A DEVICE FOR RECOVERY OF FLUE-GAS HEAT OF A DOMESTIC BOILER

Abstract: The present invention regards a device (1) for recovery of flue-gas heat of a boiler of a domestic or industrial type. The device (1) comprises a first tubular element (10), which is operatively connected to the boiler so as to be traversed by the flue gas. Appropriate heat exchanger means are housed within the first tubular element (10) in order to transfer the thermal energy of the flue gas to water at lower temperature circulating within the heat exchanger means themselves. The device (1) according to the invention has advantageously a dual functionality; namely, it enables at the same time discharge of the flue gas out of the boiler and recovery of the heat possessed by the flue gas itself.
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A DEVICE FOR RECOVERY OF FLUE-GAS HEAT OF A DOMESTIC BOILER

DESCRIPTION

The present invention relates to a device for recovery of flue-gas heat of a boiler normally used in domestic or industrial environments.

As is known, boilers are thermal apparatuses traditionally used for heating water that is to be introduced into a heating circuit or else that is to be used by the users for personal needs.

Boilers traditionally comprise a combustion chamber in the proximity of which there is housed a heat exchanger, referred to as primary heat exchanger, having the purpose of providing heating of the water. The flue gas produced following upon the phenomenon of combustion possesses, as known, a high thermal energy that can advantageously be recovered in order to pre-heat the water entering the primary heat exchanger. This enables a limitation of the amount of fuel consumed since the thermal jump involved becomes smaller given the same final temperature required of the water leaving the boiler.

In order to recover said thermal energy, devices for recovery of flue-gas heat, referred to as "economizers", are traditionally used. They usually comprise heat exchangers, referred to also as secondary heat exchangers, located inside the boiler along the path used for discharge of the flue gas towards the outside.

An example of boiler provided with a secondary heat exchanger is proposed in the patent application EP 0945688. In particular, in this technical solution, similar to many others in the sector, the secondary heat exchanger is constituted by a bank of tubes housed in a container within the boiler casing. The tubes are traversed internally by water, and the outside of the tubes is lapped by the combustion fumes conveyed inside the container by means of a fan. By means of a convection-conduction heat exchange, the thermal energy of the flue gas is transferred from the flue gas to the water. In order to favour this heat exchange, the solution illustrated envisages the use of a partition wall, which, by separating the inlet of the flue gases from the outlet, enables said flue gases to follow a pre-defined path.

Instead, the patent application No. EP1243866 illustrates a secondary heat exchanger for boilers made up of a plurality of tubes maintained in their mutual positions through the use of flanges mounted at the ends thereof. The flanges are shaped on the outside to enable communication among the different tubes in order to provide a pre-set circuit in which the water is forced to pass.

The two solutions just indicated and many others traditionally employed in this technical sector present some limits linked in particular to the modalities of construction and assembly.
of the heat exchangers. Currently existing secondary heat exchangers are rather bulky and require for their positioning appropriate housings inside the boiler. The design and definition of the layout of the components of the boiler are hence markedly affected by the type of heat exchanger used and often entail long and laborious preliminary studies. In the second solution illustrated, for example, the use of external shaped flanges for positioning the tubes leads to an increase in the overall dimensions of the heat exchanger, which obviously results in a disadvantageous increase in the costs of production.

Almost all of the heat exchangers currently used are made using tubes that comprise on their outer surface a plurality of fins distributed according to a substantially comb-like configuration such as the one illustrated, for example, in the patent application EP 0905457. In this latter example, also deviators are used, which have the purpose of directing the flue gases according to pre-set directions. The shape of the fins and the use of such deviators give rise to considerable head losses, which reduce the overall efficiency of the boiler.

On the basis of the considerations presented so far, there emerges the need to have available new devices for recovery of the thermal energy of the flue gas which will be economically advantageous, easy to assemble, and with contained overall dimensions.

Consequently, the main aim of what forms the subject of the present invention is to provide a device for recovery of flue-gas heat which will enable the drawbacks indicated above to be overcome.

Within this aim, a purpose of the present invention is to provide a device for recovery of flue-gas heat that will be made using a limited number of components that can be readily assembled together.

Another purpose of the present invention is to provide a device for recovery of flue-gas heat that will enable operative connection to the boiler in a fast and simple way.

A further purpose of the present invention is to provide a device for recovery of flue-gas heat that will be extremely efficient from the functional standpoint.

Not the last important purpose of what forms the subject of the present invention is to provide a device for recovery of flue-gas heat for a boiler that will present a high reliability and will be relatively easy to produce at competitive costs.

The above main aim, as well as the above and other purposes that will appear more clearly hereinafter, are achieved through a device for recovery of flue-gas of a boiler comprising at least one first tubular element such as to be operatively connected to said boiler and traversed by said flue gas. The device is characterized in that it comprises heat-exchanger means housed
within said first tubular element in order to transfer the thermal energy of said flue gas to water at lower temperature circulating within said heat-exchanger means.

The possible location of the device for the recovery of flue-gas heat in a position external to the structure of the boiler certainly represents one of the main advantages of the invention in so far as it enables reduction, for example, of the overall dimensions of the boiler itself since there is no longer required pre-arrangement of spaces inside said boiler for containing heat-exchanger means. These latter are, instead, inserted within a first tubular element advantageously used also as element for discharge of the boiler fumes.

Further characteristics and advantages of the invention will emerge more clearly from the description of preferred, but non-exclusive, embodiments of the device for recovery of flue-gas heat according to the invention, illustrated by way of indicative and non-limiting examples, with the aid of the attached drawings, in which:

- Figure 1 is a longitudinal section of a first embodiment of the device for recovery of flue-gas heat according to the invention;
- Figure 2 is an exploded view of heat-exchanger means of the device of Figure 1;
- Figures 3 is a cross-sectional view according to the line I-I indicated in Figure 1;
- Figure 4 is a longitudinal section of a second embodiment of the device for recovery of flue-gas heat according to the invention;
- Figure 5 is an exploded view of heat-exchanger means of the device of Figure 4;
- Figures 6 is a cross-sectional view according to the line IV-IV indicated in Figure 4; and
- Figure 7 is a perspective view of components of the device of Figure 4.

With reference to the above figures, the device for recovery of flue-gas heat 1 according to the invention comprises a first tubular discharge element 10, which is operatively connected to a boiler 2 so as to be traversed by the products of combustion, referred to as flue gas, generated within the boiler itself. The first tubular element 10 is preferably housed within a second tubular element 20 so as to generate a space 25 for the passage of air from the outside environment into the boiler 2. Once the air is introduced into the boiler 2, it can advantageously be directed towards the combustion chamber so as to be used as supporter of combustion.

The device 1 is characterized in that it comprises heat-exchanger means housed within the first tubular element 10 and functionally used to transfer the thermal energy of the flue gas to water at a lower temperature circulating within the heat-exchanger means. The water so
heated is then sent to the primary heat exchanger of the boiler 2 set up, for example, close to the combustion chamber.

On the basis of what has just been described, it is understood that the device 1 performs a dual function. In fact, it enables discharge of the boiler fumes towards an outer environment and at the same time operates as “economizer” recovering the thermal energy of the flue gas.

The device 1, as illustrated for example in Figure 1, is advantageously located on the outside of the boiler 2 unlike the traditional technical solutions, in which the heat exchangers, used as economizers, are located in an internal housing. This arrangement of the device 1 on the outside enables, for example, reduction in the dimensions of the boiler 2 or in any case facilitates the design and arrangement of the components inside it with considerable benefits in terms of final production costs.

According to a preferred embodiment of the invention, the tubular elements 10 and 20 are made of aluminium, and each comprise at least one first rectilinear stretch. As indicated hereinafter, the rectilinear stretch of the first tubular element 10 is designed to house the heat-exchanger means according to the invention.

In the solution illustrated in Figure 1, the first and second elements 10 and 20 comprise, respectively, a first radius bend 13 and a second radius bend 14, which are operatively connected to the respective rectilinear stretches. The two bends 13 and 14 advantageously enable orientation of the device 1 in space according to the service requirements, thus facilitating location of the boiler 2 within the boiler room in which it is installed. In the solution illustrated in Figure 1, for example, the two bends 13 and 14 enable an orientation of the corresponding rectilinear stretches of the tubular elements 10 and 20 in a substantially horizontal direction with respect to the plane 3 of the boiler 2, in such a way that one end 201 of the tubular elements 10 and 20 comes out of a hole made in the wall 200 of the boiler room.

In an alternative embodiment, the two tubular elements 10 and 20 could be without the radius bends 13 and 14; i.e., they are built in the form of two substantially rectilinear tubes inserted into one another and operatively connected at a free end thereof to the boiler 2. Likewise, it is possible for the tubular elements 10 and 20 to be operatively connected to the boiler 2 in the proximity of a terminal part of the respective rectilinear stretches in such a way that the device will assume a substantially vertical configuration with respect to the plane 3 of the boiler 2.

The first and second tubular elements 10 and 20 are operatively connected to the boiler 2 through interposition of an appropriate adapter 5. This latter can be stably fixed to the boiler 2
by means of a traditional flange connection 5a, and comprises an outer jacket 6 and an internal core 7, which is housed in the former, so as to generate a prolongation of the space 25 designed for passage of the air.

The adapter 5 can be connected to the tubular elements 10 and 20 through a coupling referred to as "end coupling", in which the outer jacket 6 couples, in the proximity of a first rim 6a, to a first end 21 of the second tubular element 20, whilst the internal core 7 couples, in the proximity of a second rim 7b, to a second end 11 of the first tubular element 10. In particular, in the solution in Figure 1, the first end 21 and the second end 11 each coincide with one free end of the second bend 14 and of the first bend 13.

The end coupling between the adapter 5 and the tubular elements 10 and 20 is specifically obtained by press fit of the first end 21 within the first rim 6a, whilst the second end 11 is instead press fitted within the second rim 7b. Seal element 8 are advantageously set between the coupled parts for avoiding mixing in the space 25 of the air and the flue gas that flows inside the first tubular element 10. The seal elements can be constituted, for example, by double-lip gaskets such as the ones illustrated in Figure 1.

An end coupling altogether similar to the one just described can advantageously be used for connection of each bend 13 and 14 to the rectilinear stretch of the corresponding tubular element 10 and 20.

Figure 2 illustrates a first possible embodiment of said heat-exchanger means. In particular, they comprise a tube 30 including one or more longitudinal cavities designed to be traversed by water. In particular, in the embodiment illustrated, the tube 30 comprises, at least along one stretch thereof, fins shaped so as to define a space 26 for conveying the products of combustion in the longitudinal direction of the tube.

Figure 3 illustrates in detail an embodiment of the tube 30 that comprises a plurality of longitudinal fins 35, which, viewed on a plane orthogonal to the longitudinal axis of the tube 30, develop according to a sheaf of planes having as centre said longitudinal axis. The tube 30 preferably comprises a first longitudinal cavity 31 and a second longitudinal cavity 32, which are separated from one another by a diametral wall 33 so as to enable a flow of the water in the two cavities 31 and 32 according to opposite directions. To enable this particular circulation of the water, a shaped plug 40 is connected to one end 36 of the tube 30, for example, by means of a threaded connection. The shaped plug 40 is provided with a concave internal surface 44 capable of enabling passage of the water from the first cavity 31 to the second cavity 32, i.e., capable of enabling reversal of the flow of water.
The aforesaid two longitudinal cavities 31 and 32 and the shaped plug 40, by co-operating with one another form a hydraulic circuit within which the water is forced to pass. The water is hence heated by heat exchange partially in equicurrent, when the direction of the water flow is concordant with that of the flue gas, and partially in countercurrent, when said direction is opposite. The combination of these modalities of heat exchange enables an excellent efficiency of the heat-exchanger means to be achieved, thus favouring energy saving of the boiler.

The tube 30 can advantageously be made of extruded aluminium and can be chosen with a length that can vary according to the service requirements, i.e. to the degree of heat exchange that it is intended to obtain.

With reference to Figure 2, the tube 30 according to the invention comprises a first connection 75 and a second connection 76 for introduction and evacuation, respectively, of the water into/from the longitudinal cavities 31 and 32. The two aforesaid connections 75 and 76 are preferably connected to a terminal part 39 of the tube 30 opposite to said first terminal part 36. In particular, in the solution illustrated in Figure 1, the second stretch 39 without fins comes out of the tubular elements 10 and 20 through a passage 45, which is made on the radius bends 13 and 14 and is appropriately integrated with gaskets such as, for example, the seal rings 47 illustrated.

The first and second connections 75 and 76 are in communication, respectively, with the first longitudinal cavity 31 and the second longitudinal cavity 32 by means of an interface element 100, which is operatively connected to the second stretch 39 without fins on the outside of the tubular elements 10 and 20.

The interface element 100 is internally hollow with a first annular pocket 101 and a second annular pocket 102, which are respectively connected to the first connection 75 and the second connection 76. The first annular pocket 101 is moreover in communication with the first longitudinal cavity 31 of the tube 30 through a first opening 55, and likewise the second annular pocket 102 is in communication with the second longitudinal cavity 32 through a second opening 46. Purposely provided O-rings 48 or functionally equivalent gaskets are set between the interface element 100 and the stretch without fins 39 of the tube 30 in order to guarantee tightness of the connection.

With reference to Figure 2, connected one end of to the second stretch 39 of the tube 30 is connected, for example via a threaded connection, to a second arrest plug 41, which has the function of preventing the water from coming out of the longitudinal cavities 31 and 32. At
the same time, the arrest plug 41 also favours positioning of the interface element 100, as may be seen, for example, in Figure 1.

On the basis of what has been described up to now, the working principle of the device 1 according to the invention is immediately understandable. The hot fumes coming from the combustion chamber of the boiler 2, while traversing the rectilinear stretch of the first tubular element 10, externally lap the longitudinal fins 35 of the tube 30 transferring the thermal energy to the water circulating within the longitudinal cavities 31 and 32. The water is introduced through the first connection 75 into the first cavity 31, where it is heated by an equicurrent heat exchange. By means of the shaped plug 40, the water is then transferred into the second longitudinal cavity 32 and here is further heated by a countercurrent heat exchange. After following this second stretch of circuit, the water comes out from the second connection 76 so as to be conveyed to the inlet of the primary heat exchanger, for example via the use of traditional flexible pipes.

With reference to Figure 1, the first tubular element 10 is housed within the second element 20 so that the two axes of symmetry will be mutually inclined at least along the rectilinear stretch. This particular arrangement has the purpose of favouring discharge of the condensate, which inevitably forms following upon heat exchange by convection between the fumes and the longitudinal fins 35 of the tube 30.

With reference to this event, according to the invention, the device 1 also comprises a system for discharge of the condensate, which can advantageously be located in the proximity of the adapter 5.

An example of embodiment, shown in Figure 1, comprises, in particular, an annular basin 9, for collection of the condensate, which is operatively connected to a perforated stub tube 9a. The annular basin 9 is defined by the internal core 7 and by a cylindrical wall 9c coaxial thereto. Following upon inclination of the first tubular element 10, the condensate runs along the longitudinal fins 35 of the tube 30 in the direction of the adapter 5, and is then collected in the annular basin 9 and expelled through the perforated stub tube 9a.

In order to limit any head loss, the device 1 according to the invention can advantageously comprise deflectors (not illustrated in the figures) positioned at the start of the rectilinear stretch of the tubular elements. In the solution illustrated, for example, the deflectors could be inserted within the first radius bend 13 so as to favour the change of direction of the flue gas, i.e., so as to convey uniformly the flow of the flue gas within the heat-exchanger means.

Figures 4 to 7 regard a second embodiment of the device 1 according to the invention, which
is distinguished from the previous one above all on account of a different structure of the heat-exchanger means and of the two tubular elements 10 and 20. The first tubular element 10 has a first stretch 10A followed by a second stretch 10B having a smaller radial dimension. A converging element 10C connects the two stretches 10A and 10B favouring passage of the products of combustion. The heat-exchanger means are located within the first stretch 10A to exploit the higher thermal content of the flue gas. In a way similar to the first embodiment described above, in order to help the condensate to run off, the first stretch 10A is arranged in a markedly inclined position within the second tubular element 20, which is also divided into a first rectilinear part 20A and a second rectilinear part 20B of substantially similar radial dimensions.

Use of tubular elements 10 and 20 formed by a number of stretches facilitates installation of the device and at the same time enables, where necessary, greater distances to be covered.

With reference to Figures 5 and 6, the heat-exchanger means are constituted by a plurality of finned hollow elements 133 located according to a substantially petal-like arrangement on a central stem 130. In particular, the finned elements 133 are mutually arranged so as to define a space 26 for passage of the products of combustion in a longitudinal direction of the first tubular element 10.

Each of the finned elements 133 comprises a corresponding longitudinal cavity 133A designed to be traversed by water. According to a preferred embodiment of the invention, each element further comprises one or more lateral fins 155 having preferably a curvilinear profile, as illustrated for example in Figure 6. It has been seen that this particular structure of the finned elements 133 enables improvement in the efficiency of the heat exchange and hence in the performance of the device 1 forming the subject of the invention.

The central stem 130 comprises a plurality of radial seats, in each of which one end of one of the finned elements 133 is inserted. It further comprises a central cavity 130A, which develops longitudinally in order to lighten the structure.

The central stem 130 and the elements 133 can advantageously be made of extruded aluminium or in any case of another functionally equivalent material.

With reference to the exploded view of Figure 5, the device 1 comprises also in this solution a tube 30 provided with a first cavity and a second cavity separated from one another by a diametral wall to enable a flow of water in two opposite directions. A terminal part 39 of the tube 30 comes out of the tubular elements 10 and 20 according to modalities substantially identical to the ones illustrated with reference to the first embodiment of the device 1.
according to the invention.

A second end of the tube 30 is instead operatively connected to the finned elements 133 through a shaped attachment 188 constituted by a cylindrical part 188A and a shaped part 188B provided with radial cavities 199, the arrangement of which recalls that of the finned elements 133.

Figure 7 is a perspective view that shows in detail the structure of said shaped attachment 188. The cylindrical part 188A is connected to the end of the tube 30 through the use of a sleeve 194 visible also in the exploded view of Figure 5. Basically, the cylindrical part 188A is designed to constitute the physical continuation of the tube 30.

The cavities 199 depart radially from the longitudinal axis of the cylindrical part 188A and correspond in number to the finned elements 133 in such a way that each of them will constitute the leading part of one of the finned elements 133. For said purpose, the shaped part 188B is operatively connected to the finned elements 133 through first connection means 141, which stably fix the shaped part 188B to the finned elements 133 in such a way that each of the radial cavities 199 will remain aligned with the cavity 133A of a corresponding finned element 133.

The first connection means 141 are constituted, for example, by screws or pins which are inserted in seats 185 provided on the shaped part 188B and within the cavity of each element 133. The use of the screws, or of functionally equivalent means, enables a perfect alignment of each radial cavity 199 with the cavity 133A of a corresponding finned element 133. The connection is advantageously improved thanks to the presence of appropriate seal elements 166.

The shaped attachment 188 is equipped on the inside with a flow separator 132 (see Figure 7), the purpose of which recalls that of the diametral wall 32 of the tube 30. Via the flow separator 132, the water coming from the first cavity 31 is directed towards a pre-set number of radial cavities 199 and from these is transferred to the cavities of the corresponding finned elements 133. Basically, the separator 132 selects a first plurality of finned elements 133A, in which heat exchange occurs in equicurrent, from a second plurality 133B in which heat exchange occurs in countercurrent conditions.

The shaped attachment 188 is completed by a plug 152, for example cylindrical, which is inserted in a position corresponding to the central cavity 130A of the central stem 130 to prevent inlet of the water. The cylindrical plug 152 favours alignment of the shaped attachment 188 with the central stem 130, thus substantially facilitating the operations of
assembly of the device 1.

With reference in particular to Figure 5, to provide reversal of the flow of water, the device 1 comprises a flow-reversal plug 140 provided inside with interconnected cavities so as to enable communication between the cavities 133A of the finned elements 133. The water conveyed by the first plurality of finned elements 133A is deviated, through the flow-reversal plug 140, towards the cavities 133A of the remaining finned elements 133. According to a preferred embodiment of the invention, the flow-reversal plug 140 has a structure similar to that of the shaped part 188B of the shaped attachment 188.

The flow-reversal plug 140 is connected to the finned elements 133 through second connection means 142 and corresponding seal elements 166 similar in construction and modes of use to the first connection means 191 referred to above. Advantageously, the flow-reversal plug 140 can comprise also a central through hole provided for housing means 191 designed to favour anchorage of the heat-exchanger means within the first tubular element 10.

The technical solutions adopted for the device for discharge of the flue gas enable the pre-set tasks and purposes to be fully achieved. In particular, the device for recovery and discharge of the flue gas is built with a reduced number of components that can be readily assembled together. Possible location of the device on the outside of the boiler enables a more convenient housing of the other components making up the boiler, in this way limiting the production costs.

In practice, the materials used, as well as the corresponding dimensions and shapes, may be any according to the requirements and the state of the art.
CLAIMS

1. A device (1) for recovery of the flue-gas heat of a boiler (2) comprising at least one first tubular element (10) such as to be operatively connected to said boiler (2) and traversed by said flue gas, characterized in that it comprises heat-exchanger means housed within said first tubular element (10) in order to transfer the thermal energy of said flue gas to water at lower temperature circulating within said heat-exchanger means.

2. The device (1) according to Claim 1, characterized in that said first tubular element (10) is housed within a second tubular element (20) so as to generate a space (25) for the passage of air from an external environment to the inside of said boiler (2).

3. The device (1) according to Claim 1 or Claim 2, characterized in that said first tubular element (10) and said second tubular element (20) each have at least one first substantially rectilinear stretch.

4. The device according to Claim 2 or Claim 3, characterized in that said first tubular element (10) is housed within said second tubular element (20) so that the respective axes of symmetry are mutually inclined.

5. The device (1) according to Claim 4, characterized in that said first tubular element (10) comprises a first rectilinear stretch (10A) followed by a second rectilinear stretch (10B) having smaller radial dimensions, said rectilinear stretches (10A, 10B) being connected together through a converging element (10C), said second tubular element (20) comprising a first rectilinear portion (20A) and a second rectilinear portion (20B).

6. The device (1) according to one or more of Claims 2 to 5, characterized in that said first tubular element (10) and said second tubular element (20) comprise, respectively, a first radius bend (13) and a second radius bend (14).

7. The device (1) according to Claim 6, characterized in that said first radius bend (13) and said second radius bend (14) are connected to said rectilinear stretch, respectively, of said first tubular element (10) and of said second tubular element (20) through an end coupling.

8. The device (1) according to one or more of Claims 2 to 7, characterized in that it comprises an adapter (5) for connecting said first tubular element (10) to said second tubular element (20).

9. The device (1) according to Claim 8, characterized in that said adapter (5) is provided for being connected to said boiler (2) through a flange connection (5a).
10. The device (1) according to Claim 8 or Claim 9, characterized in that said adapter (5) is coupled to said first tubular element (10) and to said second tubular element (20) through an end coupling.

11. The device (1) according to one or more of Claims 8 to 10, characterized in that said adapter (5) comprises an outer jacket (6) having a first rim (6a) so as to couple with a first end (21) of said second element (20), said adapter (5) comprising an internal core (7) provided with a second rim (7b) so as to couple to a second end (11) of said first tubular element (10).

12. The device (1) according to Claim 11, characterized in that said first end (21) is inserted within said first rim (6a) of said outer jacket (6), said second end (11) being inserted within said second rim (7b), said device (1) comprising seal elements (8) located between said first rim (6a) and said first end (21) and between said second rim (7b) and said second end (11).

13. The device (1) according to Claim 12, characterized in that said seal elements (8) comprise double-lip gaskets.

14. The device (1) according to one or more of Claims 8 to 13, characterized in that it comprises a system for discharge of the condensate located in the proximity of said adapter (5).

15. The device (1) according to Claim 14, characterized in that said system for discharge of the condensate comprises an annular collection basin (9), to which a perforated stub tube (9a) is operatively connected for discharge of said condensate, said annular basin (9) being defined by said internal core (7) and by a substantially cylindrical wall (9c) coaxial thereto.

16. The device (1) according to one or more of Claims 1 to 15, characterized in that it comprises deflectors located within said first tubular element for conveying uniformly the flow of said flue gas.

17. The device (1) according to one or more of Claims 1 to 16, characterized in that said heat-exchanger means comprise a tube (30) provided with one or more longitudinal cavities designed to be traversed by water.

18. The device (1) according to Claim 17, characterized in that it comprises a first connection (75) and a second connection (76), respectively, for introduction and evacuation of water into/from said tube (30).

19. The device (1) according to Claim 17 or Claim 18, characterized in that it comprises a
first longitudinal cavity (31) and a second longitudinal cavity (32) separated by a
diametral wall (33) so as to allow the flow of water in said longitudinal cavities (31,
32) according to opposite directions.

20. The device (1) according to one or more of Claims 17 to 19, characterized in that said
tube (30) comprises a terminal part (39) that comes out of said first tubular element
(10) and of said second tubular element (20) for connection of said first connection
(75) and of said second connection (76).

21. The device (1) according to Claim 20, characterized in that said terminal part (39)
comes out of said first (10) and second tubular elements (20) through a passage (45)
made in said first bend (13) and said second bend (14).

22. The device (1) according to one or more of Claims 18 to 21, characterized in that said
first connection (75) and said second connection (76) are, respectively, in
communication with said first longitudinal cavity (31) and said second longitudinal
cavity (32) through an interface element (100) operatively connected to said terminal
part (39) on the outside of said first tubular element (10) and said second tubular
element (20).

23. The device (1) according to Claim 22, characterized in that said interface element
(100) is hollow, with a first annular pocket (101) and a second annular pocket (102)
designed to be operatively connected to said first connection (75) and to said second
connection (76), said first annular pocket (101) and said second annular pocket (102)
being in communication, respectively, with said first longitudinal cavity (31) and with
said second longitudinal cavity (32) through a first opening (55) and a second opening
(46) made on said terminal part (39).

24. The device (1) according to Claim 22 or Claim 23, characterized in that it comprises
an arrest plug (41) connected to said terminal part (39) so as to prevent exit of said
water from said first longitudinal cavity (31) and from said second longitudinal cavity
(32).

25. The device (1) according to one or more of Claims 17 to 24, characterized in that said
tube (30) comprises at least one first finned stretch, which is located within said
rectilinear stretch of said first tubular element (10), said finned stretch comprising fins
shaped so as to define a space (26) for conveying said products of combustion in a
longitudinal direction.

26. The device (1) according to Claim 25, characterized in that said finned stretch
comprises a plurality of longitudinal fins (35).

27. The device (1) according to Claim 26, characterized in that said longitudinal fins (35), viewed on a plane orthogonal to the longitudinal axis of said finned tube (30), develop according to a sheaf of planes having as centre said longitudinal axis.

28. The device (1) according to one or more of Claims 25 to 27, characterized in that it comprises a shaped plug (40) such as to enable passage of water from said first longitudinal cavity (31) to said second longitudinal cavity (32), said shaped plug (40) performing reversal of the flow of said water and being connected to an end opposite to said arrest plug (41).

29. The device (1) according to one or more of Claims 25 to 28, characterized in that said tube (30) is made of extruded aluminium.

30. The device (1) according to one or more of Claims 17 to 24, characterized in that said tube (30) is operatively connected to a plurality of finned elements (133) located on a central stem (130) according to a substantially petal-like arrangement, said central stem (130) and said finned elements (133) being arranged inside said rectilinear stretch of said first tubular element (10).

31. The device (1) according to Claim 28, characterized in that said finned elements (133) comprise longitudinal cavities (133A) such as to enable circulation of water inside them, said elements (133) being mutually arranged so as to define a space (26) for conveying said products of combustion.

32. The device (1) according to Claim 30 or Claim 31, characterized in that said finned elements (133) comprise lateral fins (155) with a curvilinear profile.

33. The device (1) according to one or more of Claims 30 to 32, characterized in that said central stem (130) comprises a plurality of radial seats, located in each of which one end of one of said finned elements (133) is located.

34. The device (1) according to one or more of Claims 30 to 33, characterized in that said tube (30) is operatively connected to said finned elements (133) through a shaped attachment (188), comprising a cylindrical part (188A) and a shaped part (188B) provided with radial cavities (199), said cylindrical part (188A) being connected to said tube (30) through a sleeve (194).

35. The device (1) according to Claim 34, characterized in that said shaped part (188B) is operatively connected to said finned elements (133) through first connection means (141) so that each of said radial cavities (199) is aligned with a corresponding
longitudinal cavity (133A) of one of said finned elements (133).

36. The device (1) according to Claim 35, characterized in that said shaped attachment (188) comprises a flow separator (132) such as to direct the water coming from said first longitudinal cavity (31) of said tube (30) towards the longitudinal cavities (133A) of a pre-set number of finned elements (133).

37. The device (1) according to Claim 36, characterized in that it comprises a cylindrical plug (152) to favour alignment of said shaped attachment (188) with said central stem (130).

38. The device (1) according to one or more of Claims 30 to 37, characterized in that it comprises a flow-reversal plug (140) operatively connected to said finned elements (133) at one end opposite to that in which said shaped attachment (188) is set, said flow-reversal plug (140) comprising interconnected cavities so as to enable communication between the longitudinal cavities of said finned elements (133).

39. The device (1) according to one or more of Claims 1 to 38, characterized in that it comprises means for anchorage (191) of said heat-exchanger means within said first tubular element (10).

40. The device (1) according to one or more of Claims 30 to 39, characterized in that said finned elements (133) and said central stem (130) are made of extruded aluminium.

41. A boiler (2) for heating water for domestic or industrial purposes, characterized in that it comprises a device for recovery of flue-gas heat according to one or more of Claims 1 to 40.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. F24D12/02 F28F1/16 F28D7/10 F28D7/12 F23J15/06

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)

F24D F28F F28D F23J

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, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>X</td>
<td>GB 2 116 299 A (JOHN BARRY * JACKSON) 21 September 1983 (1983-09-21) the whole document</td>
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X Further documents are listed in the continuation of Box C.

**X** See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"S" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search 13 April 2006

Date of mailing of the international search report 21/04/2006

Name and mailing address of the ISA/
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HN Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016

Authorized officer
Garcia Moncayo, O
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