(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 555 396 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
20.07.2005 Bulletin 2005/29

(51) Int Cl.[7]: **F01K 25/08**

(21) Application number: **04425916.6**

(22) Date of filing: **13.12.2004**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR LV MK YU

(30) Priority: **16.12.2003 IT BS20030128**

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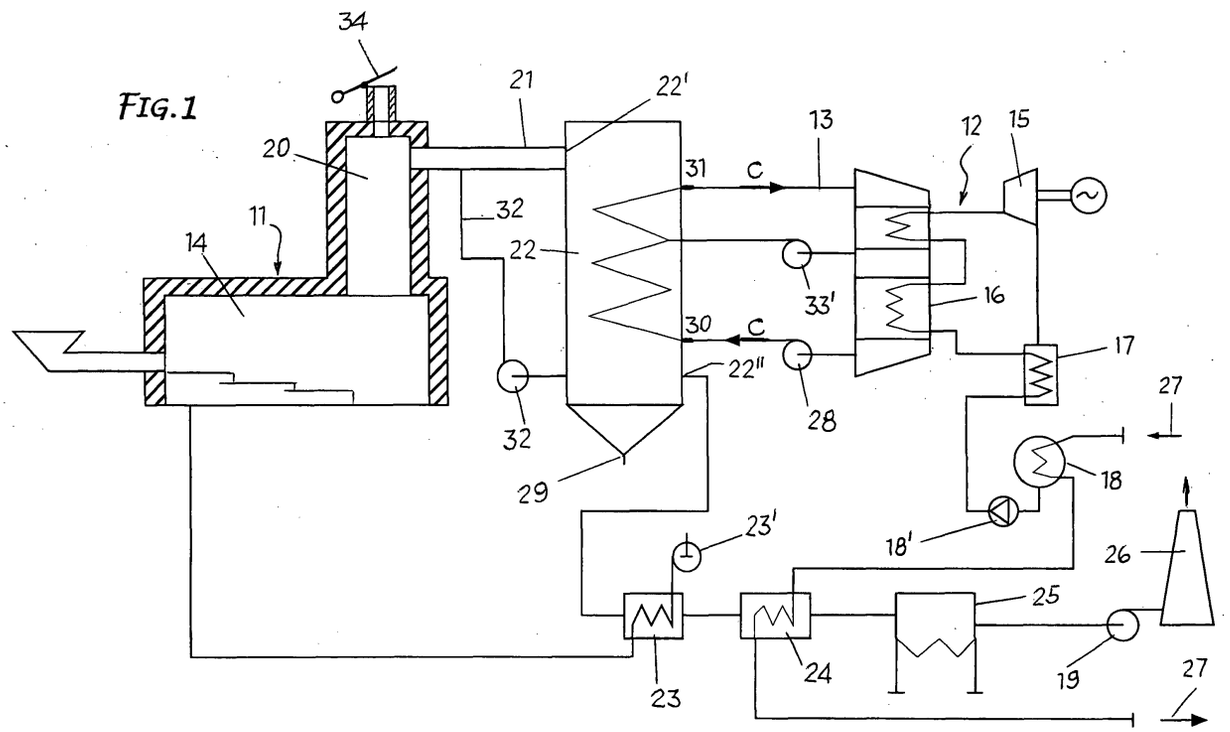
(54) Apparatus for the production of electric energy using high temperature fumes or gasses

(57) This invention concerns a system for producing electric or mechanical energy, starting from the fumes or gasses from combustion of a biomass or from some other origin that includes a turbogenerator group (12) operating according to the Rankine cycle and an intermediate heat exchange between the high temperature fumes or gasses and an working fluid evaporation heat exchanger (16) feeding the turbogenerator group (12). Flowing in the intermediate heat exchange circuit (13) is a aeriform fluid that on the one hand, is heated by the high temperature gasses or fumes and on the other, releases heat to the working feed fluid of the turbogenerator group (12). The aeriform fluid can be an inert gas or air with a low oxygen content.

FIG.1



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Description

Field of Invention

[0001] This invention concerns in general an apparatus for producing electric or mechanical energy, starting from the combustion of a biomass or a gasses at a high temperature coming from any heat source. In particular, the invention refers to an innovative intermediate thermal exchange circuit between high temperature fumes or gasses of any kind and an organic or inorganic operating fluid used in a turbo generator (ORC) operating according to a Rankine cycle.

State of the Art

[0002] A system for the production of electric or mechanical energy of the above considered type comprises principally: a combustion chamber fed by the combustible biomass, a heat exchanger unit for heat exchange between the combustion fumes or gasses and thermal carrier fluid flowing in an intermediate circuit, a heat exchanger between the intermediate thermal carrier fluid and an organic or inorganic evaporable working fluid for the evaporation of the latter, a turbogenerator fed by the working fluid vapour, a recovery regenerator of the heat content of the working fluid vapour on exit from the turbogenerator and a condenser group for the working fluid before it returns into circulation.

[0003] Usually, a system of this kind uses as an intermediate thermal carrier fluid, a thermal oil, moreover combustible, and as an working fluid, if organic, a high molecular mass siliconic oil, and if inorganic, water, for example. To heat the thermal oil it is made to circulate in a coil which is in contact with high temperature fumes or gasses and at the same time it heats the working fluid and generates the vapour feeding the turbogenerator.

[0004] Even though the technique is well established, a system for feeding a turbogenerator as described above has certain drawbacks which are connected mainly to the use of thermal oil in the intermediate heat exchanger circuit and which can be identified as follows:

- the need for an expansion vessel to compensate the variations in volume due to the thermal dilatation and to separate the liquid and gaseous phases of the thermal oil,
- a double pump, usually electrical, for the circulation of the thermial oil,
- an additional pump with motor, typically Diesel, for the circulation of the thermal oil in case of an emergency
- filling up with thermal oil which means a significant initial cost and similar costs for renewal when it needs changing,
- limitations as regards to the maximum operating temperature depending on the characteristics of the thermal oil,
- reliable sealing means to prevent leaking and loss of thermal oil,
- fire risks from loss of flammable oil should there be breakdowns.

[0005] Actually, a type of electric energy turbogenerator apparatus has been proposed and produced in which the working fluid is made to contact and be heated directly by fumes or gasses coming from the combustion of biomass or other source without, therefore, the presence of an intermediate heat carrier fluid circuit. However, for many reasons the presence of an intermediate heat carrier fluid circuit is preferable in that it ensures protection against overheating of the working fluid, in particular if organic, it avoids the need for a qualified operator and does not require cooling of the combustion chamber and fumes should the turbogenerator units stop.

Object and Summary of the Invention

[0006] The object of this invention is to eliminate or at least limit the negative aspects of the known technique referred to above and to propose, at the same time, an apparatus for the production of electric or mechanical energy, starting from the high temperature fumes or gasses, improved with regard to safety and inexpensiveness of operating costs.

[0007] This object is achieved in an operating apparatus comprising a source of high temperature fumes or gasses, a turbogenerator group operating according to the Rankine cycle with an organic or inorganic working fluid, an intermediate heat exchange circuit between said source of high temperature fumes or gasses, and a heat exchanger for the evaporation of the working fluid feeding the turbogenerator group, and characterised in that in the intermediate heat exchange circuit there is a aeriform fluid which, on the one hand, is heated by the high temperature fumes and gasses and on the other, releases heat to the working fluid feeding the turbogenerator.

[0008] The aeriform fluid in the intermediate circuit can be an inert gas, such as nitrogen, carbon dioxide, etc., incapable of, or unlikely of forming a flammable mixture with other substances. Or else, the aeriform fluid in the intermediate circuit could be air with a drastically reduced oxygen content, produced for example by a controlled combustion of a fuel such as propane. The intermediate circuit can be the open or preferably, the closed type depending on the aeriform fluid circulating in it. The pressure in the circuit can be the same or different from atmospheric pressure.

Brief Description of Drawings

[0009] Further aspects and features of the invention will be illustrated more in detail in the continuation of this description made in reference to the enclosed indicative

and not limiting drawings, in which:

Fig. 1 is a schematic diagram of an apparatus for producing electric or mechanical energy according to the invention, and

Fig. 2 is a part of the apparatus with a variation in the intermediate heat exchange circuit.

Detailed Description of the Invention

[0010] As shown, the apparatus primarily comprises a high temperature gasses or fumes source 11, a turbogenerator operating with an organic or inorganic fluid 12, and an intermediate circuit 13 containing a heat carrier fluid 13.

[0011] In the example illustrated, the high temperature gasses or fumes source is made up of a combustor 14 fed by a combustible biomass fuel. The turbogenerator group 12, is made up, as is known, of a turbine 15 and a heat exchanger 16 designed for heating and evaporating the working fluid that feeds the turbine. The vapour on exit from the turbine is usually made to pass through at least one regenerator 17 in which the heat of the vapour is used to preheat the working fluid, and then through a working fluid condenser 18 before returning the working fluid to the heat exchanger 16 by means of a pump 18'.

[0012] The high temperature gasses or fumes are made to circulate by means of a respective fan 19. They are collected in a starting chamber 20 and from here, by means of a leader 21, directed to the input 22' of an intermediate heat exchanger 22, the output 22' of which can be connected to a possible pre-heater 23 followed by an economizer 24, a filter 25 and a flue 26 discharging in the atmosphere the cooled gasses or fumes.

[0013] Advantageously, the pre-heater 23 can be used to pre-heat air to be supplied the combustor by means of a respective fan 23'. The economizer 24, where envisaged, can be used to pre-heat a liquid, such as for example, water for urban heating or for other uses passing in respective circuit 27, as usually takes place with the condenser of the turbogenerator group. As an option, pre-heater and economizer can be in the opposite order.

[0014] The intermediate circuit 13 containing a heat carrier fluid extends between the intermediate heat exchanger 22 and the heat exchanger 16 of the turbogenerator 12. The heat carrier fluid in said intermediate circuit 13 is made up of an aeriform fluid which is made to circulate by means of a respective fan 28 according to the arrows C. Inert gasses such as nitrogen, carbon dioxide or similar, or air with a reduced oxygen content in open or closed circuit may be used as an aeriform fluid in the intermediate circuit.

[0015] The intermediate heat exchanger 22 is metal, such as carbon steel or stainless steel. It is usually equipped with a bottom discharge 29 for the ashes and input and output connections 30,31 for the heat carrier fluid, that is to say the aeriform substance, which circulates in it.

[0016] The heating of the aeriform fluid in the intermediate exchanger 22 can be carried out in two phases: one by radiation and one by convection, the one by radiation having a tube and hollow spaces with the fluid to be heated flowing through them.

[0017] The temperature at input of the gasses or fumes feed leader 21 and consequently at the intermediate exchanger 22 can be adjusted by a partial recycling of cooled gasses. This gas can be collected directly at the exit 22' of the heat exchanger 22 or at any point downstream of the latter, using a fan 32' inserted in a recycle circuit 32 which can be controlled by a temperature probe.

[0018] An additional circuit 33 can also be envisaged with a respective fan 33' for a partial recycling of the heat carrier fluid, that is to say the aeriform substance, between a zone downstream of the evaporation unit of the turbogenerator group 12 and the intermediate exchanger 22 in order to avoid too high temperatures of the aeriform substance on entering the working fluid evaporation heat exchanger.

[0019] Furthermore, a part of the flow of the aeriform substance in the intermediate exchanger can be canalised and used to cool parts of the combustion chamber and/or the biomass combustor grate 14, should said grate includes ducts with diameters sufficient to allow circulation of the aeriform fluid in a closed circuit.

[0020] The initial high temperature gasses or fumes collection chamber 20 can be made of refractory steel and can be equipped with a "clapet" type safety valve 34, usually kept closed by a respective control or a balance weight and used to open and discharge the gasses into the atmosphere and exclude the part downstream of the system should cooling fail, that is in the absence of absorption of thermal power by the working fluid.

[0021] This chamber 20 can be enclosed by a double walled casing 35 in which the aeriform fluid can be made to circulate and heated according to the scheme in Fig. 2. In addition, probes can be inserted in the circuit to identify the presence of the working fluid in the aeriform substance and to protect the system, by stopping the circulation of the heat carrier fluid and opening the gasses or fumes release "clapet" valve to release the gasses or fumes from the initial collection chamber 20.

[0022] Finally, the option also exists for the intermediate heat exchanger can be equipped with an automatically opening discharge valve for rapid cooling of the circuit should there be an emergency, and with a fan there exits the possibility of acting regeneratively on the cooled fluid to reduce the power transmitted in the system.

Claims

1. Apparatus for producing electric or mechanical en-

ergy starting from fumes or gasses from combustion or other origin, comprising a source of high temperature fumes or gasses, a turbogenerator group operating according to the Rankine cycle, an intermediate heat exchange circuit between said high temperature fumes or gasses source and a heat exchanger for the evaporation of a working fluid feeding the turbogenerator, means for regenerating/condensing the working fluid on exiting the turbogenerator, and where the working fluid is an organic or inorganic fluid, **characterised in that** in the intermediate heat exchange circuit a aeriform fluid circulates which, on the one hand, is heated by the high temperature fumes and gasses and on the other, releases heat to the working fluid flowing in the turbogenerator.

2. Apparatus for producing electric or mechanical energy according to claim 1, in which the aeriform fluid in the intermediate heat exchange circuit is an inert gasses which is incapable of forming a flammable mixture with other substances.

3. Apparatus for producing electric or mechanical energy according to claim 1, in which the aeriform substance in the intermediate heat exchange circuit is air with a reduced oxygen content.

4. Apparatus for producing electric or mechanical energy starting from fumes or gasses from combustion or some other origin, consisting in a source of high temperature fumes or gasses, a turbogenerator group operating according to the Rankine cycle, an intermediate heat exchange circuit between said high temperature fumes or gasses source and a heat exchanger for the evaporation of a working fluid feeding the turbogenerator, means for regenerating/condensing the working fluid on exiting the turbogenerator, and where the working fluid is an organic or inorganic fluid, **characterised in that** in the intermediate heat exchange circuit an inert gas circulates which, on the one hand, is heated by the high temperature fumes and gasses and on the other, releases heat to the working fluid flowing in the turbogenerator.

5. Apparatus for producing electric or mechanical energy starting from fumes or gasses from combustion or some other origin, consisting in a source of high temperature fumes or gasses, a turbogenerator group operating according to the Rankine cycle, an intermediate heat exchange circuit between said high temperature fumes or gasses source and an operating fluid evaporation heat exchanger feeding the turbogenerator group, means for regenerating/condensing the operating fluid on exiting the turbogenerator, and where the operating fluid is an organic or inorganic fluid, **characterised by** the fact that flowing in the intermediate heat exchange circuit is air with a low oxygen content which, on the one hand, is heated by the high temperature fumes and gasses and on the other, releases heat to the feed operating fluid of the turbogenerator.

6. Apparatus for producing electric or mechanical energy according to any of the previous claims, in which the intermediate heat exchange circuit is a closed circuit operating a pressure equal to or different from atmospheric pressure.

7. Apparatus for producing electric or mechanical energy according to any of the previous claims, **characterised by** an initial high temperature gasses or fumes collection chamber, and in that the intermediate heat exchange circuit includes an intermediate exchanger connected to said chamber by means of a feed duct in which a aeriform fluid flows to heat the latter in two phases, one by radiation and the other by convection.

8. Apparatus for producing electric or mechanical energy according to claim 7, **characterised by** a circuit for a partial recycle of the gasses and fumes between a part downstream of their exit from the intermediate exchanger and the feed duct of the gasses or fumes to said intermediate exchanger to control, by means of temperature probes, the temperature of the gasses and fumes between said initial chamber and the input into the exchanger.

9. Apparatus for producing electric or mechanical energy according to any of the previous claims, **characterised in that** around the initial high temperature gasses and fumes collection chamber a double walled casing is provided, in which can be made to circulate and heat the aeriform fluid flowing in the intermediate heat exchange circuit.

10. Apparatus for producing electric or mechanical energy according to any of the previous claims and where the high temperature gasses or fumes source is a biomass combustor or similar, characterised furthermore by a circuit to direct a part of the aeriform fluid flow to cool the grate or parts of the combustion chamber of said combustor.

11. Apparatus for producing electric or mechanical energy according to any of the previous claims, **characterised in that** a valve usually closed and intended to open is associated with the high temperature initial collection chamber to discharge the gasses and fumes should the operating fluid fail to absorb the heat power.

12. Apparatus for producing electric or mechanical energy according to claim 10 and where the operating

fluid is organic, further **characterised in that** it includes organic fluid presence sensors in the aeriform fluid circuit to enable stopping of the aeriform fluid circulation in the intermediate circuit and opening of a discharge valve of the high temperature gasses or fumes in the collection chamber in answer to the presence of organic fluid in the aeriform substance.

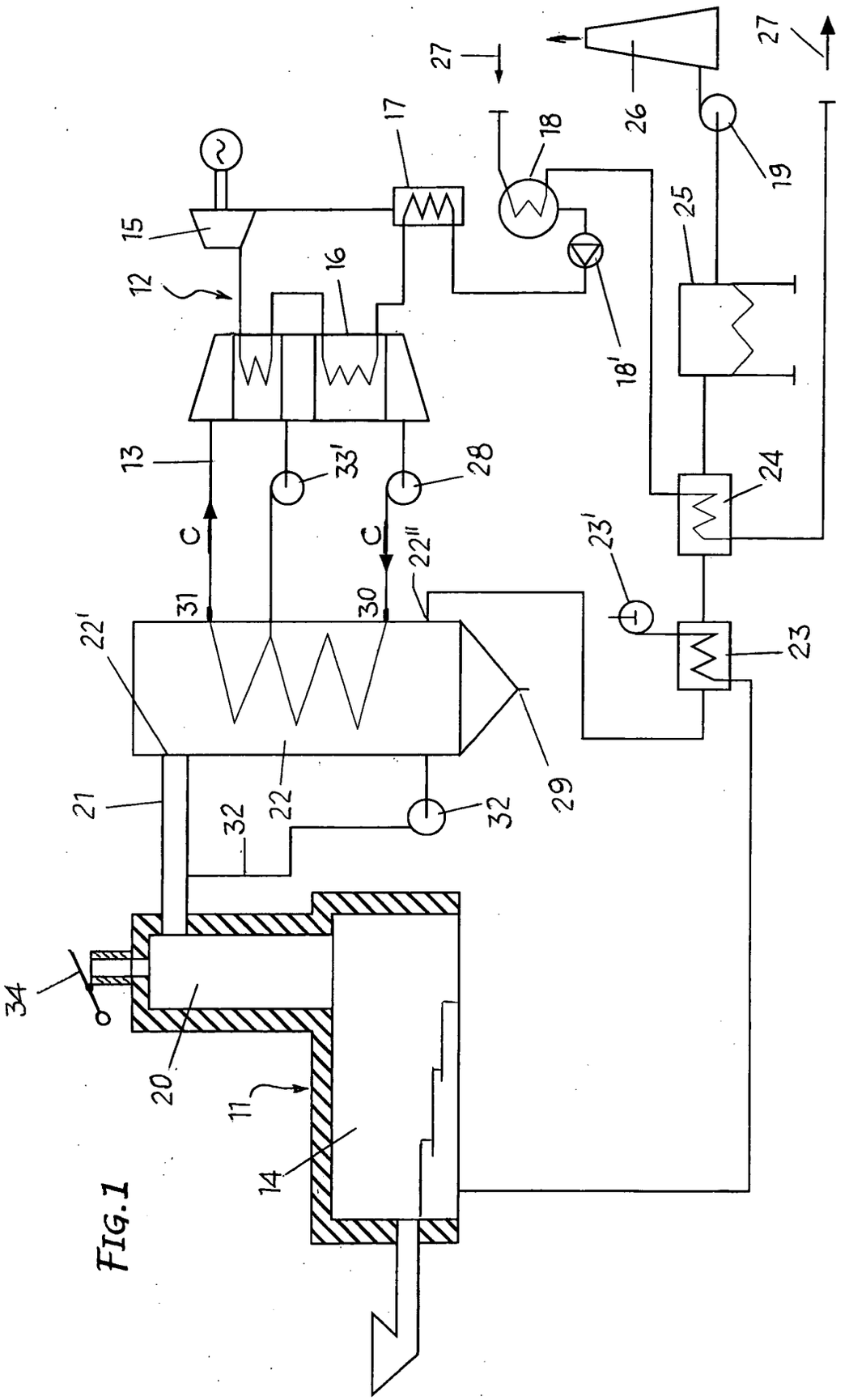
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FIG.1

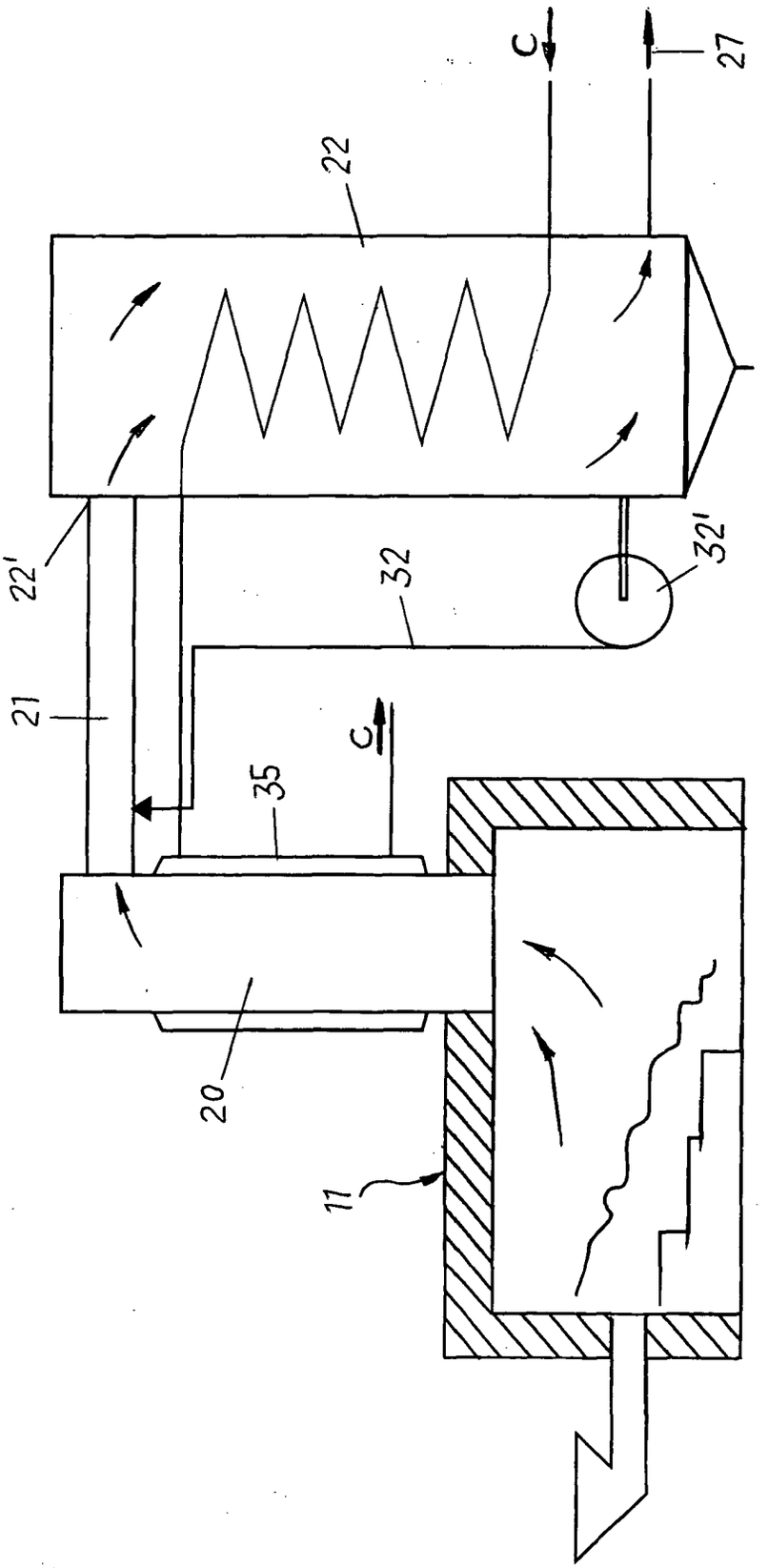

FIG.2

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EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5916

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 May 2005	Zerf, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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