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(54) **Electric energy delivery device and connected method**

(57) Electric energy delivery device using waste energy sources such as steam, hot water, hot gases etc., a turbine being inserted into a circuit where a fluid suitable to change state (gas and liquid) at low temperature, com-

prising at least a heat exchanger where the fluid is made gaseous, a condenser where the fluid is made liquid and a recirculation pump, the turbine being fed with said gaseous fluid.

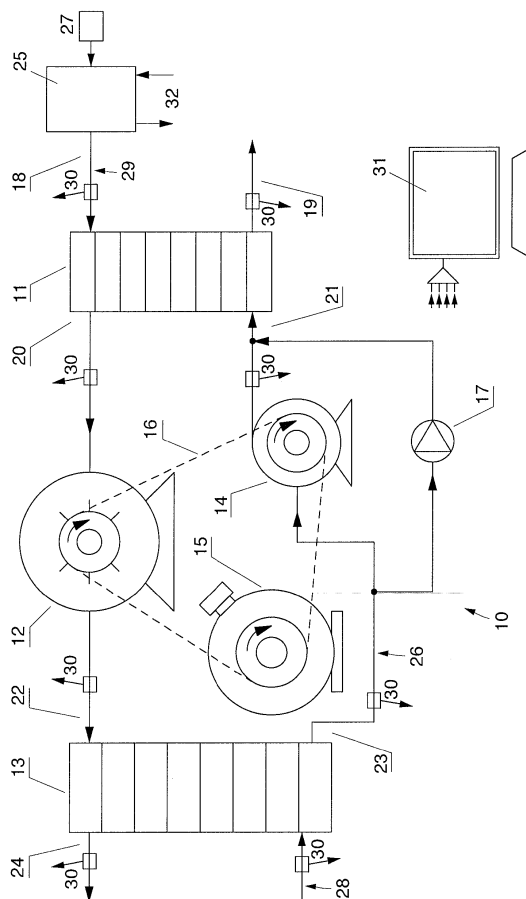


FIG. 1

Description

FIELD OF THE INVENTION

[0001] The present invention is applied in the energy sector and in particular concerns a device for the production of electric energy and the corresponding method.

[0002] Energy has been an indispensable source for the survival and development of mankind, in particular since the discovery and development of energy, and indeed the current level of civilization and life of mankind cannot disregard this versatile and transferable source of energy, which can be used everywhere.

[0003] It is also obvious that there is a shortage of electricity and irregular supply thereof, in particular in industrially developed areas or developing areas.

[0004] It is known that coal, oil, natural gas and other non-renewable sources can be used to generate electricity but, since they are not renewable, they are always rarer and more costly.

[0005] Therefore, all over the world, there is a tendency to use waste material, even with a low energy power, to generate electricity.

[0006] It is known, for example, that centralized air conditioning plants and plants to refine minerals, in order to work concrete or steel etc., have considerable emissions of substances at high temperature, such as (but not only) re-fluent gases, exhaust steams, waste water, either boiling or at a medium to low temperature, in any case above 60°C.

[0007] Even the activities connected to the working of steel are sources of substances containing energy which are dispersed.

[0008] For example, the cooling systems for rolled products, the exhaust gases in the production of steel in electric furnaces, the exhaust gases in furnaces for refining steel, the thermal energy of the preheating furnaces are all sources of energy which can be reused to produce electric energy; they are substances with a high energy content which at the moment are, for the most part, dispersed, and with them the energy contained therein is also dispersed; often further energy is expended in order to reduce the energy component which these resources contain, in order to disperse it into the environment.

[0009] It must also be remembered that the temperature of the water of the geothermal sources is generally comprised between about 60 and 200°C.

[0010] At the moment the rate of use of these substances containing energy which are discarded is very low.

[0011] The purpose of the present invention is therefore to obtain a process and a device able to use these sources of energy, capturing the energy in order to transform it into electricity.

[0012] It is also a purpose of the present invention to obtain a device suitable to exploit energy which would otherwise be discarded, even if produced by plants for conditioning, rolling, melting and refining steel, geother-

mal sources etc., therefore energy which is relatively modest but nevertheless of considerable quantities.

SUMMARY OF THE INVENTION

[0013] The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

[0014] In accordance with the above purposes, the invention concerns a thermo-electric device which uses waste thermal energy having a medium-low temperature to generate electricity with a high energy conversion rate, a good applicability and stable production.

[0015] According to the present invention the thermo-electric device comprises at least a heat exchanger, a turbine, an electric energy generator, a condenser and a recirculation pump, everything cooperating in a closed circuit while the exchanger and the condenser also have respective open circuits.

[0016] According to a variant, upstream of the device and between it and the waste energy source, there is a cooling system of the energy substances to bring their temperature within the parameters provided for the device.

[0017] According to said variant, the cooling system, for example cooling towers, also generates waste energy substances which can be used in the device or in another device.

[0018] The open circuit of the heat exchanger is connected to the source of thermal energy, that is, to the cooling system of the energy substance.

[0019] The energy substance enters the exchanger at a temperature comprised between 50°C and 70°C, advantageously around a temperature of 60°C.

[0020] The heat exchanger also has a segment of closed circuit in which a liquid enters at a low temperature and steam exits containing thermal energy which drives the turbine, advantageously a two-stage turbine or more.

[0021] In the closed circuit a fluid which transports energy circulates, able to vaporize at the rated temperatures of the exchanger and to become liquid in the condenser.

[0022] The turbine drives the generator and the steam exiting from the turbine is mainly a low temperature steam which in the closed circuit goes to the condenser.

[0023] A liquid exits from the condenser having a low temperature which in any case stays inside the closed circuit.

[0024] The low-temperature liquid is fed to a recirculation pump which sends it to the heat exchanger, which transforms it again into low temperature steam and the cycle is repeated.

[0025] Control means, for example to control the temperature and also, possibly, the flow rate and/or the pressure, that is, the control parameters of the fluids, are present in the system and supply the specific information to a management, processing, control and command

system.

[0026] A variant of the invention provides an auxiliary feeding pump.

[0027] The turbine can drive both the electric energy generator and the recirculation pump, and if necessary, the auxiliary pump with any motion transmission system of a known type.

[0028] The invention therefore provides a closed circuit which involves the exchanger, the turbine, the condenser and at least the recirculation pump.

[0029] The heat exchanger also has an open circuit for the entrance of the thermal energy and the exit to discharge said energy, which has already given up most of its heat.

[0030] The condenser also has an open circuit in which a cooling liquid, such as water or air, passes.

[0031] As we said, the energy-carrying fluid which circulates in the closed circuit is a fluid which is able to vaporize at the temperature supplied by the thermal energy source in the exchanger.

[0032] The whole is subject to a control, management and command system. Possible purification systems of the thermal energy entering can be provided.

[0033] Two or more exchangers can also be provided which work in parallel or which are alternated for cleaning and/or maintenance.

[0034] The same is true for the condenser.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The attached figure 1 gives a schematic example of the present invention and is given as a non-restrictive example.

DETAILED DESCRIPTION OF A PREFERENTIAL FORM OF EMBODIMENT

[0036] With reference to the attached drawing, number 10 indicates a device according to the present invention.

[0037] The device 10 has a closed circuit 26 which comprises a heat exchanger 11 with a steam outlet 20 which feeds a turbine 12 which can have one or more stages.

[0038] The turbine 12 drives both the electric energy generator 15 and the recirculation pump 14 and if necessary the auxiliary pump 17, for example by means of a belt 16.

[0039] The exhaust steam, which exits from the turbine 12 through the pipe 22, enters into the condenser 13 from where it exits, through the pipe 23, in the form of a liquid which is drawn by the recirculation pump 14 which sends it, through the pipe 21, into the exchanger 11.

[0040] In the case shown, an auxiliary pump 17 is provided should there be problems with the recirculation pump 14, or as an integrative factor at particular moments, for example at pickup or at start-up.

[0041] The exchanger 11 also has an open circuit 29 which receives the thermal energy from the source 27

through the pipe 18 and discharges it through the exit 19, after having transmitted a large part of it to the energy transporter fluid which circulates in the closed circuit 26.

[0042] In the case shown, a cooling tower 25, which receives the energy substance from the source 27, feeds the energy substance to the pipe 18 at a desired temperature.

[0043] The cooling tower 25 is fed with a cooling fluid (air, water or other) through the circuit 32.

[0044] The cooling fluid exiting from the circuit 32 is also a substance which can be used in the device 10.

[0045] The condenser 13 also has an open circuit which, through the pipe 28, receives the cooling water or other cooling fluid, which it then discharges through the exit.

[0046] Detection and control systems 30 are provided in the various pipes, which transmit the data to a central management, processing, control and command unit 31, which can even be disposed remote, that is, commanding several devices 10.

[0047] In order to maintain the desired conciseness, the example does not show the reintegration systems, the systems for choking and managing the flow rates, and more generally that which allows the practical and continuous use of the device, since this comes within the normal knowledge of an engineer.

[0048] In the case shown, as a work hypothesis, it is possible to have the energy substance which supplies water at about 90°C, with a flow rate of 90 tons/hour, so that the cooling tower 25 has to be used to cool said water to around 60°C. The system can function for example for about 8000 hours per annum. In the condenser 13 the inlet temperature of the water is about 25°C and the outlet temperature is 30°C with a flow rate of 400 tons/hour.

From this example, it can be inferred that the recyclable energy is equal to $42 \text{ kJ kg}^{-1}\text{°C} \times 20\text{°C} \times 90000 \text{ kg/h} = 2100 \text{ kW/h}$. Given a net yield of the device 10 equal to 10%, the electric power is therefore 210 kW/h which can be delivered continuously. The cooling tower 25 also supplies the exhaust cooling fluid to the device 10 for generating electricity with a net yield per annum equal to $200 \times 8000 = 160 \text{ wkW/h}$.

[0049] The above description, given as an example, constitutes the method and device according to the invention, and the field of protection thereof is not limited to the one described: indeed, persons of skill shall be able to make modifications connected to the principle described, and these shall also be protected.

Claims

1. Electric energy delivery device using waste energy sources (27) such as steam, hot water, hot gases etc., **characterized in that** a turbine (12) is inserted into a closed circuit (26) where an energy transporter fluid circulates, suitable to change the state (gas and liquid) at low temperature, comprising at least a heat

exchanger (11) where said fluid is made gaseous at the rated temperature of the exchanger (11), a condenser (13) where said fluid is made liquid and a recirculation pump (14) of said liquid, the turbine (12) being fed with a gaseous energy transporter fluid coming from the exchanger (11) and driving at least an electric energy generator (15).

2. Device as in claim 1, **characterized in that** the energy substance (gas, steam, water or other) enters into the exchanger (11) at a temperature comprised between 50°C and 70°C, advantageously around 60°C. 5
3. Device as in claim 1 or 2, **characterized in that** the turbine (12) has at least two stages. 10
4. Device as in any claim hereinbefore, **characterized in that** the energy substance recovered is made to circulate in the open circuit (29) of the exchanger (11). 15
5. Device as in any claim hereinbefore, **characterized in that** there is at least a cooling mean (25) to cool the energy substance upstream of the exchanger (11). 20
6. Device as in any claim hereinbefore, **characterized in that** a cooling fluid is made to circulate in the open circuit (24-28) of the condenser (13). 25
7. Device as in any claim hereinbefore, **characterized in that** the turbine (12) also drives the recirculation pump (14). 30
8. Device as in any claim hereinbefore, **characterized in that** there is also an auxiliary pump (17) present. 35
9. Device as in any claim hereinbefore, **characterized in that** there are also detection and control means (30) present, associated to a management, processing, control and command unit (31). 40
10. Method to generate electricity with the device as in any claim hereinbefore, **characterized in that** an energy transporter fluid, suitable to change state and to vaporize at the exchange temperatures of an exchanger (11) into which a recovered energy substance enters, such as steam, water, hot gases or other, at a temperature comprised between 50°C and 70°C, is made to circulate in a closed circuit (26) becoming gaseous in the exchanger (11). 45
11. Method as in claim 10, **characterized in that** said vaporized energy transporter fluid feeds a turbine (12) in a closed circuit before being sent into a condenser (13) where it becomes liquid again to be fed once again to the exchanger (11), restarting the cycle. 50

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12. Method as in claim 10 or 11, **characterized in that** said energy transporter fluid, made liquid, is fed to the exchanger (11) by means of a recirculation pump (14). 55
13. Method as in any claim from 10 to 12, **characterized in that**, before entering the exchanger (11), the energy substance transits in a cooling mean (25) which takes it to a temperature advantageously around 60°C.
14. Method as in any claim from 10 to 13, **characterized in that** the cooling fluid used to cool the energy substance to be sent to the exchanger (11), at exit from the cooling mean (25), becomes an energy substance to be used according to the present invention.

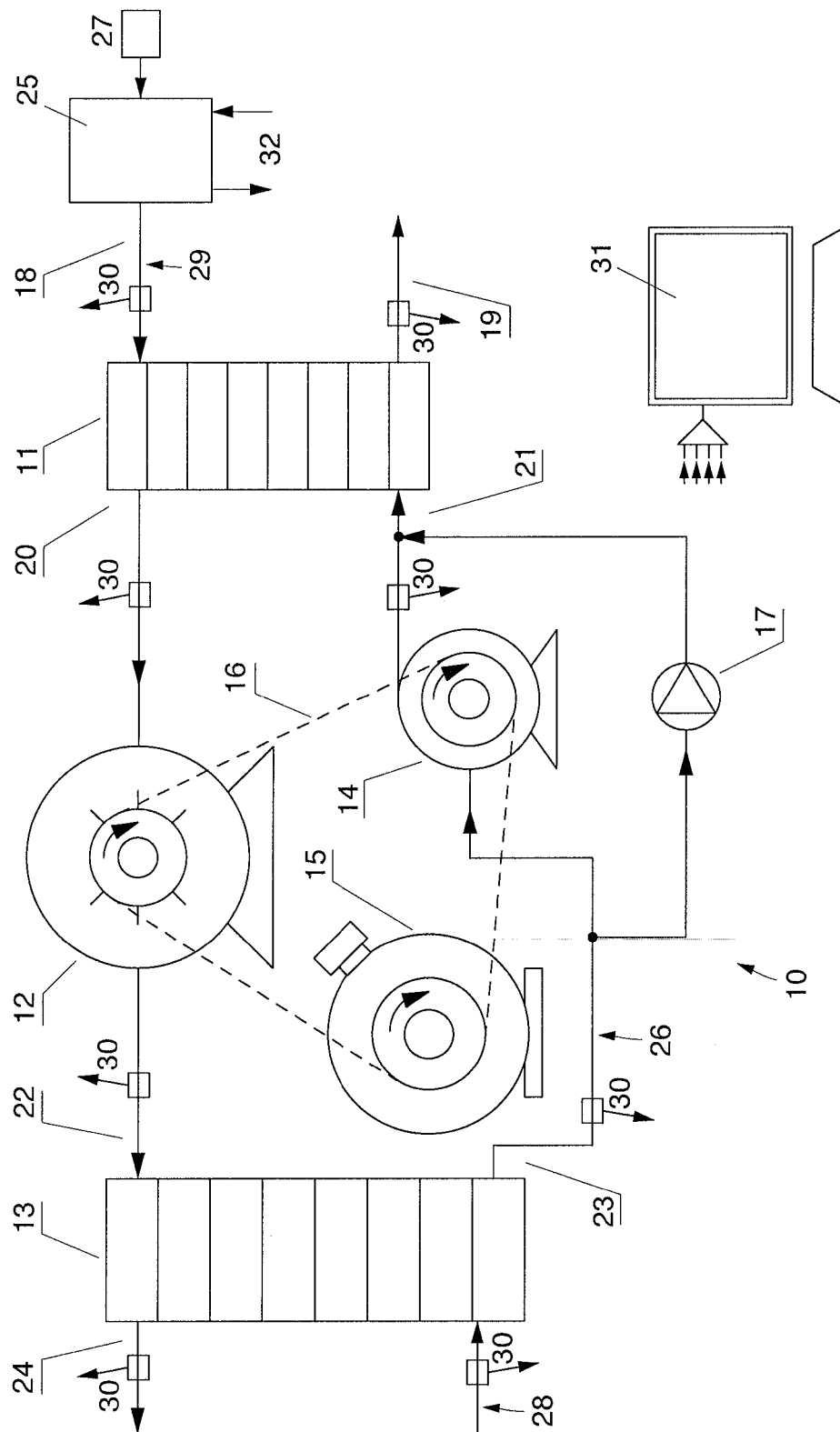


FIG. 1



EUROPEAN SEARCH REPORT

Application Number
EP 12 16 4263

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	EP 2 071 184 A1 (BOLD RIVER [FR]) 17 June 2009 (2009-06-17) * paragraphs [0020] - [0026]; figure 1 *	1,10,14	TECHNICAL FIELDS SEARCHED (IPC) F01K
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 September 2012	Examiner Röberg, Andreas
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 16 4263

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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