes to hot water supply module. The hot water supply module includes a hot water connecting unit and a domestic hot water supply unit. The hot water connecting unit in turn includes at least one heat exchanger, at least one expansion vessel and at least one circulation pump, which are connected by pipes to the domestic hot water supply unit. The domestic hot water supply unit, on the other hand, includes one or more water boilers configured for connecting by pipes to said domestic hot water supply installation.

[0008] In another embodiment of the modular geothermal energy center, according to the present invention, said plate heat exchanger is connected by pipes to a heating and cooling module. The heating and cooling module includes a heating and cooling connecting unit and an energy storage unit. The energy storage unit in turn includes one or more buffer vessels connected by pipes to the heating and cooling connecting unit. The heating and cooling connecting unit, on the other hand, includes at least one electronically controlled circulation pump and collectors configured for connecting by pipes to said heating and cooling installation.

[0009] In a further embodiment of the modular geothermal energy center, according to the present invention the hot water connecting unit from the hot water supply module is further connected by pipes to an additional heat consumption module. The additional heat consumption module includes an additional heat consumption connecting unit and a secondary energy storage unit. The secondary energy storage unit in turn includes one or more buffer vessels connected by pipes to the secondary heat consumption connecting unit. The additional heat consumption connecting unit, on the other hand, includes at least one electronically controlled circulation pump and collectors configured for connecting by pipes to at least one additional heat consumer.

[0010] In yet another embodiment of the modular geothermal energy center, according to the present invention, at least one water heater, configured to run on hydrogen fuel, is connected by pipes after said plate heat exchanger as a secondary source of heating fluid for the heating and cooling installation, and at least one dry air cooler is connected to the geothermal circulation unit as a secondary source of low-potential fluid for the geothermal heat pump.

[0011] In a further embodiment of the modular geothermal energy center, according to the present invention, the hot water supply module and/or the heating and cooling module and/or the additional heating module and/or said at least one water heater and/or said at least one dry air cooler is installed in the main container or respectively in at least one additional container.

[0012] In an alternative embodiment, according to the present invention, in which the management and control of the modular geothermal energy center is performed by the power supply and control panel, at least one outdoor air temperature source, at least one indoor air temperature sensor, at least one heating or cooling fluid temperature sensor, at least one primary low-potential fluid temperature sensor and at least one secondary low-potential fluid temperature sensor are connected to the power supply and control panel. The power supply and control panel has a control section and an acquisition section. The acquisition section is configured to obtain in real-time temperature data respectively from the outdoor air temperature source, from the indoor air temperature sensor, from the heating or cooling fluid temperature sensor, from the main low-potential fluid temperature sensor and from the secondary low-potential fluid temperature sensor. The control section is configured to switch said heating and cooling installation into heating or cooling mode by respectively switching heating or cooling fluid from the heat-transferring fluids managing unit to the plate heat exchanger, and the control section is further configured to turn on/off the geothermal heat pump.

[0013] In a preferred embodiment, in which the management and control of the modular geothermal energy center are performed by the power supply and control panel according to the present invention, the control section is further configured to switch the heating and cooling installation into the heating mode at a lower outside air temperature than a predetermined outside air temperature for the heating mode. The control section is further configured to retain the current working mode of the heating and cooling installation at a higher outdoor air temperature than the predetermined outdoor air temperature for heating mode. The control section is further configured to switch the heating and cooling installation into cooling mode at a higher temperature of outside air than a predetermined outside air temperature for cooling mode. Furthermore, the control section is further configured to switch off the geothermal heat pump at a lower outside air temperature than the predetermined outside air temperature for cooling mode. Said predetermined outdoor air temperatures for heating and cooling mode are set in the control section and said outdoor air temperature is obtained in the acquisition section from said at least one outdoor air temperature source.

[0014] In a another preferred embodiment, in which the management and control of the modular geothermal energy center are performed by the power supply and control panel according to the present invention, the con-

trol section is further configured to switch the heating and cooling installation into heating or cooling mode and to turn on/off the geothermal heat pump based on the real-time indoor air temperature obtained in the acquisition section from said at least one indoor air temperature sensor and depending on a predetermined indoor air temperature set in the control section.

[0015] In a further preferred embodiment, in which the management and control of the modular geothermal energy center are performed by the power supply and control panel according to the present invention, the control section is further configured to switch the heating and cooling installation into heating or cooling mode and to turn on/off the geothermal heat pump depending on a predetermined value of a logic function. Said predetermined value of the logic function is based on differences between the real-time temperature of the heating or cooling fluid and a predetermined temperature of the heating or cooling fluid, which differences are accumulated in the control section during a predetermined time interval. Said predetermined value of a logic function, the predetermined temperature of heating or cooling fluid and a predetermined time interval are set in the control section. Said real-time temperature of the heating or cooling fluid is obtained in the acquisition section from said at least one heating or cooling fluid temperature sensor.

[0016] In yet another embodiment of the modular geothermal energy center according to the present invention, the control section is further configured in said heating mode of the heating and cooling installation to select the low-potential source fluid for the geothermal heat pump by switching the supply source of the low-potential fluid between said at least one tube heat exchanger and said at least one dry air cooler selecting the source fluid with higher temperature obtained in the acquisition section from said at least one main low-potential fluid temperature sensor and from said at least one secondary low-potential fluid temperature sensor. Furthermore, in said heating mode of the heating and cooling installation, the control section is further configured to turn on said at least one water boiler as a secondary source of heating fluid for the heating and cooling installation at a lower outside air temperature than a predetermined outdoor air temperature for operation of the water boiler and at a predetermined interval of values of said logic function. Said predetermined interval of values and said predetermined outdoor air temperature for operation of the water boiler are set in the control section. Said outdoor air temperature is obtained from said at least one outdoor air temperature source in the acquisition section.

[0017] In a further embodiment of the modular geothermal energy center according to the present invention, the control section is further configured in said cooling mode of the heating and cooling installation to switch to a passive cooling mode by selecting said at least one tube heat exchanger as a supply source of cooling fluid for the heating and cooling installation at a lower cooling fluid temperature than a predetermined source fluid tem-

perature for active cooling, set in the control section. Furthermore, in said cooling mode of the heating and cooling installation, the control section is further configured in said cooling mode of the heating and cooling installation to switch to an active cooling mode by selecting said evaporating part of the geothermal heat pump as a supply source of cooling fluid for the heating and cooling installation at a higher cooling fluid temperature than the predetermined source fluid temperature for active cooling, set in the control section. Said supply fluid temperature is obtained in the acquisition section from said at least one main low-potential fluid temperature sensor. Moreover, in said active cooling mode, the control section is further configured to select the low-potential fluid source for the geothermal heat pump by switching the source of supply fluid from said at least one tube heat exchanger or said at least one dry air cooler, selecting the source fluid with a lower temperature obtained in the acquisition section from said at least one main low-potential fluid temperature sensor and from said at least one secondary low-potential fluid temperature sensor.

[0018] The modular geothermal energy center is a system for domestic hot water, heating and cooling using a field with geothermal wells with corresponding boreholes for a primary energy source. The modular geothermal energy center uses a geothermal heat pump that provides domestic hot water supply, heating, active and passive cooling, while a system of electronically controlled three-way valves provides simultaneous heating and cooling, as well as can be connected further to circulation circuits requiring heating or cooling fluids with different temperature potential. A significant economy of primary energy sources such as fossil fuels can be realized because of the modular geothermal energy center and a high degree of satisfaction of the increasing need for flexible solutions in the market can be achieved. The technical solution, according to the present invention, provides a possibility for mass production, because of the complete factory equipping of the center and the use of pre-prepared standard assembly units, thus achieving a rapid delivery of various technical solutions depending on the needs of the customer. The modular geothermal energy center is easy to install to a wide range of buildings (objects with different purposes) and is easy to service and maintain, because of the standardized elements located in one or several containers, without having to access other parts of buildings.

BRIEF DESCRIPTION OF DRAWINGS

[0019] The figures depicting specific embodiments of the modular geothermal energy center are exemplary only and are not intended to limit the present invention, its application or use, wherein:

Figures 1 and 2 show isometric views of the main container of the modular geothermal energy center, according to a basic embodiment of the invention;

Figure 3 shows a scheme of the main container according to a basic embodiment of the present invention, and Figures 3a and 3b show enlarged views of parts of Figure 3;

Figure 4 shows a scheme of the domestic hot water supply module according to the invention;

Figure 5 shows a scheme of the heating and cooling module according to the invention;

Figure 6 shows a scheme of the additional heat consumption module according to the invention;

Figures 7 and 8 show an exemplary variant for connection of said at least one water heating boiler and respectively said at least one dry air-cooler, according to the invention;

Figure 9 discloses a scheme of the modular geothermal energy center having a main container as well as additional heating and cooling modules, a domestic hot water module and an additional heat consumption module, according to another embodiment of the invention.

Figure 10 discloses a scheme of connecting the power supply and control panel to the temperature sources and sensors.

MODES FOR CARRYING OUT THE INVENTION

[0020] Unless otherwise defined, all terms used in disclosing the invention, including technical and scientific terms, have the meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. By means of further guidance, term definitions are included to better appreciate the teaching of the present invention.

[0021] Whereas the terms "one or more" or "at least one", such as one or more or at least one feature(s) of a group of features, is clear per se, by means of further exemplification, the term encompasses inter alia a reference to any one of said features, or to any two or more of said features, such as, e.g., any $>_3$, $>_4$, ≥ 5 , ≥ 6 or ≥ 7 etc. of said features, and up to all said features.

[0022] Reference in this specification to "one embodiment (variant)" or "embodiment (variant)" means that a particular feature, structure or feature described in connection with the embodiment is included in at least one embodiment disclosed in the present invention. Therefore, it is not necessary that all expressions "in one embodiment" or "in the embodiment" appearing in different places in this specification refer to the same embodiment. Further, features, structures, or properties can be combined in any suitable manner that would be apparent to one skilled in the art of the present disclosure in one or more embodiments. Furthermore, although some of the embodiments described herein include some but not other features that are included in other embodiments, combinations of the features of different embodiments are included within the scope of the invention and constitute different embodiments, as would be understood for specialists in the field. For example, all of the claimed variants

in the present claims may be used in any combination.

[0023] The following terms used in the present invention have the following meanings:

The terms "main container", "additional container" or for short "container" as used herein refer to an intermodal container, often referred to as a shipping container, which is a large standardized container for shipping designed and constructed in this particular case preferably of powder-coated metal supporting structure having walls and a ceiling of three-layered panels with 50 to 100 mm thermal insulation of polyurethane foam and powder-coated sheet metal, as well as a floor of corrugated sheet metal, which can be stainless, aluminum or of other type according to the customer's preference.

[0024] The term "geothermal heat pump" as used herein is heating/cooling unit for buildings that uses a heat pump to transfer heat to or from the ground by taking advantage of the relatively constant temperature throughout the seasons below ground. The geothermal heat pump unit is a machine whose working principle is based on the "Reverse Carnot Cycle" and generally has a condenser, a throttling valve, an evaporator and a compressor, dividing the unit conditionally into a condensing and evaporating parts, which condensing and evaporating parts have essential meaning in the present invention.

[0025] The term "unified unit" or for short "unit", used herein, refers to different functional units in the system, each having a distinct function depending on the corresponding equipment in them and including control and regulating equipment for automatic switching and regulation of the modes of the modular geothermal energy center and/or equipment, allowing prevention and servicing without a complete interruption of the operation of the modular geothermal energy center.

[0026] The term "connected(s) by pipes" or simply "piped", used herein, refers to connecting by means of supply and return pipelines, which are used to separate circulation circuits with heat-transferring fluids between the individual functional modules of the system, as well as between the individual elements of the system. Additionally, the terms "heat transferring fluids", "low-potential source fluid", "main low-potential fluid", "secondary low-potential fluid", "intermediate heat-transferring fluid", "source fluid" and "heating or cooling fluid" as used herein, refer to the purpose of each individual fluid in the respective circulation circuit of the modular geothermal energy center, regardless of the type of specific fluid used.

[0027] The present invention relates to a modular geothermal power center, shown generally in Figures 1 and 2, which is a main operating unit housed in a main container 1. At least one geothermal heat pump 2 is installed in the main container 1, for the use of which geothermal heat pump 2 a field with geothermal wells with corresponding boreholes connected to underground collector distribution shafts is provided. The depth of each borehole depends on the geological features, the area on which they are located, and the load provided by the earth's field. Tube heat exchangers 8.1 with two or four

tubes, factory-connected at their lower end, are lowered into each of them. It is recommended to fill the boreholes with thermal cement with a high coefficient of thermal conductivity. It is appropriate to place four pipes in each borehole, which on the surface are united into two with a larger diameter (supply and return) and are brought underground to a supply and return collector in a collectors' shaft. The collectors are equipped with flow meters and regulating valves to equalize the flow rates. The number of boreholes can be optimized after carrying out a thermal conductivity test of the ground layers of the investor's site with simulations for the distribution of the energy obtained from different numbers of geothermal wells. Based on the obtained results, the required number of boreholes can be calculated.

[0028] On Figures 3, 3a and 3b are shown in detail schemes of the main container 1 of the modular geothermal energy center, from which can be seen that each geothermal heat pump 2 is generally configured to be connected by corresponding circulation pumps, safety, regulation and other types of equipment, as well as additional equipment ensuring its operation, which are well known to any specialist in the field. Each geothermal heat pump 2 mainly has an evaporating and a condensing part, which evaporating part is intended to be connected to said field with geothermal wells, and the condensing part of the geothermal heat pump 2 is connected by pipes to a heating and cooling installation, as well as to a domestic hot water supply installation. For this purpose, the evaporating part of the geothermal heat pump 2 through an evaporating part connecting unit 3 is connected by pipes with a cooling fluid to a heat-transferring fluids managing unit 5, which heat-transferring fluids managing unit 5 through a condensing part connecting unit 4 is connected by pipes with a heating fluid to the condensing part of the geothermal heat pump 2. The evaporating part connecting unit 3, the condensing part connecting unit 4 and the heat-transferring fluids managing unit 5 are installed in the main container 1.

[0029] The geothermal heat pump 2 is connected to said field with geothermal wells through the heat-transferring fluids managing unit 5, which is connected by pipes with an intermediate heat-transferring fluid to the geothermal circulation unit 8, which is installed in the main container 1. The geothermal circulation unit 8 includes at least one electronically controlled circulation pump. The circulation pump of the geothermal circulation unit 8 is connected by pipes with a low-potential source fluid to the supply and return collectors from said geothermal wells with said at least one tube heat exchanger 8.1. Each tube heat exchanger 8.1 is a main source of low-potential fluid for the geothermal circulation unit 8, which geothermal circulation unit 8 by heat-transferring fluids managing unit 5 is connected by pipes with an intermediate heat-transferring fluid through the evaporating part connecting unit 3 to the evaporating part of the geothermal heat pump 2.

[0030] The geothermal heat pump 2 is connected to

said heating and cooling installation, as well as to said domestic hot water supply installation through the condensing part connecting unit 4, which condensing part connecting unit 4, apart from being connected by pipes with heating fluid to the heat-transferring fluids managing unit 5, is further connected by pipes with heating fluid to a hot water distribution unit 6.1. The hot water distribution unit 6.1 is also installed in the main container 1 and is configured to direct heating fluid via three-way valves to said domestic hot water supply installation or to the heat-transferring fluids managing unit 5. The heat-transferring fluids managing unit 5, in turn, is connected by pipes with heating or cooling fluids to a plate heat exchanger 9. The plate heat exchanger 9 is installed in the main container 1 and is configured to be connected to said heating and cooling installation.

[0031] In the modular geothermal energy center, safety units 10 are provided, installed in the main container 1 and each including at least one closed expansion vessel with safety valves. At least one of the safety units 10 is piped to the supply and return collectors from said geothermal wells before the geothermal circulation unit 8, and another one is connected by pipes after the heat-transferring fluids managing unit 5 before the plate heat exchanger 9. Safety units 10 provide the security of the modular geothermal energy center and absorb the temperature expansion of the heat-transferring medium. Also, in the main container 1 are installed a heat transfer fluid replenishment station 11 connected to the geothermal circulation unit 8, as well as a power supply and control panel 21 of the modular geothermal energy center.

[0032] In one embodiment, according to the present invention, shown in detail in Figure 4, the hot water distribution unit 6.1 can be connected by pipes to a hot water supply module 7. The hot water supply module 7 includes a hot water connecting unit 6.2 and a domestic hot water supply unit 6.3. The hot water connecting unit 6.2, in turn, includes at least one heat exchanger, at least one expansion vessel and at least one circulation pump, which are connected by pipes to the domestic hot water supply unit 6.3. The domestic hot water supply unit 6.3 includes one or more water boilers configured for connecting by pipes to said domestic hot water supply installation.

[0033] In another embodiment, according to the present invention, shown in detail in Figure 5, said plate heat exchanger 9 can be piped to a heating and cooling module 12. The heating and cooling module 12 includes a heating and cooling connecting unit 14 and an energy storage unit 15. The energy storage unit 15 includes one or more buffer vessels piped to the heating and cooling connecting unit 14. The heating and cooling connecting unit 14 includes at least one electronically controlled circulation pump and collectors configured for connecting by pipes to said heating and cooling installation.

[0034] In the embodiment, according to the present invention, which includes the hot water supply module 7 or in a further embodiment combining the previous two embodiments, the hot water connecting unit 6.2 of the

hot water supply module 7 can be further piped to an additional heat consumption module 13, as shown in detail in Figure 6. The additional heat consumption module 13 includes an additional heat consumption connecting unit 16 and a secondary energy storage unit 17. The secondary energy storage unit 17, in turn, includes one or more buffer vessels, piped to the additional heat consumption connecting unit 16. The additional heat consumption connecting unit 16 includes at least one electronically controlled circulation pump and collectors configured for connecting by pipes to at least one additional heat consumer such as a pool, a heat exchanger for refrigerating spaces or a non-standard climate circuit such as a refrigerated warehouse, an "ice" pool, a jacuzzi and the like external heat energy consumers.

[0035] In other embodiments, according to the present invention, at least one water heater 19 can be piped after said plate heat exchanger 9, preferably piped directly to the domestic and cooling module 12, as shown in detail at Figure 7. Said at least one water heater 19 is preferably working with hydrogen fuel and is configured to operate as a secondary source of heating fluid for the heating and cooling installation. Furthermore, at least one dry air cooler 20 can be connected to the geothermal circulation unit 8 as a secondary source of low-potential fluid for the geothermal heat pump 2, as shown in detail in Figure 8. This provides at least two sources of low-potential fluid for the modular geothermal energy center, with said at least one tube heat exchanger 8.1 providing a main low-potential fluid for the geothermal heat pump 2 and said at least one dry air cooler 20 providing an secondary low-potential fluid for the geothermal heat pump 2.

[0036] Each of said hot water supply module 7, heating and cooling module 12, additional heat consumption module 13, as well as said at least one water heater 19, when available in the modular geothermal energy center and depending on the required power, as well as according to the customer's requirements, can be installed in the main container 1, in at least one additional container 18 or in the building itself. It is also possible that each of said hot water supply module 7, heating and cooling module 12, additional heat consumption module 13, as well as said at least one water heater 19 can be installed in a separate additional container 18, as shown in detail at figure 9. Furthermore, it is possible to make different combinations, in which some of said hot water supply module 7, heating and cooling module 12, additional heat consumption module 13 and said at least one water heater 19 can be installed in at least one additional container 18, and the other(s) can be in the building and/or in the main container 1. All possible combinations depend on the requirements of the customer and the specific project of the modular geothermal energy center. Said at least one dry air cooler 20 can be installed to the main container 1, or to at least one additional container 18 or to be installed to the building, being preferably placed on the respective container 1, 18 or on the object to which it is installed. Regardless of whether said hot water supply

module 7, said heating and cooling module 12, said additional heat consumption module 13 and said at least one water boiler 19 are in the main container 1 or distributed in combinations with at least one additional container 18, then each container 1, 18 mainly can preferably have a metal powder-coated supporting structure with walls and a ceiling of three-layered panels having thermal insulation preferably of polyurethane foam with a thickness between 50 to 100 mm, covered by powder-coated sheet metal. The ceiling of each container 1, 18 can be made of LT sheet metal with the corresponding load capacity to be used as a remaining formwork when built into a building at the customer's request. The floor is preferably made of corrugated sheet metal, which can be stainless, aluminum or other at the customer's request. Each of the containers 1, 18 can be repeatedly opened and closed from all sides in the event of a need for service activities. The containers 1, 18 can be provided with grip parts for transfer with any type of loading and unloading equipment, including they can be configured for transfer by helicopter.

[0037] In the modular geothermal energy center, any suitable heat transferring fluid known to one skilled in the art can be used as the heat transferring fluid, but a 25% aqueous solution of monoethylene glycol is preferred, which is an organic compound with a freezing point of about - 15°C. The plate heat exchanger 9 and the hot water connecting unit 6.2 in the modular geothermal energy center are configured to increase the safety of the system when using a 25% aqueous solution of monoethylene glycol as a heat transferring fluid, as they serve to separate the circuit with the heat transferring fluid and the circuit with the water to the heating and cooling installation, as well as to the domestic hot water supply installation.

[0038] The heat-transferring fluids managing unit 5, shown in detail in figures 1 and 3a, includes electronically controlled three-way valves that serve to direct the flows of heat transferring fluids in the modular geothermal energy center coming from the evaporating part connecting unit 3, the condensing part connecting unit 4, the hot water distribution unit 6.1 and the geothermal circulation unit 8. Additionally, depending on the needs, heating fluid is supplied from the condensing part connecting unit 4 to the heat-transferring fluids managing unit 5 and/or to the hot water connecting unit 6.2, which is controlled by the three-way valves of hot water distribution unit 6.1. This provides a wide range of quickly achieved working modes of the modular geothermal energy center (high flexibility of the systems), because of the modular principle of equipping the specific energy center, providing the possibility of different modes of operation such as:

- heating mode, in which the heating fluid is provided from the heat-transferring fluids managing unit 5 to be supplied to the plate heat exchanger 9, wherein the plate heat exchanger 9 directly or through the heating and cooling module 12 is connected by pipes

to the heating and cooling means of said heating and cooling installation, which heating and cooling means can include, for example, radiators, under-floor heating, convector(s), air conditioner(s) and other similar heating devices and equipment, well known from the state of the art to a specialist in the field.

- domestic hot water supply mode, in which the heating fluid from the hot water connecting unit 6.2 is supplied to the domestic hot water supply unit 6.3, which domestic hot water supply unit 6.3 includes the required number of boilers, according to the needs of the building.
- additional heat consumers mode, in which, alternatively, the heating fluid from the hot water connecting unit 6.2 can be supplied to the additional heat consumption module 13, and the switching control signal from the hot water connecting unit 6.2 is the temperature in said boilers in the domestic hot water supply unit 6.3, which is adjusted according to the specific requirements of the site, and the supply of heat to the boilers is prioritized, and the maximum operating time for them is selected for the specific site.
- passive or active cooling mode, in which a signal is given to the three-way valves of the heat-transferring fluids managing unit 5 and the cooling fluid from the heat-transferring fluids managing unit 5 is supplied to the plate heat exchanger 9, which plate heat exchanger 9 directly or through the heating and cooling module 12 supplies the cooling fluid to an air-conditioning installation, part of the heating and cooling installation. In the passive cooling mode, a low-potential fluid from the field with geothermal wells is used without turning on the compressing part (refrigeration cycle) of the geothermal heat pump 2. When there is a lack of power to reach the set parameters in the passive cooling mode, the modular geothermal energy center switches to the active cooling mode, and for that purpose the heat-transferring fluids managing unit 5 switches the heat transferring fluid - the condensing part is connected to the field with geothermal wells and the evaporating part directs heat transferring fluid to the plate heat exchanger 9. When operating the geothermal heat pump 2 in active cooling mode, it is possible that all thermal energy to not be directed to the geothermal wells, but to be used by the hot water supply module 7 and/or to the additional heat consumption module 13.

[0039] All processes and modes of operation, as well as their optimization and monitoring, are implemented through the power supply and control panel 21, which controls the processes according to a predetermined methods for operation and control of geothermal energy center, implemented through the optimal and synchronous operation of the individual modules of the modular geothermal energy center. Said modes of heating, domestic hot water supply, inclusion of additional heat con-

sumer(s) and passive or active cooling are controlled by the power supply and control panel 21, which has a control section 21.1 and an acquisition section 21.2. The selection of the operating modes depends on the predetermined temperatures set in the control section 21.1, as well as the corresponding real-time temperatures obtained in the acquisition section 21.2. In control section 21.1 adjustable parameters such as hard wait time in minutes and/or hours as well as time for averaging the outside temperature (filtering time) are preset, which prevents frequent switching of operating modes and which are a known practice for the specialists in the field.

[0040] At least one outdoor air temperature source 22, at least one indoor air temperature sensor 23, at least one heating or cooling fluid temperature sensor 24, at least one main low-potential fluid temperature sensor 25 and at least one secondary low-potential fluid temperature sensor 26 are connected to the power supply and control panel 21 as shown in detail in Figure 10 for the optimal operation of the modules of geothermal module energy center. Acquisition section 21.2 is configured to obtain real-time temperature data respectively from said outdoor air temperature source 22, said indoor air temperature sensor 23, said heating or cooling fluid temperature sensor 24, said main low-potential fluid temperature sensor 25 and said secondary low-potential fluid temperature sensor 26. In addition, all models of said modes of heating, domestic hot water supply, inclusion of additional heat consumer(s) and passive or active cooling are configured as control methods in the control section 21.1, wherein leading is the method of switching the said heating and cooling installation in the heating or cooling modes by selecting heating or cooling fluid accordingly from the heat-transferring fluids managing unit 5 which directs the corresponding heating or cooling fluid to the plate heat exchanger 9, but other leading method is the operation of the geothermal heat pump 2, when supply of heating or cooling fluid from it is not necessary. In a preferred embodiment, in which the control methods are performed by the power supply and control panel 21, according to the present invention, a predetermined outdoor air temperatures are set for heating mode and cooling mode of the heating and cooling installation in the control section 21.1, and said outside air temperature is obtained in the acquisition section 21.2 from said at least one outdoor air temperature source 22. Control section 21.1 first checks whether the outdoor air temperature is lower or higher than said predetermined outdoor air temperature for heating mode. When the outdoor air temperature is lower than a predetermined outdoor air temperature for heating mode, the control section 21.1 switches the heating and cooling installation to heating mode, but if the outdoor air temperature is higher than the predetermined outdoor air temperature for heating mode, the control section 21.1 saves the current operating mode of the heating and cooling installation. Afterwards, the control section 21.1 checks whether the outdoor air temperature is lower or higher than said predetermined outdoor

air temperature for cooling mode. When the outdoor air temperature is higher than a predetermined outdoor air temperature for cooling mode, the control section 21.1 switches the heating and cooling installation to cooling mode, but if the outdoor air temperature is lower than a predetermined outdoor air temperature for cooling mode, the geothermal heat pump 2 does not turn on or the control section 21.1 turns it off.

[0041] In another preferred embodiment, in which the control methods are performed by the power supply and control panel 21, according to the present invention, the control section 21.1 can switch the heating and cooling installation in heating or cooling mode, respectively can turn on/off the geothermal heat pump 2, based on the real-time indoor air temperature obtained in the acquisition section 21.2 from said at least one indoor air temperature sensor 23 and depending on a predetermined indoor air temperature set in the control section 21.1.

[0042] In a further preferred embodiment, in which the control methods are performed by the power supply and control panel 21, according to the present invention, the control section (21.1) is further configured to switch the heating and cooling installation into heating or cooling mode and to turn on/off the geothermal heat pump 2 depending on a predetermined value of a logic function. Said predetermined value of the logic function is based on differences between the real-time temperature of the heating or cooling fluid and a predetermined temperature of the heating or cooling fluid, which differences are accumulated in the control section 21.1 during a predetermined time interval. Said predetermined value of a logic function, the predetermined temperature of heating or cooling fluid and a predetermined time interval are set in the control section 21.1, also said real-time temperature of the heating or cooling fluid is obtained in the acquisition section 21.2 from said at least one heating or cooling fluid temperature sensor 24.

[0043] Said predetermined logic function value is calculated before being set in the control section 21.1 by considering essential characteristics of the building such as the climatic area in which the building is located, geographical orientation of the building, type of building structure, heat losses from transmissions, heat losses from infiltration, solar protection, type of heating and cooling installation/s and the like. Furthermore, the calculation of the said predetermined logic function value also takes under consideration essential characteristics of the heating and cooling installation, such as the type of installation, type and number of heating or cooling sources, concrete tempering time, ceiling cooling/heating, fan convectors, centralized and decentralized comfort control, number of climate circuits and the like. An additional prime factor in the calculation of said predetermined logic function value is the prediction of the change in the outdoor temperature obtained from said at least one outdoor air temperature source 22.

[0044] In all preferred embodiments where the control methods are performed by the power supply and control

panel 21, according to the present invention, the control section 21.1 is further configured in said heating mode of the heating and cooling installation to select the low-potential source fluid for the geothermal heat pump 2 by switching the supply source of the low-potential fluid between said at least one tube heat exchanger 8.1 and said at least one dry air cooler 20 selecting the source fluid with higher temperature obtained in the acquisition section 21.2 from said at least one main low-potential fluid temperature sensor 25 and from said at least one secondary low-potential fluid temperature sensor 26. Alternatively, the control section 21.1 is further configured in said heating mode of the heating and cooling installation to turn on said at least one water boiler 19 as a secondary source of heating fluid for the heating and cooling installation at an outside air temperature lower than a predetermined outdoor air temperature for operation of the water boiler 19 and at a predetermined interval of values of said logic function, which predetermined interval of values is set in the control section 21.1. Said predetermined outdoor air temperature for operation of the water boiler 19 is set in the control section 21.1 and said outdoor air temperature is obtained from said at least one outdoor air temperature source 22 in the acquisition section 21.2. Same as said predetermined logic function value, said predetermined range of logic function values is calculated before setting in control section 21.1 again considering said essential characteristics of the building and the heating and cooling installation, also considering said prediction of the change in outdoor temperature obtained from said at least one outdoor air temperature source 22.

[0045] In all preferred embodiments where the control methods are controlled by the power supply and control panel 21, according to the present invention, the control section 21.1 is further configured in said cooling mode of the heating and cooling installation to switch to a passive cooling mode by selecting said at least one tube heat exchanger 8.1 as a supply source of cooling fluid for the heating and cooling installation at a lower cooling fluid temperature than a predetermined source fluid temperature for active cooling set in the control section 21.1. Alternatively, in said cooling mode of the heating and cooling installation to switch to an active cooling mode by selecting said evaporating part of the geothermal heat pump 2 as a supply source of cooling fluid for the heating and cooling installation at a higher cooling fluid temperature than the predetermined source fluid temperature for active cooling set in the control section 21.1, wherein said supply fluid temperature is obtained in the acquisition section 21.2 from said at least one main low-potential fluid temperature sensor 25. Alternatively, the control section 21.1 is further configured in said active cooling mode to select the low-potential fluid source for the geothermal heat pump 2 by switching the source of supply fluid from said at least one tube heat exchanger 8.1 or said at least one dry air cooler 20, selecting the source fluid with a lower temperature obtained in the acquisition section 21.2 from said at least one main low-potential

fluid temperature sensor 25 and from said at least one secondary low-potential fluid temperature sensor 26.

[0046] Said at least one outdoor air temperature source 22 can be at least one outdoor temperature sensor configured to measure the air temperature outside the building or may be at least one outdoor temperature source such as a database of real-time outdoor temperatures, a database of weather forecasts or a database of average outdoor temperatures for the season in a pre-determined area, or a combination of at least one outdoor temperature sensor with at least one outdoor temperature source. Said at least one indoor air temperature sensor 23 can be at least temperature sensor placed inside of a building configured to measure the air temperature in at least one room of the building, which can preferably be a pilot room or can be configured to calculate the air temperature in the building based on integral averaging of the measured temperatures in several rooms. Said at least one heating or cooling fluid temperature sensor 24 is configured to measure the temperature of the heating or cooling fluid which is directed to be supplied from the heat-transferring fluids managing unit 5 to the plate heat exchanger 9 for the heating and cooling installation. Said at least one main low-potential fluid temperature sensor 25 is configured to measure the temperature of the source low-potential fluid from said at least one tubular heat exchanger 8.1, and said at least one secondary low-potential fluid temperature sensor 26 is configured to measure the temperature of the fluid from said at least one dry air cooler 20.

[0047] The modular geothermal energy center can be used in new and existing buildings, being a particularly suitable source of heat and cooling in residential buildings with a central heating and cooling system, in existing buildings to improve their energy efficiency and comfort systems, in residential and hotel complexes, in public buildings such as schools, hospitals, office buildings and the like, as well as in production sites, especially in the food and processing industry, in data centers and other buildings having special purpose. The technical solution, according to the present invention, is an irreplaceable source of heat and cooling, including for the condensers of refrigeration systems in underground facilities (as metro stations, military facilities), since no other contact with the environment is required except with the earth's field. The modular geothermal energy center can be installed in the field or standing alone on a leveled site, as well as built into a building as a standard technical room, in addition it can be located on a roof or as a standard underground technical room with access.

Claims

1. Modular geothermal energy center, including a main container (1) in which at least one geothermal heat pump (2) having an evaporating and a condensing part is installed, wherein the evaporating part of the

geothermal heat pump (2) is connected by pipes with an intermediate heat-transferring fluid to a geothermal circulation unit (8), which geothermal circulation unit (8) is installed in the main container (1) and includes at least one electronically controlled circulation pump which circulation pump is connected by pipes with a low-potential source fluid to at least one tube heat exchanger (8.1) located in at least one geothermal well with said tube heat exchanger (8.1) being a main source of low potential fluid for the geothermal heat pump (2), wherein the condensing part of the geothermal heat pump (2) is connected by pipes to a heating and cooling installation as well as to a domestic hot water installation, **characterised in that** the evaporating part of the geothermal heat pump (2) through an evaporating part connecting unit (3) is connected by pipes with a cooling fluid to a heat-transferring fluids managing unit (5), which heat-transferring fluids managing unit (5) through a condensing part connecting unit (4) is connected by pipes with a heating fluid to the condensing part of the geothermal heat pump (2), such as the evaporating part connecting unit (3), the condensing part connecting unit (4) and the heat-transferring fluids managing unit (5) are installed in the main container (1), wherein the condensing part connecting unit (4) is additionally connected by pipes with a heating fluid to a hot water distribution unit (6.1), which hot water distribution unit (6.1) is installed in the main container (1) and is configured to direct the heating fluid via three-way valves to said domestic hot water installation or to the heat-transferring fluids managing unit (5), which heat-transferring fluids managing unit (5) is connected by pipes with an intermediate heat transfer fluid to the geothermal circulation unit (8) and which heat-transferring fluids managing unit (5) is connected by pipes with a heating or cooling fluid to a plate heat exchanger (9), which plate heat exchanger (9) is installed in the main container (1) and is configured for connecting to said heating and cooling installation, wherein after said geothermal well(s) and after the heat-transferring fluids managing unit (5), respectively before the geothermal circulation unit (8) and before the plate heat exchanger (9), are connected by pipes safety units (10), which safety units (10) are installed in the main container (1) and each safety unit (10) includes one or more closed expansion vessels with safety valves, and in the main container (1) are additionally installed a heat-transferring fluids refilling station (11), connected to the geothermal circulation unit (8), as well as a power supply and control panel (21).

2. Modular geothermal energy center, according to claim 1, **characterised in that** the hot water distribution unit (6.1) is connected by pipes to hot water supply module (7), which hot water supply module (7) includes hot water connecting unit (6.2) and do-

- mestic hot water supply unit (6.3), wherein the hot water connecting unit (6.2) includes at least one heat exchanger, at least one expansion vessel and at least one circulation pump, which are connected by pipes to the domestic hot water supply unit (6.3), which domestic hot water supply unit (6.3) includes one or more water boilers configured for connecting by pipes to said domestic hot water supply installation.
3. Modular geothermal energy center, according to claim 1 or 2, **characterised in that** said plate heat exchanger (9) is connected by pipes to a heating and cooling module (12), which heating and cooling module (12) includes a heating and cooling connecting unit (14) and an energy storage unit (15), wherein the energy storage unit (15) includes one or more buffer tanks connected by pipes to the heating and cooling connecting unit (14), which heating and cooling connecting unit (14) includes at least one electronically controlled circulation pump and collectors configured for connecting by pipes to said heating and cooling installation.
 4. Modular geothermal energy center, according to claim 2 or 3, **characterised in that** the hot water connecting unit (6.2) from the hot water supply module (7) is further connected by pipes to an additional heat consumption module (13), which additional heat consumption module (13) includes an additional heat consumption connecting unit (16) and an secondary energy storage unit (17), wherein the secondary energy storage unit (17) includes one or more buffer tanks connected by pipes to the additional heat consumption connecting unit (16), which includes at least one electronically controlled circulation pump and collectors configured for connecting by pipes to at least one additional heat consumer.
 5. Modular geothermal energy center, according any of claims 1 - 4, **characterised in that** at least one water heater (19), configured to run on hydrogen fuel, is connected by pipes after said plate heat exchanger (9) as a secondary source of heating fluid for the heating and cooling installation, and at least one dry air cooler (20) is connected to the geothermal circulation unit (8) as a secondary source of low-potential fluid for the geothermal heat pump (2).
 6. Modular geothermal energy center, according to claim 5, **characterised in that** the hot water supply module (7) and/or the heating and cooling module (12) and/or the additional heating module (13) and/or said at least one water heater (19) and/or said at least one dry air cooler (20) is installed in the main container (1) or respectively in at least one additional container (18).
 7. Modular geothermal energy center, according to claim 5 or 6, **characterised in that** at least one outdoor air temperature source (22), at least one indoor air temperature sensor (23), at least one heating or cooling fluid temperature sensor (24), at least one primary low-potential fluid temperature sensor (25) and at least one secondary low-potential fluid temperature sensor (26) are connected to the power supply and control panel (21), and the power supply and control panel (21) having a control section (21.1) and an acquisition section (21.2), which acquisition section (21.2) is configured to obtain in real-time temperature data respectively from the outdoor air temperature source (22), from the indoor air temperature sensor (23), from the heating or cooling fluid temperature sensor (24), from the main low-potential fluid temperature sensor (25) and from the secondary low-potential fluid temperature sensor (26), and the control section (21.1) is configured to switch said heating and cooling installation into heating or cooling mode by respectively switching heating or cooling fluid from the heat-transferring fluids managing unit (5) to the plate heat exchanger (9), and the control section (21.1) is further configured to turn on/off the geothermal heat pump (2).
 8. Modular geothermal energy center, according to claim 7, **characterised in that** the control section (21.1) is further configured to switch the heating and cooling installation into the heating mode at a lower outside air temperature than a predetermined outside air temperature for the heating mode, and the control section (21.1) is further configured to stay in the current heating or cooling mode of the heating and cooling installation at a higher outdoor air temperature than the predetermined outdoor air temperature for heating mode, wherein the control section (21.1) is further configured to switch the heating and cooling installation into cooling mode at a higher temperature of outside air than a predetermined outside air temperature for cooling mode, and the control section (21.1) is further configured to switch off the geothermal heat pump (2) at a lower outside air temperature than the predetermined outside air temperature for cooling mode, wherein said predetermined outdoor air temperatures for heating and cooling mode are set in the control section (21.1), and said outdoor air temperature is obtained in the acquisition section (21.2) from said at least one outdoor air temperature source (22).
 9. Modular geothermal energy center, according to claim 7, **characterised in that** the control section (21.1) is further configured to switch the heating and cooling installation into heating or cooling mode and to turn on/off the geothermal heat pump (2) based on the real-time indoor air temperature obtained in the acquisition section (21.2) from said at least one

indoor air temperature sensor (23) and depending on a predetermined indoor air temperature set in the control section (21.1).

10. Modular geothermal energy center, according to claim 8 or 9, **characterised in that** the control section (21.1) is further configured to switch the heating and cooling installation into heating or cooling mode and to turn on/off the geothermal heat pump (2) depending on a predetermined value of a logic function, which predetermined value of the logic function is based on differences between the real-time temperature of the heating or cooling fluid and a predetermined temperature of the heating or cooling fluid, which differences are accumulated in the control section (21.1) during a predetermined time interval, wherein said predetermined value of a logic function, the predetermined temperature of heating or cooling fluid and a predetermined time interval are set in the control section (21.1), and said real-time temperature of the heating or cooling fluid is obtained in the acquisition section (21.2) from said at least one heating or cooling fluid temperature sensor (24).
11. Modular geothermal energy center, according to any of claims 7 - 10, **characterised in that** the control section (21.1) is further configured in said heating mode of the heating and cooling installation to select the low-potential source fluid for the geothermal heat pump (2) by switching the supply source of the low-potential fluid between said at least one tube heat exchanger (8.1) and said at least one dry air cooler (20) selecting the source fluid with higher temperature obtained in the acquisition section (21.2) from said at least one main low-potential fluid temperature sensor (25) and from said at least one secondary low-potential fluid temperature sensor (26).
12. Modular geothermal energy center, according to claim 11, **characterised in that** the control section (21.1) is further configured in said heating mode of the heating and cooling installation to turn on said at least one water boiler (19) as a secondary source of heating fluid for the heating and cooling installation at an outside air temperature lower than a predetermined outdoor air temperature for operation of the water boiler (19) and at a predetermined interval of values of said logic function, which predetermined interval of values is set in the control section (21.1), wherein said predetermined outdoor air temperature for operation of the water boiler (19) is set in the control section (21.1), and said outdoor air temperature is obtained from said at least one outdoor air temperature source (22) in the acquisition section (21.2).
13. Modular geothermal energy center, according to any of claims 7 - 10, **characterised in that** the control

section (21.1) is further configured in said cooling mode of the heating and cooling installation to switch to a passive cooling mode by selecting said at least one tube heat exchanger (8.1) as a supply source of cooling fluid for the heating and cooling installation at a lower cooling fluid temperature than a predetermined source fluid temperature for active cooling set in the control section (21.1), which control section (21.1) is further configured in said cooling mode of the heating and cooling installation to switch to an active cooling mode by selecting said evaporating part of the geothermal heat pump (2) as a supply source of cooling fluid for the heating and cooling installation at a higher cooling fluid temperature than the predetermined source fluid temperature for active cooling set in the control section (21.1), wherein said supply fluid temperature is obtained in the acquisition section (21.2) from said at least one main low-potential fluid temperature sensor (25).

14. Modular geothermal energy center, according to claim 13, **characterised in that** the control section (21.1) is further configured in said active cooling mode to select the low-potential fluid source for the geothermal heat pump (2) by switching the source of supply fluid from said at least one tube heat exchanger (8.1) or said at least one dry air cooler (20), selecting the source fluid with a lower temperature obtained in the acquisition section (21.2) from said at least one main low-potential fluid temperature sensor (25) and from said at least one secondary low-potential fluid temperature sensor (26).

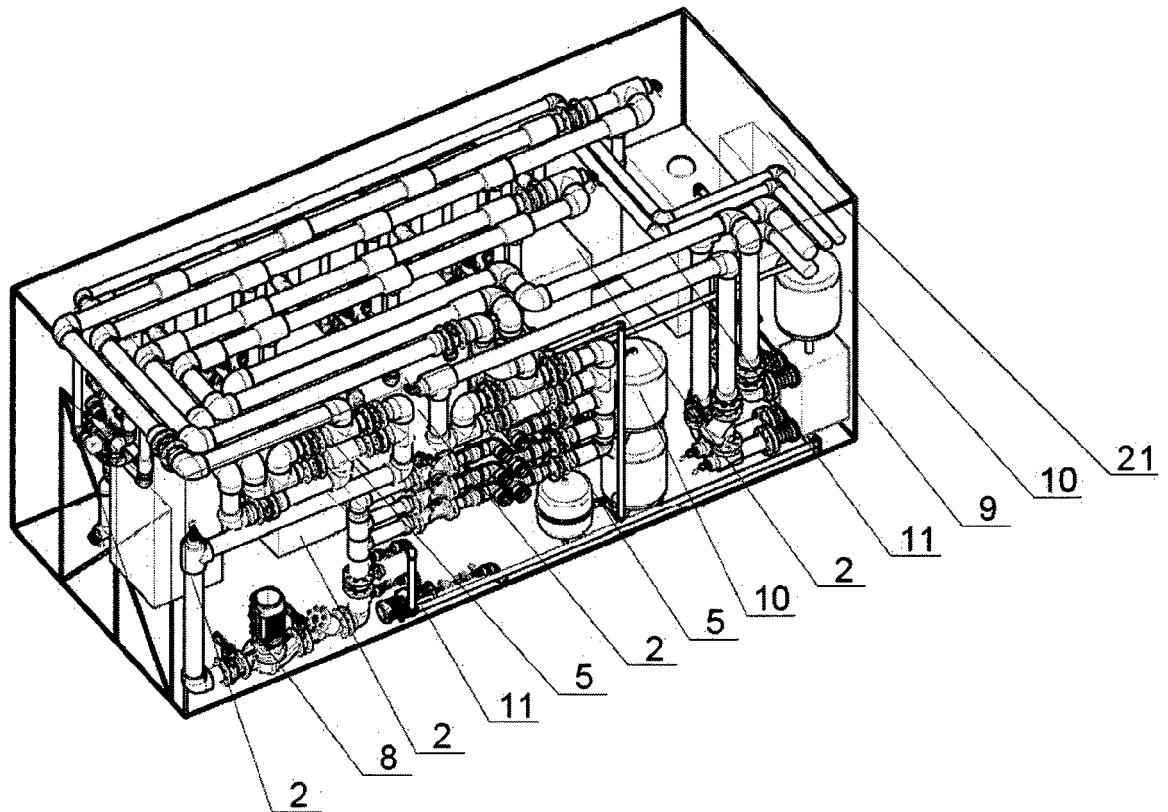


Fig. 1

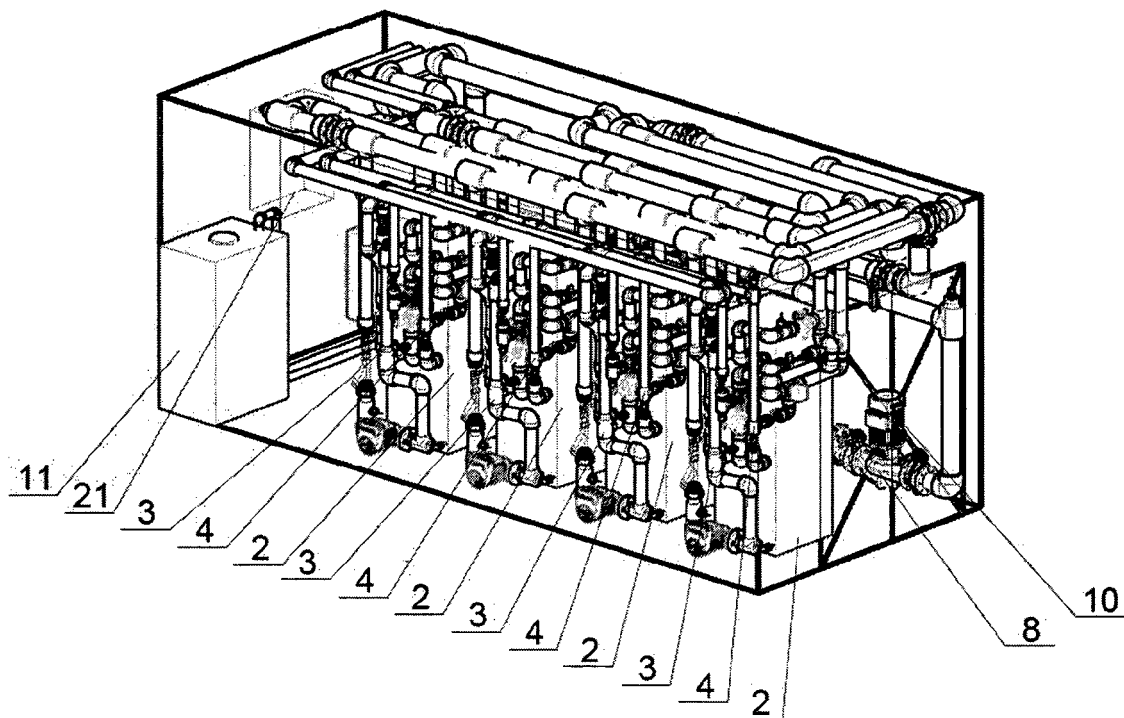


Fig. 2

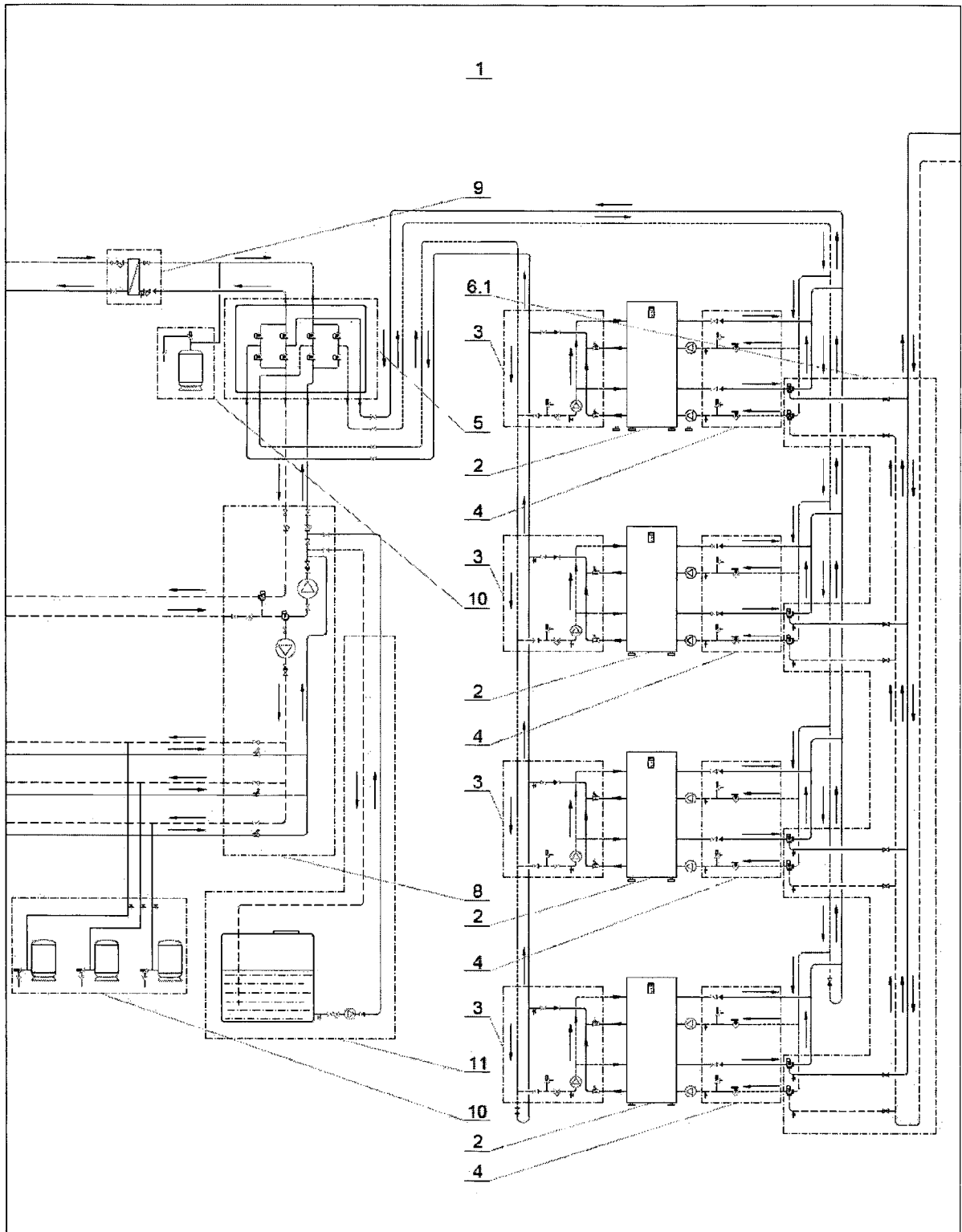


Fig. 3

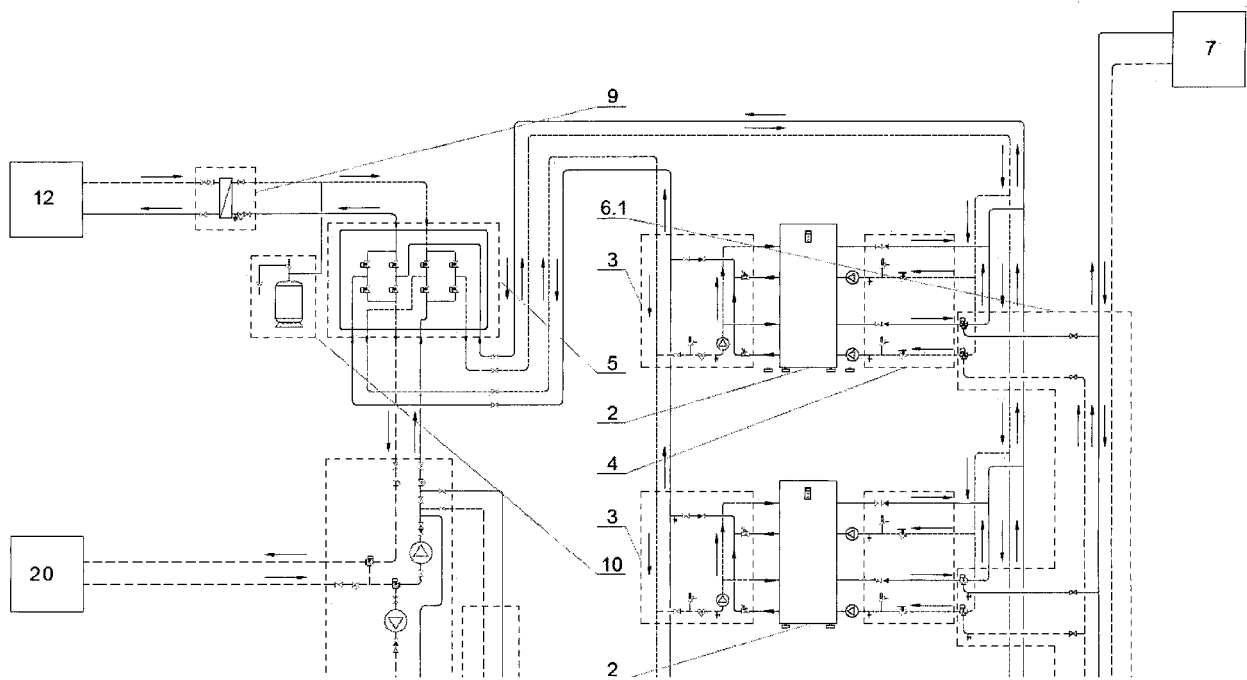


Fig. 3a

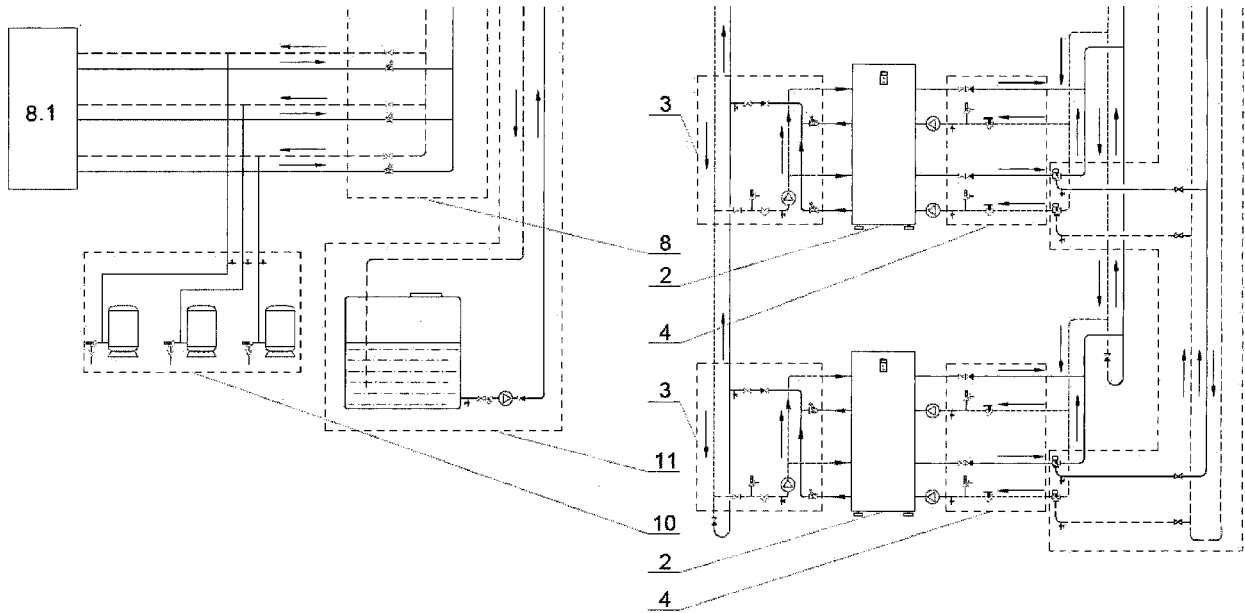


Fig. 3b

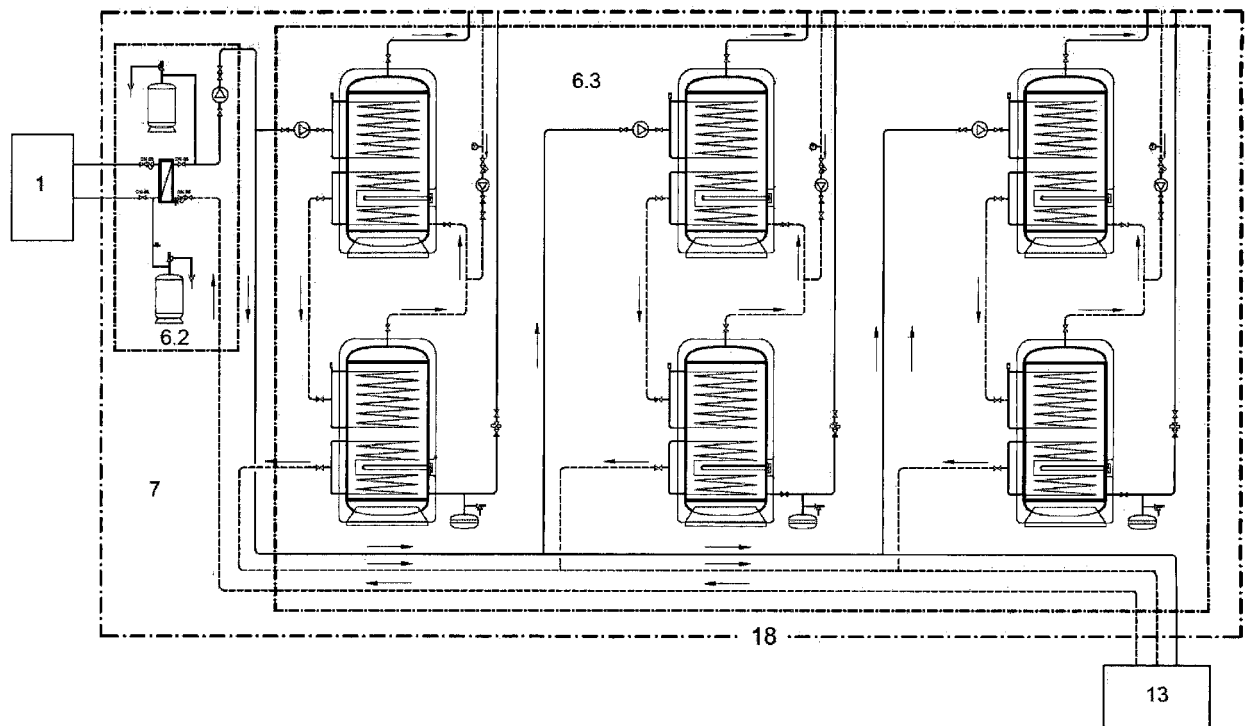


Fig. 4

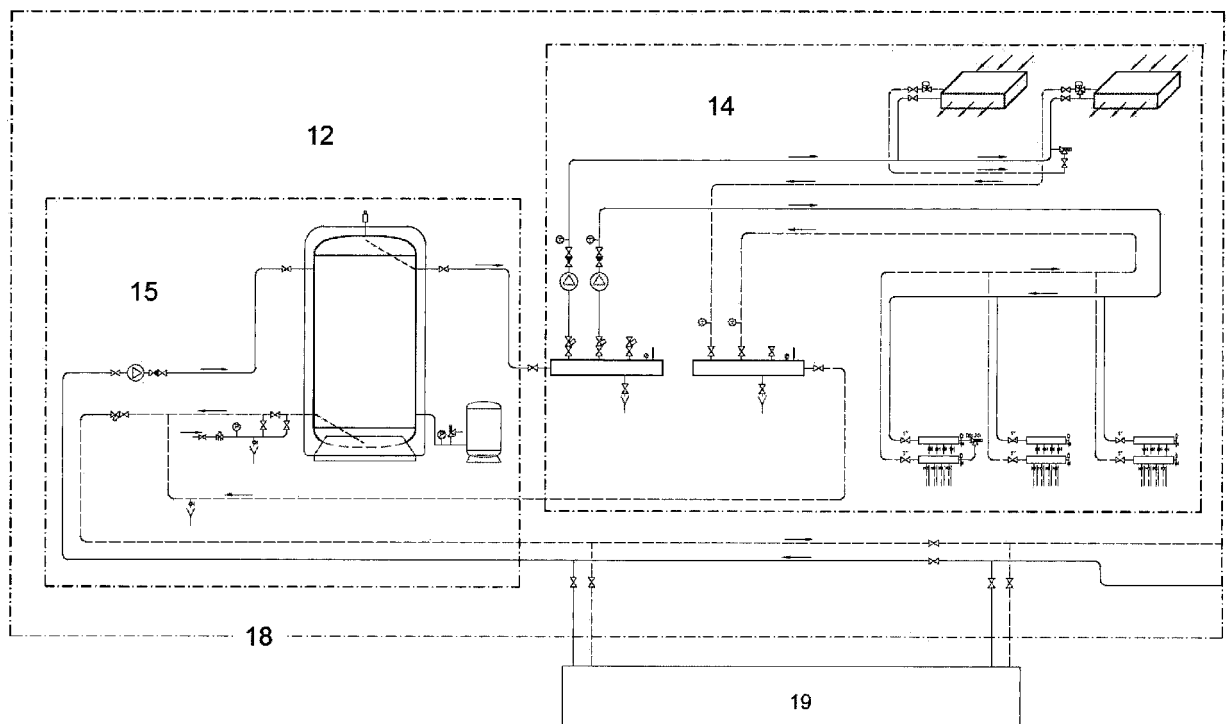


Fig. 5

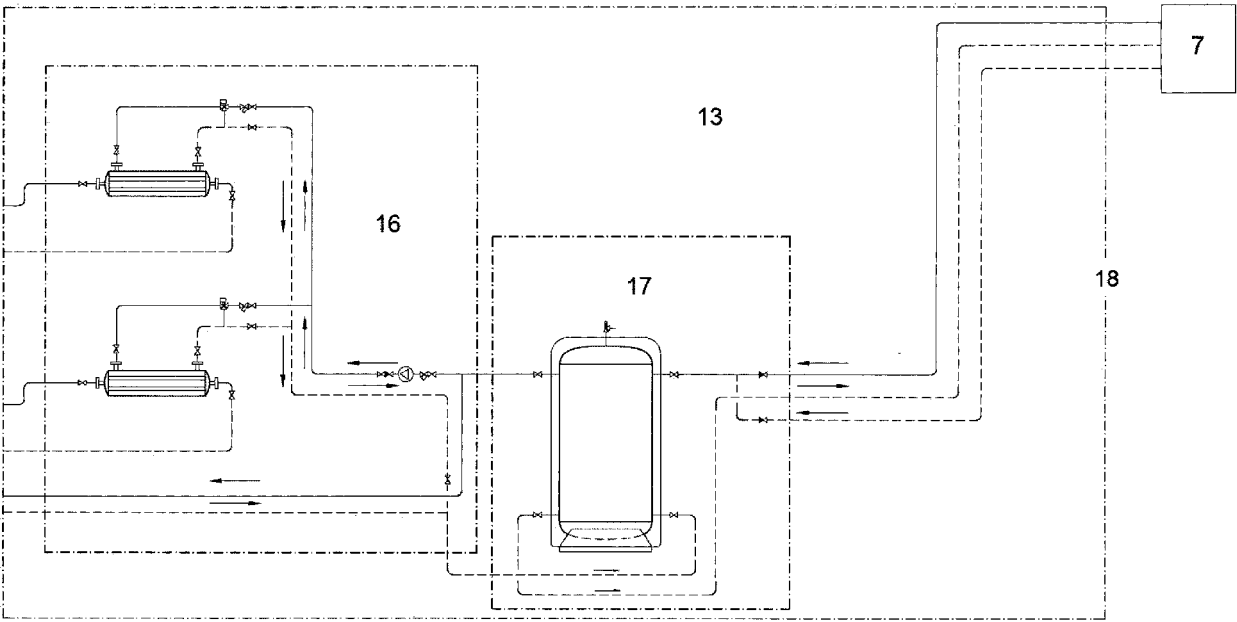


Fig. 6

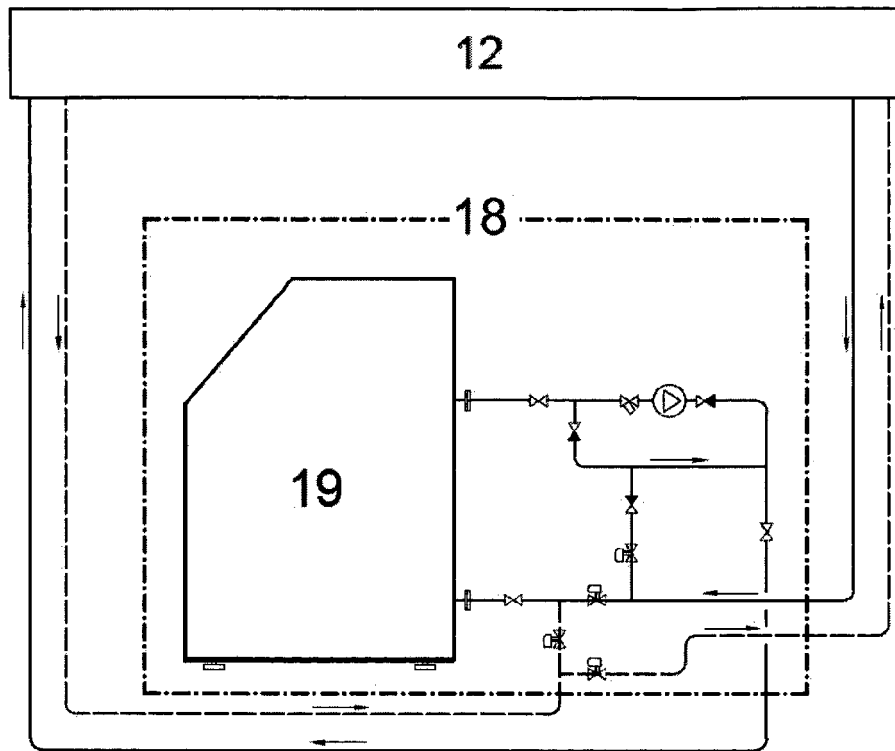


Fig. 7

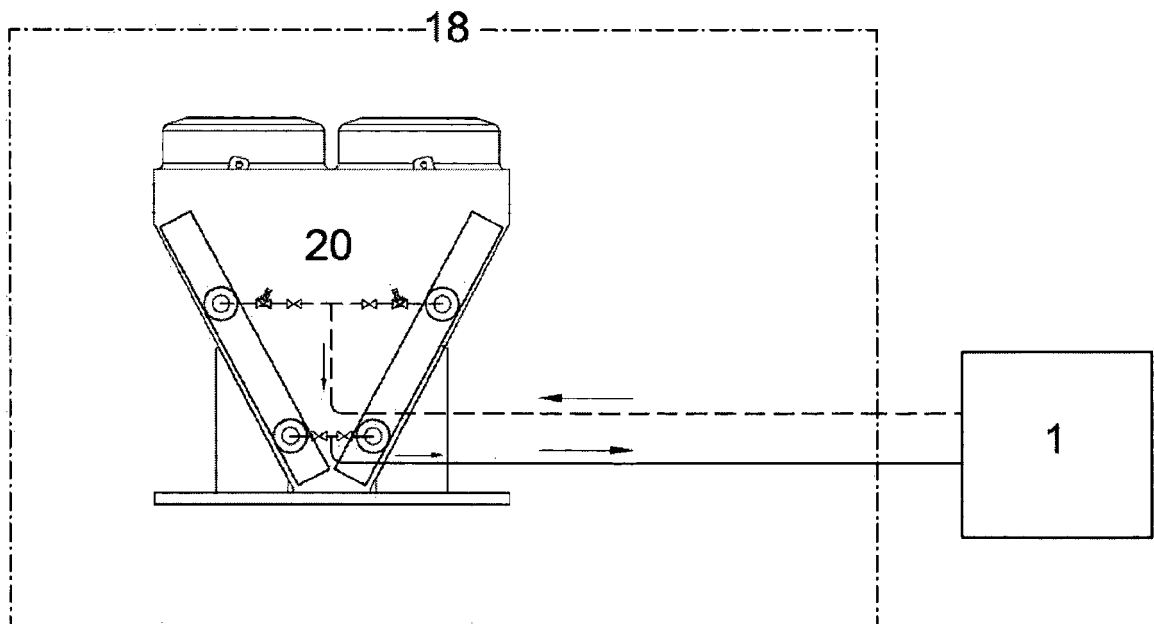


Fig. 8

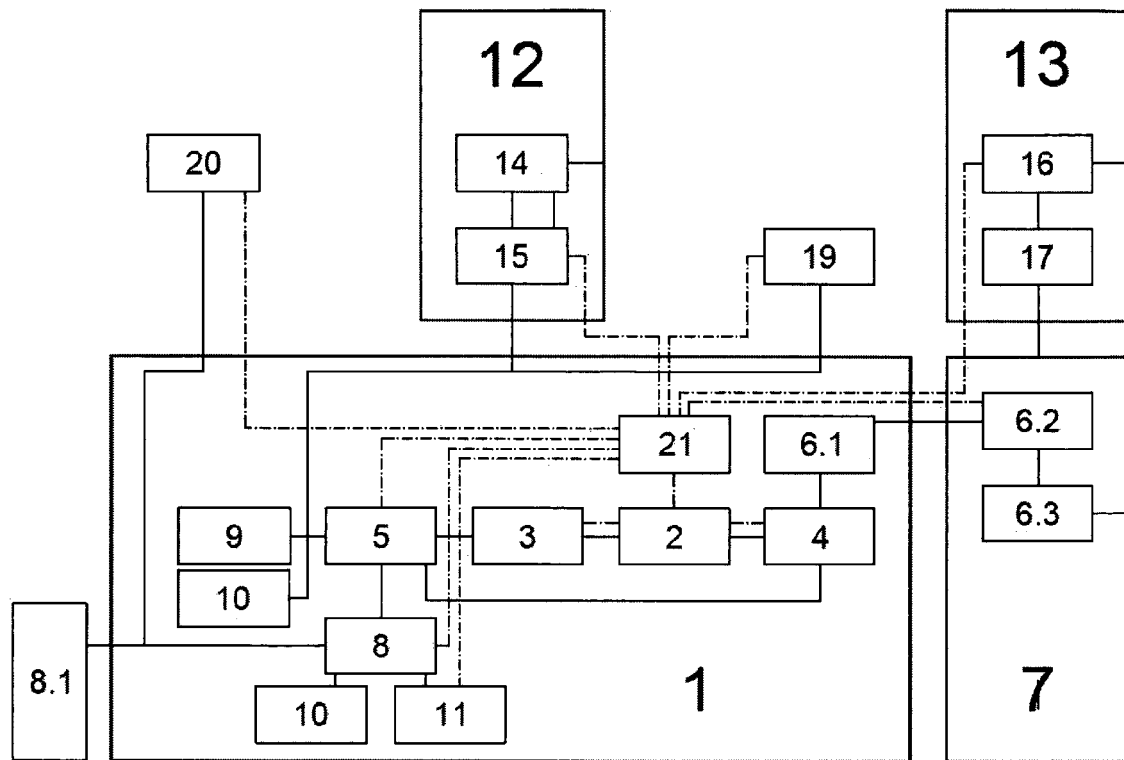


Fig. 9

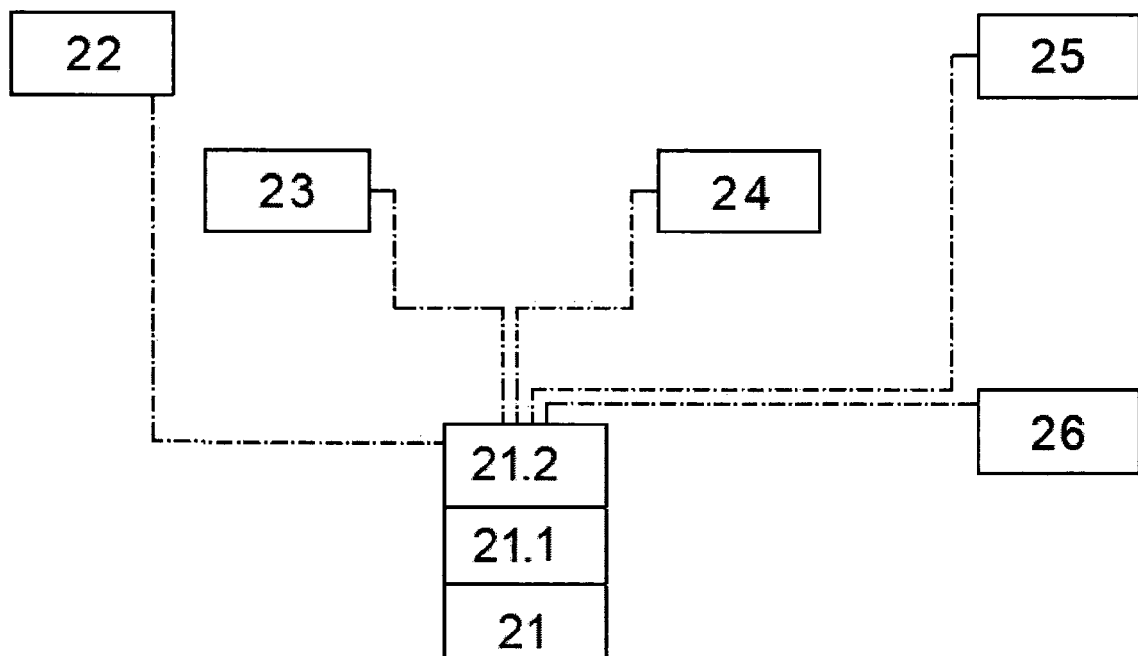


Fig. 10



EUROPEAN SEARCH REPORT

Application Number

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A, D	EP 2 597 379 A2 (SANCHEZ PEREZ VICENTE [ES]; DE ISABEL GARCIA JUAN ANTONIO [ES]) 29 May 2013 (2013-05-29) * the whole document *	1	
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The present search report has been drawn up for all claims

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Place of search

Munich

Date of completion of the search

30 January 2024

Examiner

Riesen, Jörg

CATEGORY OF CITED DOCUMENTS

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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