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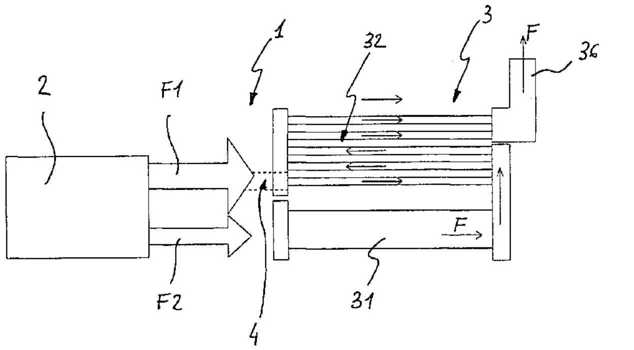

Fig. 2

(57) Abstract: The subject of the disclosed invention is a heat generator (3) for thermal energy production connected through a conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205) to one or multiple heat sources (2). The hot gases (Fl, F2) generated by said one or multiple heat sources (2) are carried through said conveyor (4) to said heat generator (3) for recovery of their enthalpy content.

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HEAT RECOVERY APPARATUS

DESCRIPTION

The present invention refers to an apparatus for recovering thermal energy from the exhaust fumes and gases of heat engines and from the cooling and ventilation air and/or any of the components or auxiliary circuits of the same plants, or of other plants.

In particular, the invention refers to heat generators adapted to serve as heat recovery apparatuses.

More particularly, said heat generators are fire-tube apparatuses.

The invention is especially useful to realize electrical and thermal energy cogeneration plants, particularly in the micro cogeneration sector.

Cogeneration (or "combined production") is essentially based on using the heat generated by the electricity production phase of thermoelectric generators; such "residual" energy can be used as a heat source for heating buildings or for production and industrial purposes.

A major advantage of micro cogeneration is that it enables widespread, small-scale distributed production of electrical energy for households, the tertiary sector and small-sized industries, whose power requirements are relatively modest.

The spread of micro cogeneration has been hampered by the difficulty of meeting minimum cost per unit of power, yield, reliability and efficiency requirements in small-sized devices. As a consequence, current cogeneration systems range from 100 - 300 kW to several MW.

The micro cogeneration market offers substantially two options that are based on the same energy generation concept, but on two different types of prime mover. In particular, micro gas turbines can be employed in the 50 to 100 kW range, whereas alternative internal combustion engines with a Diesel or, preferably, an Otto cycle can be used for smaller plants.

The thermal energy produced by the functioning of a prime mover (be it an internal combustion engine or a micro gas turbine) is partly dissipated in the external environment by radiation; while this fraction can effectively be reduced, most of the thermal energy is transferred to the combustion gases (whose temperature in fact ranges from 350 to 600 °C) discharged to the flue and to the cooling air of various engine components and auxiliary circuits.

Heat is not usually recovered from cooling air, essentially due to its low enthalpy and convective heat transfer coefficient, which would require exchangers endowed with large exchange surfaces, adversely affecting the cost/benefit ratio of the cogenerator. Only rarely is cooling air harnessed to heat water, generally in alternative internal combustion engines.

In contrast, devices have already been developed to recover heat from prime mover exhaust fumes, despite their not very high enthalpy and, especially, the risk of acid condensation during cooling.

Such devices are usually fitted downstream of the prime mover; they may be exchangers (also known as recuperators), which use the heat of the combustion fumes, for example to preheat the combustion air, or recovery furnaces, where the fumes are further burned or merely cooled via heat exchangers, preferably dedicated to production of steam, hot water or superheated water. However, apparatuses for the recovery of the enthalpy of prime mover combustion gases and fumes have a major drawback: their close integration with the engine itself.

As a consequence, malfunction of the prime mover or the heat recovery apparatus can compromise the overall efficiency of the cogeneration system. In addition, separate maintenance of the engine and the heat recovery apparatus is difficult, since it generally requires also the shutdown of the component functioning correctly.

Moreover regulation devices are needed, to provide the thermal energy recovered at the temperature required by the user.

Altogether, current heat recovery apparatuses are relatively expensive in terms of the gains they provide (recovery of prime mover thermal loss).

Finally, it is not always simple to transport the heat energy thus recovered to possible users.

If, as noted above, the enthalpy of the cooling air of a prime mover and its auxiliary circuits is difficult to reuse, its recovery from the various heat sources of an industrial plant, e.g. the cooling system of a plastic stamping plant; hot air from industrial painting plants; or exhaust fumes from elderly, poorly efficient industrial furnaces and boilers, is even harder.

Clearly, also in these cases the main issue is the cost/benefit ratio, since ad hoc exchangers and heat energy transport plants are needed for each heat source.

A first object of the disclosed invention is to devise a simple and economical heat recovery method in relation to the amount of thermal and electrical power involved.

A second object of the invention is to devise a heat recovery method characterized by low pollutant emissions and environmental impact.

An additional object of the invention is to devise a heat recovery method characterized by high flexibility in terms of the amount of heat to be recovered.

A further object of the disclosed invention is to devise a heat recovery method characterized by high flexibility in terms of the number and type of plants from which heat can be recovered.

A still further object of the present invention is to devise a method to integrate the heat recovery and production systems with electricity and/or mechanical power production plants.

Another object of the invention is to devise high flexibility means to integrate a prime mover and a fire-tube boiler in terms of the amount of electrical power to be integrated.

Additional objects and advantages of the disclosed invention are better demonstrated by the following detailed description of a preferred embodiment, made in line with the patent claims and with reference to attached diagrams reported purely by way of example and not intended to limit the invention, where:

- figure 1 is a schematic perspective view of a heat generator according to the prior art;
- figure 2 is a block diagram of a heat recovery apparatus according to the disclosed invention;
- figures 4a, 4b, and 4c report three side and front cross-sections of the apparatus illustrated in figure 2, with emphasis on the heat generator according to a first variant of the invention.
- figures 5a and 5b are two side and front cross-sections of the apparatus shown in figure 2, with special reference to the heat generator, according to an additional variant of the invention;
- figure 5c reports a detail of the variant shown in figures 5a and 5b.

In figure 2 of the attached diagrams 1 indicates overall the heat recovery apparatus, the subject of the invention, which includes one or multiple generic heat sources 2 and a heat generator 3.

As noted above, said generic heat sources 2 can be electrical and/or mechanical power generators, such as internal combustion engines, micro gas turbines, steam turbines, fuel cells; simpler heat sources such as low-efficiency heat generators, whose fumes can still be used to extract thermal energy; and even simpler devices such as heat exchanger batteries of cooling systems of plants such as plastic stamping or extrusion machines.

During operation, said heat sources 2 emit heat substantially as hot gases, i.e. combustion gases F1 and/or cooling and ventilation air F2 heated by the cooling of various types of equipment.

Said heat sources 2 can be for instance:

- internal combustion engines and micro gas turbines, where heat is generated both as combustion gases F1 and as auxiliary circuit cooling and ventilation air F2,
- low-efficiency heat generators, where heat is generated in the form of combustion gases F1,
- heat exchanger batteries of cooling systems, where heat is generated as cooling and ventilation air F2.

Hot gases F1 and F2, generated by said heat sources 2, are often insufficient in amount and/or temperature for heat recovery to be feasible and/or economical through individual recovery apparatuses.

Figures 1 and 2 schematically show the combustion chamber (or furnace) 31, the heat exchanger 32, and the flue 36 of the heat generator 3.

According to the disclosed invention the enthalpy of the hot gases F1 and F2 issuing from the heat source 2 is recovered by said generator 3.

More precisely, the combustion gases F1, whose temperature is sufficiently high, are sent to the exchanger 32 to transfer heat, whereas the cooling air F2 is used in the same generator 3 as combustion air for the furnace 31.

Other operating conditions are not excluded, such as those where the cooling air F2 is sufficiently hot to be treated like the combustion gases F1 and is accordingly sent to the exchangers 32, or vice versa, conditions where combustion gases F1, similar to cooling air F2 due to low temperature or high oxygen content, need to be sent to the furnace 31 together with the combustion air, provided they do not adversely affect oxygen combustion.

The heat generator 3 is preferably a type for production of steam and/or hot water and/or diathermic oil; in particular, it is a fire-tube boiler (see figure 1).

Since the technology and operating principles of the fire-tube boiler 3 (henceforth the boiler) are well known, a short description will suffice here.

The features of the fire-tube boiler 3 shown in the schematic view of figure 1 and in figures 4a through 5c are a furnace 31, usually cylindrical, where combustion occurs, and a number of pipes 33, constituting overall the exchanger 32, carrying the exhaust gases. Said pipes 33 are arranged into bundles (or fume circuits) in which the gases course, passing through the boiler 3 once or multiple times. The furnace 31 and pipes 33 are surrounded by water A (in liquid and steam state); the water is contained in a cylindrical vessel 38 fitted at either end with pipe plates 3801 for the insertion of the furnace 31 and pipes 33.

More in particular (see for instance figure 4a), the exhaust gases issuing from the furnace 31, which coincides with the first fume circuit 3101, pass through a first inversion chamber 34; from said chamber they are sent, confined above by a partition 3401, into the pipes 33 of the second fume circuit 3302, and from there to a second inversion chamber 35, which is usually found on the front of the boiler 3 (note the direction of the arrows F on various pipes 33 in figure 1), and finally, sufficiently cooled after coursing through the third fume circuit 3303, they are conveyed to the flue 36.

A hatch 37 for inspection and maintenance, commonly found on the front of the boiler 3, is schematically drawn in figures 4a through 5c.

Upstream of the furnace 31 the boiler 3 also includes at least a burner and the respective fan (or blower), to supply combustion air (not shown in the figures).

All known components of the boiler 3 have now been described.

In the disclosed invention a conveyor 4 carries said combustion gases F1 to at least one part of the exchanger 32, to recover their thermal energy.

The inspection hatch 37 is modified compared with the prior art, to accommodate the conveyor 4 passing through it.

Said conveyor 4 is characterized by an outer part 41 connected directly, or indirectly through ducts, to said one or multiple heat sources 2, to collect their combustion gases F1, and by an inner part 42, which is designed to couple to one or more pipes 33 of the heat exchanger 32 of the fire-tube boiler 3, in particular one or more pipes 33 of at least the third fume circuit 3303, and whose opening 4201 presses against the front pipe plate 3801.

The internal part 42 is designed to rotate and translate axially with respect to the outer part 41, where it is partially inserted, to allow coupling of the conveyor 4 to one or multiple pipes 33, as required by the flow rate and temperature of the combustion gases F1, or to prevent the conveyor 4 from interfering with said pipes 33 if no combustion gases F1 from which energy can be recovered are present.

Therefore, as shown in figures 4a to 4c, said conveyor 4 is preferably a telescopic conduit consisting of an outer part 41 coupled hermetically to the inspection hatch 37, and of an inner part 42 capable of rotation and axial translation with respect to the outer part 41, where it is partially inserted, via a telescopic coupling 5 (schematically represented in the enclosed figures). In particular, said rotation is enabled by the circular conduit tracts 4101 and 4205 of said joint 5, to which the outer 41 and inner part 42 of the conduit 4 are coupled (see in particular figure 5c).

As an example, which in no way limits the scope of the invention, the opening 4201 of the mobile internal part 42 is preferably elliptical and/or circular.

Axial translation of the inner part 42 with respect to the fixed external part 41 enables the opening 4201 to approach the pipe plate 3801 within the inversion chamber 35, to intercept said one or more pipes 33, whereas its rotation selects the pipes 33 of said plate 3801 that will carry the combustion gases F1 of the heat source 2, and consequently the number of passes of the combustion gases F1 through the heat generator 3.

As depicted in figures 4a to 4c, and 5a to 5c, said pipes 33, intercepted by said opening 4201, therefore define the part 3201 of the heat exchanger 32 of the boiler 3 dedicated to cooling the sole combustion gases F1 of said one or multiple heat sources 2.

For instance, as shown in figure 4a, the conduit 4 is capable of connecting to a suitable number of pipes 33 belonging solely to the third fume circuit 3303, whereas, as clearly shown in figures 4b and/or 4c, the inner part 42 of the conduit 4, as a result of its rotation, can connect simultaneously to multiple pipes 33 of the third circuit 3303 and to at least one pipe 33 of the second circuit 3302.

In the case depicted in figure 4a, the combustion gases F1 of the heat source 2 therefore course through the heat generator 3 just once, via the third fume circuit 3303, whereas in the example illustrated in figure 4b and/or 4c, part of said combustion gases F1 pass through the boiler 3 three times.

In fact, as shown in figures 4b and 4c, part of said gases F1 pass through the boiler 3 in front to back direction, through one or more pipes 33 of the second fume circuit 3302, their direction is then reversed in the inversion chamber 34, whence they pass through those pipes 33 of the second fume circuit 3302 that are not intercepted by the opening 4201 of the conduit 4, and subsequently they pass through the third and last fume circuit 3303, before finally going to the flue 36.

Clearly, the pipes 33 of any fume circuit that are not intercepted by the opening 4201 continue to carry the products of the internal combustion of the boiler 3, or a mixture of said products and said combustion gases F1 (like the pipes 33 of the second circuit 3302, not exclusively dedicated to carrying the same combustion gases F1, shown in the example of fig. 4b) along the direction of the arrows F and of their vector representation (depicted in the enclosed figures, where "x" indicates a vector pointing into the page and "·" a vector pointing out of the page).

Similar considerations also apply to the variant shown in figures 5a to 5c, which differs from the previous configuration by the circular (rather than generically elliptical) section of the opening 4201 of the conduit 4.

In the latter case, for the rotation of the inner part 42 of the conduit 4 to serve the purposes described above, the centre of the opening 4201 must be offset with respect to the centre of the fixed external part 41.

In figure 5c, the inner part 42 has a first tract 4202, whose axis is parallel to the fixed outer part 41, and another tract 4203 (designed to couple through its own opening 4201 to the pipe plate 3801), whose axis is parallel to the first; the two tracts 4202 and 4203 are connected through a junction 4204.

The conduit 4 is completed by an interception organ 43, e.g. a butterfly valve 43, positioned in the fixed part 41, designed to exclude the heat source 2 from the boiler 3 in case of malfunction or maintenance, or in the event that the heat recovery apparatus 1 of the disclosed invention is operated as a traditional fire-tube boiler 3.

In the latter case the valve 43 must therefore be closed, while the mobile inner part 42 of the conduit 4 is retracted inside the fixed part 41, so that all the pipes 33 of the boiler 3 carry exclusively the products of its internal combustion.

One or more magnets (not shown) can also be fitted in close proximity to the opening 4201 of the conduit 4, for an enhanced coupling of the conduit 4 and the pipe plate 3801, and thus a perfect seal. Alternatively, any means known in the prior art can be used to press the opening 4201 against the pipe plate 3801.

According to possible variants of the invention, an additional fan (not shown) can be applied to the flue 36, to enhance circulation of the combustion gases F1 through the fire-tube boiler 3, by forcing them through said pipes 33 of its exchanger 32.

The above description clearly demonstrates that the appropriate number of pipes 33 intercepted by the conduit 4 and the number of passes of the combustion gases F1 through the boiler 3 depend on multiple factors such as the temperature of the combustion gases F1 at the exit from the one or multiple heat sources 2, their amount and, more generally, their thermal energy.

The configurations shown in figures 4a and 5a (envisaging a single pass of the combustion gases F1 through the boiler 3) are preferable where the thermal power dissipation (and/or temperature) of the combustion gases F1 is low, whereas those shown in figures 4b and 4c, 5b, or any other configuration envisaging three passes of the gases F1 through the boiler, are preferable with higher values of thermal power dissipation. In any case, the number of pipes 33 intercepted by the conduit 4 and, consequently, the number of passes of the gases F1 through the boiler 3, are aimed to achieve the lowest possible temperature of the combustion gases F1 at the exit from the boiler 3.

If the physical parameters (i.e. temperature and flow rate) of the combustion gases F1 are expected to be substantially stable over time, the configuration (particularly the rotation angle of the mobile internal part 42 of the conduit 4) can be selected manually.

However, it is preferable to have an electronic control unit selecting the most appropriate configuration of the conduit 4 in response to the changes in said physical parameters, which are detected through special sensors.

Clearly, the larger the portion 3201 of the heat exchanger 32 dedicated to the combustion gases F1, the smaller the thermal power that can be supplied to the furnace 31, but modulation of such power is automatically provided by control means with which the heat generator 3 is usually endowed. In fact the power supplied to the furnace is modulated by the user's demand for heat energy, which is met with lower furnace 31 loads if combustion gases F1 are present.

As noted above, the one or multiple heat sources 2 may entail the possibility of recovering in the boiler 3, besides the combustion gases F1, the thermal energy of the cooling and/or ventilation air F2, for instance of engine components and auxiliary circuits of the heat source 2 itself, which would otherwise be dispersed in the environment.

According to a preferred and advantageous embodiment, cooling and/or ventilation air F2, warmer than the ambient temperature (from 60 °C to 90 °C), is sent by known means directly to the furnace 31 of the boiler 3 and used as combustion air. From this viewpoint the heat source 2 therefore serves as a preheater unit of the combustion air for the internal combustion of the boiler 3.

Recovery of such additional heat energy in the boiler 3, coupled to the heat recovered from the combustion gases F1, therefore increases the overall efficiency of the heat recovery apparatus 1, which is subject of the invention.

In fact it is well known that the efficiency of a boiler 3 for production of hot water and/or steam is a function of the temperature of inlet air in the burner of the furnace 31 and of the exhaust fumes: the closer the inlet air temperature to the gas temperature at the flue 36, the better the thermal yield of the boiler 3 and therefore of the heat recovery apparatus 1 overall.

Clearly, numerous additional variants of the disclosed heat recovery apparatus 1 are possible, to the person skilled in the art, without exceeding the scope of the appended claims; moreover the various components described above can be replaced with technically equivalent elements upon practical realization of the invention.

The heat source 2 is preferably a prime mover for electrical energy production. Even more preferably such prime mover 2 is, as noted above, an internal combustion engine or a micro gas turbine, two well-established and reliable technologies that require no further description. The heat recovery apparatus 1 according to this preferred embodiment is therefore a cogeneration plant for combined electrical and thermal power production, to which all the above considerations apply.

Compared with the prior art, in the present case the prime mover 2 can lack the traditional integrated recuperator, since it is connected (through said conveyor 4) to the boiler 3, where the heat that would otherwise be dissipated as combustion gases F1 and cooling and/or ventilation air F2 is efficiently recovered.

According to another embodiment the prime mover 2 (or in general the heat source 2) can be joined, through the telescopic conduit 4, to the back of the fire-tube boiler 3, rather than at the level of the inspection hatch (suitably modified to house said conduit 4) as described above.

According to a highly simplified variant of the cogeneration apparatus 1 (or in general the heat recovery apparatus 1), and particularly of the conveyor 4, the mobile inner part 42 is capable only of axial translation with respect to the fixed part 41, not also of rotation. Such configuration is especially practical, as noted above, when the physical parameters of the combustion gases F1 are substantially constant over time and the part 3201 of the heat exchanger 32 dedicated to said combustion gases F1 can be selected manually.

In a further simplified variant the conveyor 4 includes only the external part 41 (henceforth, for the sake of simplicity, the conduit 41), hermetically coupled to the inspection hatch 37 but capable of axial translation to connect to the pipes 33 of the exchanger 32 of the boiler 3 dedicated to said combustion gases F1.

It is therefore clear that the apparatus for heat recovery 1 described above in its

preferred embodiment and variants can achieve the intended goals, particularly heat recovery from diverse types of machines in a simple and economical way.
For instance, in the case where the heat source 2 is a prime mover (even though the reasoning also applies to the more general case of any alternative heat source 2), the possibility to dedicate part of the heat exchanger 32 of the boiler 3 to cooling the sole combustion gases F1 of said prime mover 2 and to recover cooling and/or ventilation air F2 significantly enhances the overall efficiency of the cogeneration apparatus 1 and allows nearly total recovery of its thermal loss.
It is also clear that integration of an existing boiler 3 with an engine 2 suitable for electricity generation can be achieved with a modest investment by any user, who can select the most appropriate size for their level of consumption. Said cogeneration apparatuses 1 are therefore capable of meeting also a user demand characterized by high thermal and low electrical power production. This is easily achieved by replacing the standard hatch 37 of the fire-tube boiler 3 with an additional hatch capable of housing and supporting the conveyor 4.
Integration of a micro gas turbine or an internal combustion engine with an existing or a commercial boiler 3 also significantly reduces their specific cost, since it obviates the need for closely integrated internal devices to recover exhaust fumes (and/or cooling air), as in the known art.
The disclosed cogeneration apparatus 1 is also characterized by a longer service life than traditional systems, to the extent that it enables separate maintenance or replacement of the prime mover 2 and the fire-tube boiler 3, where needed; in addition, repair or replacement of either component does not involve the interruption, even temporary, of electrical and/or thermal power generation.
Finally, the heat generator 3 can also be a water-tube boiler.

CLAIMS

Clm. 1 Heat generator (3) for production of thermal energy including:

- at least one furnace (31), where combustion occurs,
- one heat exchanger (32; 3201, 3101, 3302, 3303), where combustion products are cooled, and
- a flue (36) for their discharge into the atmosphere,

characterized in that

it is connected via a conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205) to one or multiple heat sources (2), said conveyor (4) carrying hot gases (F1, F2) discharged by said one or multiple heat sources (2) to said heat generator (3) to recover enthalpic content.

Clm. 2 Heat generator (3) according to the previous claim

characterized in that

said hot gases (F1, F2) discharged by said one or multiple heat sources (2) are combustion gases (F1), said combustion gases (F1) being sent via said conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205) to transfer heat to a part (3201) of said exchanger (32; 3201, 3101, 3302, 3303) that is therefore capable to be used only for cooling said combustion gases (F1).

Clm. 3 Heat generator (3) according to any previous claim

characterized in that

it is a fire-tube boiler (3) for production of steam and/or hot water and/or diathermic oil, said heat exchanger (32; 3201, 3101, 3302, 3303) thus being a multi-pipe type (33), arranged in one or multiple fume circuits (3101, 3302, 3303) and designed to transfer heat to water (A) contained in the outer container (38), with each extremity of said container (38) being fitted with a pipe plate (3801) for insertion of said pipes (33) and said furnace (31).

Clm. 4 Heat generator (3) according to the previous claim

characterized in that

said conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205), designed to carry said combustion gases (F1) from said one or multiple heat sources (2) to said heat generator (3), comprises:

- an outer part (41) connected to said one or multiple heat sources (2) designed to collect said combustion gases (F1)
- an inner part (42) devised to couple, at its opening (4201), to said pipe plate (3801) so as to intercept one or more pipes (33) of said heat exchanger (32; 3201, 3101, 3302, 3303), said one or more pipes (33) identifying the part (3201) of said heat exchanger (32; 3201, 3101, 3302, 3303) dedicated to cooling said combustion gases (F1)

Clm. 5 Heat generator (3) according to the previous claim

characterized in that

said inner part (42) is capable of being shifted towards said pipe plate (3801), so as to intercept said one or more pipes (33), thus identifying the part (3201) of said heat exchanger (32; 3201, 3101, 3302, 3303) dedicated to cooling said combustion gases (F1), or is capable of being moved away from said pipe plate (3801), so that all fume pipes (33) of said heat exchanger (32; 3201, 3101, 3302, 3303) convey exclusively the products of the combustion occurring in said furnace (31) of said generator (3).

Clm. 6 Heat generator (3) according to the previous claim

characterized in that

said inner part (42) translates axially with respect to said external part (41) in which it is partially inserted, said internal (42) and external parts (41) being joined through a telescopic coupling (5; 4101, 4205).

Clm. 7 Heat generator (3) according to the previous claim

characterized in that

said telescopic coupling (5; 4101, 4205) has circular sections (4101, 4205), said inner part (42) thus being capable of rotation with respect to said external part (41), in which it is partially inserted.

Clm. 8 Heat generator (3) according to any previous claim

characterized in that

the centre of said opening (4201) is on the same axis as said external part (41), said opening (4201) having such a section as to define, by effect of its rotation, said part (3201) of the heat exchanger (32; 3201, 3101, 3302, 3303) dedicated to cooling said combustion gases (F1).

Clm. 9 Heat generator (3) according to any one of the previous claims excepting claim 8,

characterized in that

the centre of said opening (4201) of said inner part (42) is offset with respect to said external part (41), said opening (4201) defining, by effect of its rotation, said part (3201) of the heat exchanger (32; 3201, 3101, 3302, 3303) dedicated to cooling said combustion gases (F1).

Clm. 10 Heat generator (3) according to any previous claim

characterized in that

said conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205) is housed in and passes through the inspection hatch (37) of said heat generator (3), said external part (41) of said conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205) being hermetically coupled to said inspection hatch (37).

Clm. 11 Heat generator (3) according to any previous claim

characterized in that

said conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205) also comprises an interception organ (43) designed to exclude said one or multiple heat sources (2) from said heat generator (3), said interception organ (43) being specifically a butterfly valve located on said external part (41).

Clm. 12 Heat generator (3) according to any previous claim

characterized in that

said part (3201) of the heat exchanger (32; 3201, 3101, 3302, 3303), intercepted and defined by said conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205), includes one or more pipes (33) of the second (3302) and/or third (3303) fumes circuit.

Clm. 13 Heat generator (3) according to any previous claim
characterized by
being installed and in operation or already on the market, said inspection hatch (37), in which said conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205) is housed and passes being an auxiliary hatch to replace the standard hatch on said heat generator (3).

Clm. 14 Heat generator (3) according to any previous claim
characterized in that
said hot gases (F1, F2) discharged by said one or multiple heat sources (2) also include cooling and/or ventilation air (F2) heated by cooling of various devices of said one or multiple heat sources (2), said cooling air (F2) being used to support combustion in said furnace (31).

Clm. 15 Heat generator (3) according to any previous claim
characterized in that
said one or multiple heat sources (2) consist in engines and/or low efficiency heat generators and/or cooling batteries.

Clm. 16 A conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205) for transport of hot gases (F1, F2) from one or multiple heat sources (2) to a heat generator (3) for recovery of enthalpic content, according to one or more of the previous claims.

Clm. 17 Apparatus for heat recovery (1) including a heat generator (3) and one or multiple heat sources (2), said generator (3) and said one or multiple heat sources (2) being interconnected by a conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205), according to one or more of the previous claims.

Clm. 18 Apparatus for heat recovery (1) according to the previous claim characterized in that it is a cogeneration apparatus (1), said one or multiple heat sources (2) being an engine (2) for electrical and/or mechanical power production.

Clm. 19 Recovery method for a heat generator (3) of the enthalpic content of hot gases (F1, F2) discharged by one or multiple heat sources (2), according to any of the previous claims

characterized in that

said one or more pipes (33), which are designed to be intercepted by said conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205), and which define said part (3201) of said heat exchanger (32; 3201, 3101, 3302, 3303) dedicated to cooling said combustion gases (F1), are selected manually, the physical parameters characterizing said combustion gases (F1) being essentially stable over time, said physical parameters being specifically flow rate and/or temperature.

Clm. 20 Recovery method for a heat generator (3) of the enthalpic content of hot gases (F1, F2) discharged by one or multiple heat sources (2), according to any one of the previous claims excluding claim 19

characterized in that

said one or more pipes (33), which are designed to be intercepted by said conveyor (4; 41, 4101, 42, 43, 4201, 4202, 4203, 4204, 4205) and which define part (3201) of said heat exchanger (32; 3201, 3101, 3302, 3303) dedicated to cooling said combustion gases (F1), are automatically selected through special sensors by an electronic control unit based on the variation, instant for instant, of the physical parameters of combustion gases (F1), said physical parameters being specifically flow rate and/or temperature.

Fig. 1

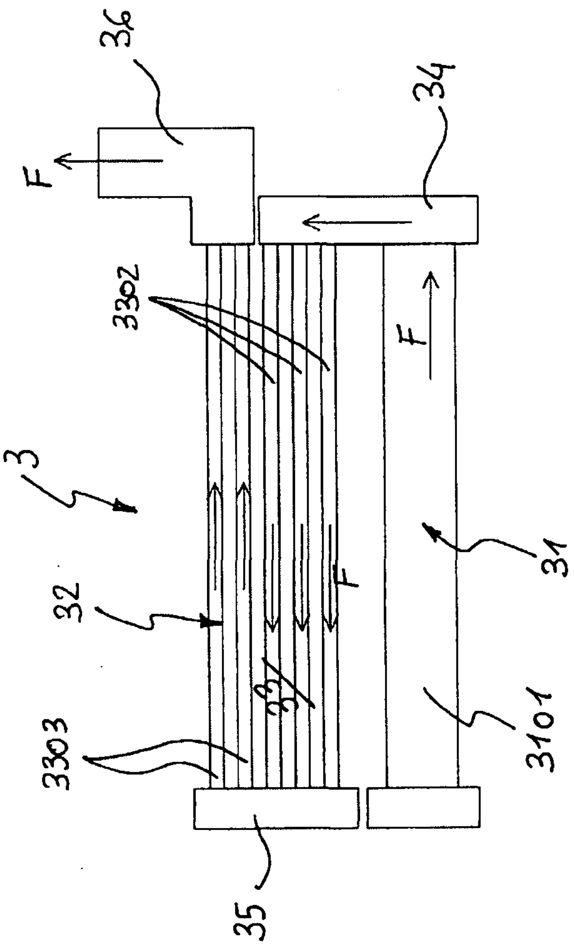
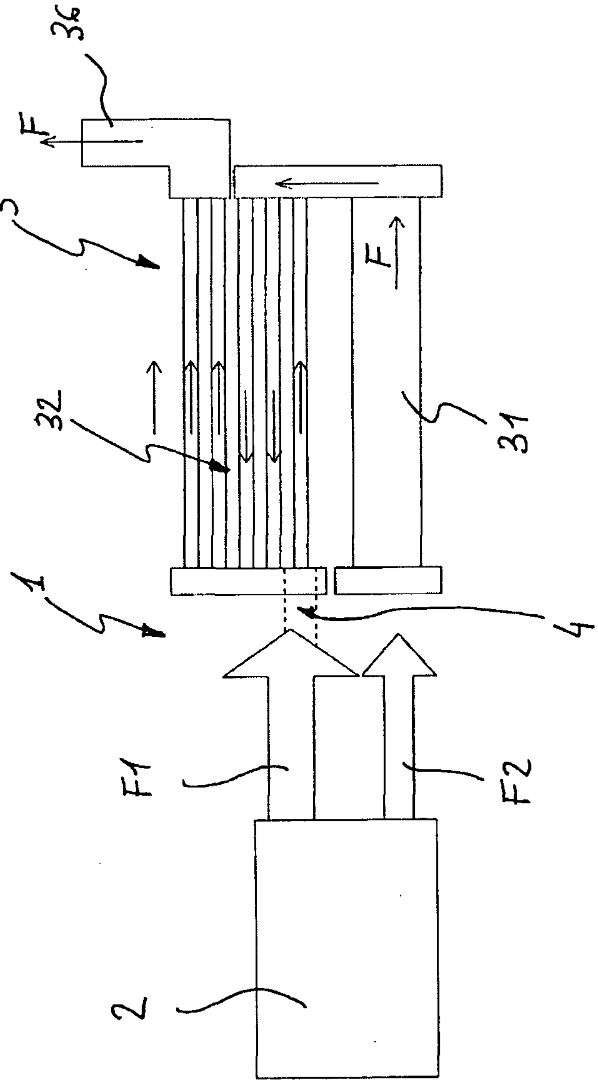


Fig. 2



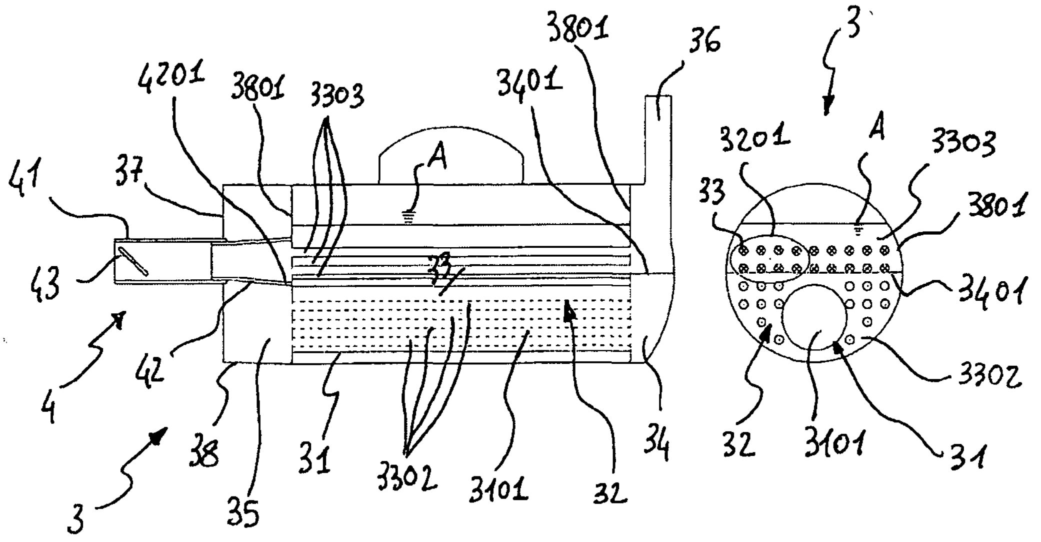


Fig. 4a

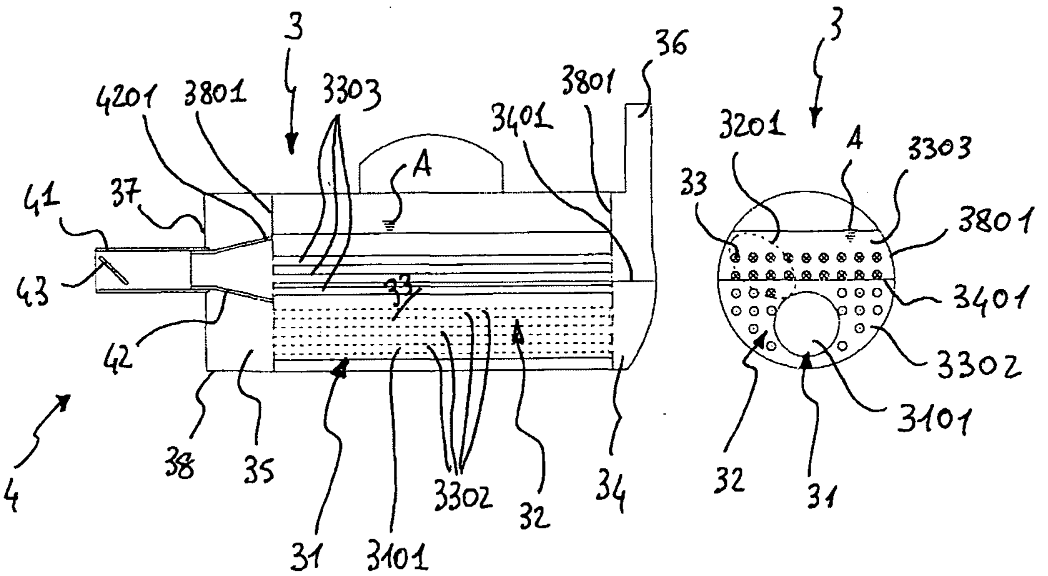


Fig. 4b

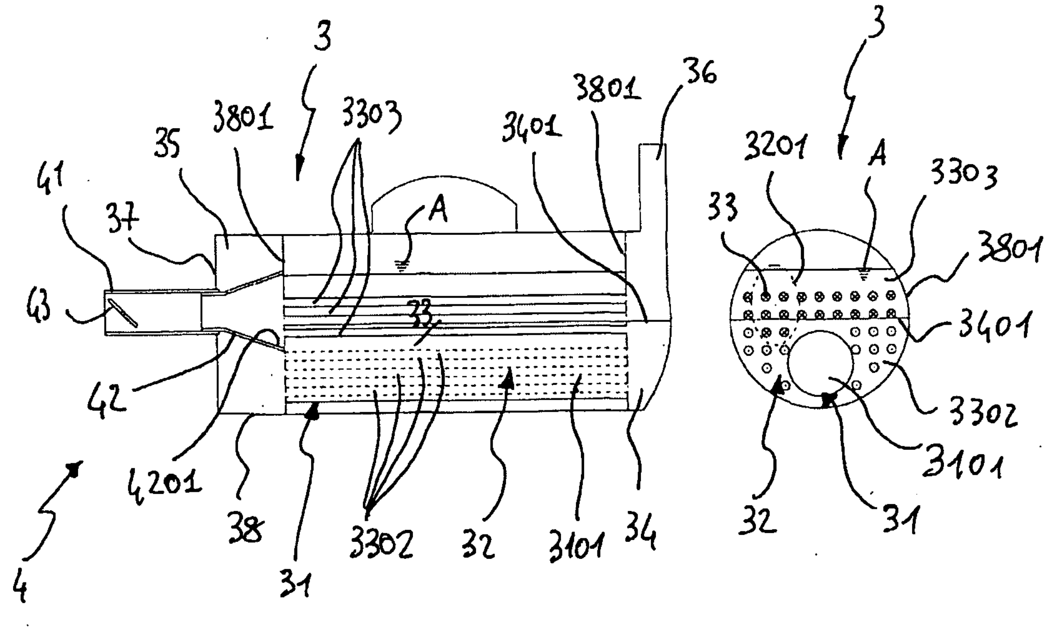


Fig. 4c

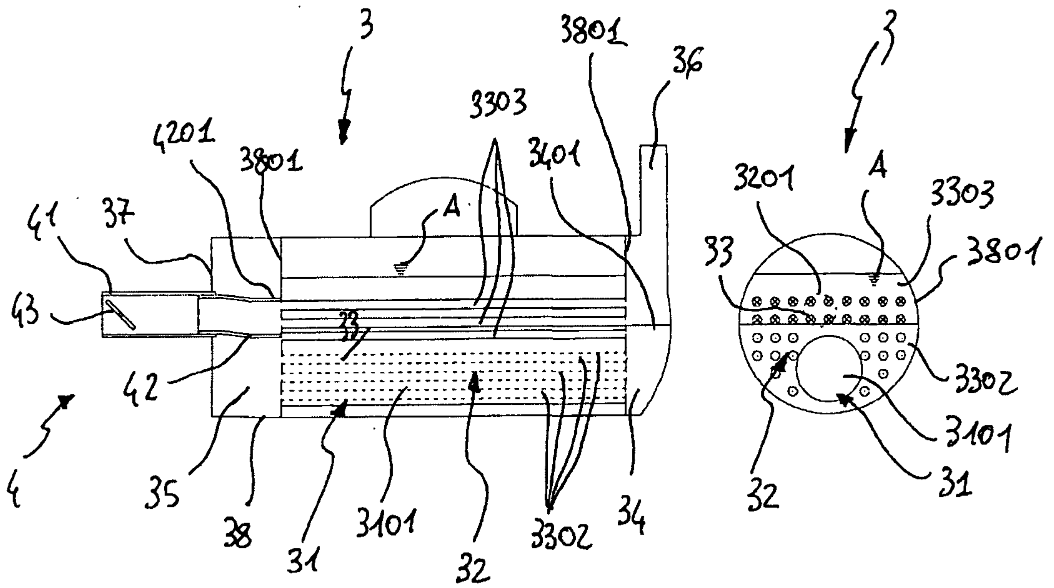


Fig. 5a

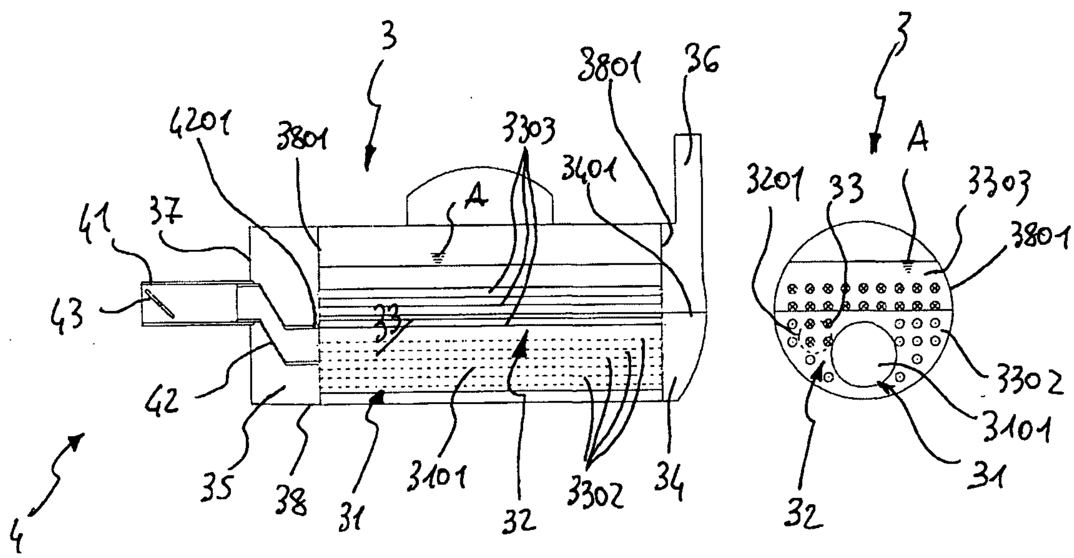


Fig. 5b

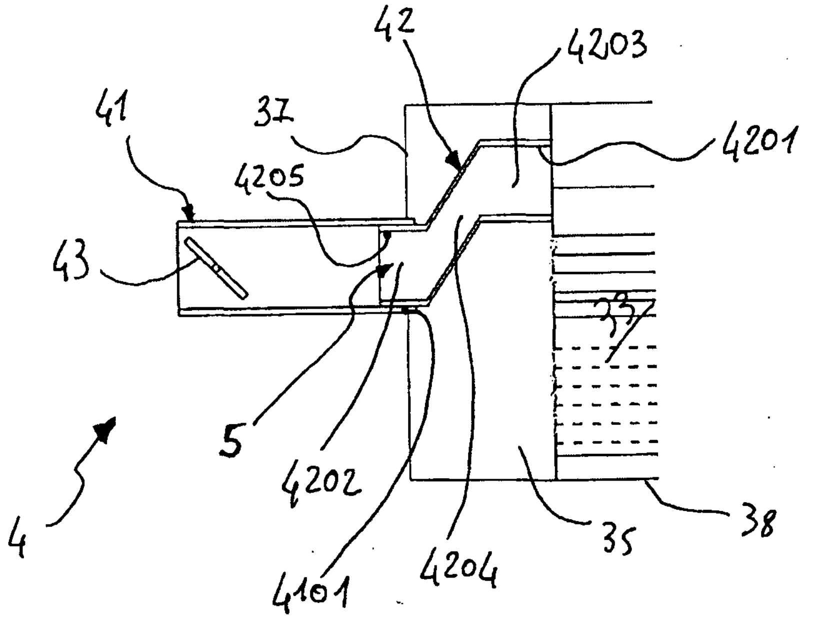


Fig. 5c

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/001174

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24H1/28 F24H9/00 F28D1/04 F28D7/00 F28D7/16 F28F27/02
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24H F28D F28F

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 4 313 399 A (BLACK ROBERT B) 2 February 1982 (1982-02-02) columns 5-9; figures 3,6-7	1,14,15
X	GB 236 352 A (FRANCIS ALBERT GARRETT; RANSOMES SIMS & JEFFERIES LTD) 9 July 1925 (1925-07-09) page 2; figure 1	1,2,15, 18
A	DE 33 04 455 A1 (ABIG WERKE CARRY GROSS GMBH [DE]) 9 August 1984 (1984-08-09) figures 1-7	4,5

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

[X] See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 October 2010	22/10/2010

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

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/001174

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DE 43 44 175 A1 (VIESSMANN WERKE KG [DE]) 29 June 1995 (1995-06-29) figure 1	4-6
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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