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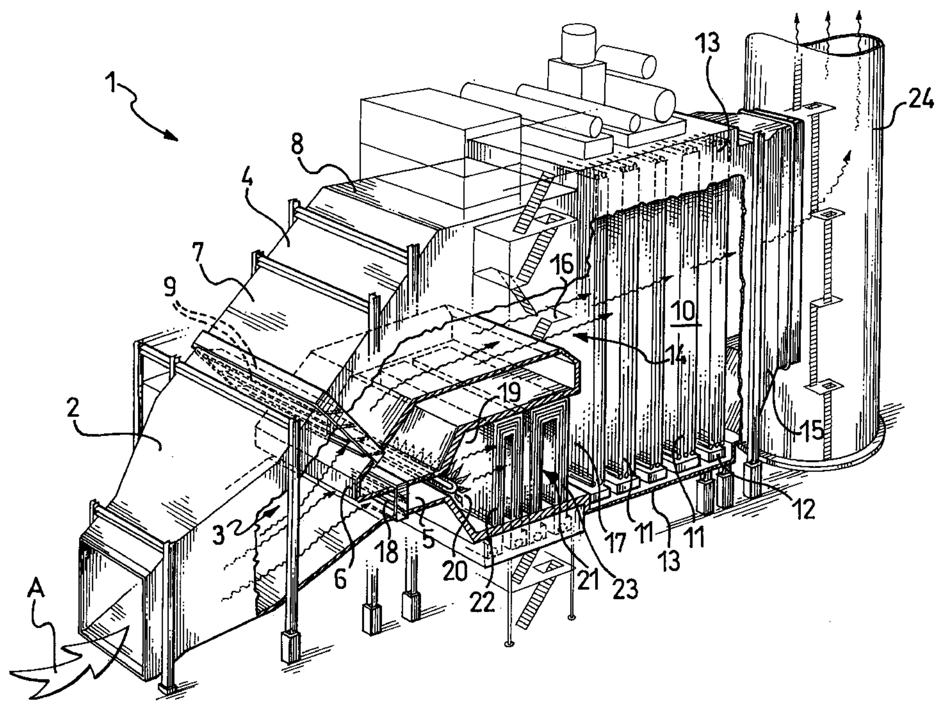
(54) Heat-recovery boiler

(57) A heat-recovery boiler (1) for generating steam from a flow (A) of hot gases, which enables high efficiency to be achieved in combined cycles, includes a supply manifold (2) for supplying the flow (A) to a chamber (10) which houses a plurality of tube nests (11) for water and/or steam and a branch (3) in the supply manifold (2) which defines a first hot gas duct (4) connected directly to the chamber (10) and a second hot gas duct (5) which houses a burner (20) for the post-combustion of poor combustible gas with part of the flow of hot gases.



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Description

The present invention relates to a heat-recovery boiler for generating steam from a flow of hot gases, of the type including a supply manifold for delivering the flow to a chamber which houses a plurality of tube nests for water and/or steam, and at least one burner in the supply manifold for the post-combustion of the gases.

Heat-recovery boilers of the type specified are known. They are used in so-called combined cycle thermoelectric power plants which generally include one or more gas turbines used to produce electricity and which generate a flow of hot gases which is sent to the heat-recovery boiler.

The steam produced in the heat-recovery boiler is used in a steam cycle which uses a steam turbine in turn connected to a generator unit.

It is known that the combustion upstream of the gas turbines occurs with a considerable excess of air so that the gases produced, which contain a high percentage of oxygen, may be used as the combustion-supporting gas for a gas burner.

Thus the gas flow entering the heat-recovery boiler is brought to a higher temperature than that of the gases leaving the gas turbines. This temperature depends upon the value of the combustible-gas flow rate which is delivered to the burner.

The excess oxygen available would allow the combustion of a much larger quantity of additional gas, with a corresponding considerable raising of the temperature of the combustion gases.

In practice, in the usual combined-cycle plants used in industry, the auxiliary combustion is limited in order to contain the temperature within values which are compatible with the nature of the heat-recovery boilers used, which are normally housed in ducts which are not cooled and which use finned tubes for almost all the heat exchange surfaces.

From the point of view of physical chemistry, these temperatures, which are of the order of 600-700°C, are sufficient to ensure that the combustion reaction occurs properly when the auxiliary fuel is natural gas or gas from refineries with a high calorific value.

When the auxiliary fuel is a so-called poor combustible gas, obtained as the by-product of various petroleum and iron and steel processes, it is however necessary to use a temperature of the order of 1000°C or more in order to sustain the combustion reaction.

Such reaction temperatures cannot normally be reached since the combustion of the quantity of auxiliary fuel available in poor gas, carried out with a considerable excess of oxygen, results in an insufficient output of heat, which is effectively diluted by the exhaust gases discharged from the turbine.

The technical problem at the basis of the present invention consists of devising a heat-recovery boiler which enables the problem mentioned above with reference to the prior art to be overcome.

This problem is resolved by a heat-recovery boiler of the type specified which is characterised in that it includes a branch in the supply manifold which defines a first hot gas duct connected directly to the said chamber and a second hot gas duct which houses the burner.

The main advantage of the heat-recovery boiler according to the invention lies in the fact that it provides a zone suitable for the combustion of poor combustible gases at an adequate reaction temperature with a flow of combustion-supporting gas to the burner which is limited to that necessary for supplying the oxygen for the combustion reaction.

Further characteristics and advantages of the heat-recovery boiler according to the invention will become more apparent from the description of one preferred embodiment thereof, given by way of non-limitative example with reference to the single appended drawing which is a perspective view, in partial section, of a heat-recovery boiler according to the invention.

In the drawing, a heat-recovery boiler for generating steam according to the invention is indicated 1. It is used in a combined-cycle thermoelectric power plant, not shown, which employs a series of gas turbines which produce a flow A of hot gases at a flow rate which varies according to the operating conditions of the plant.

The heat-recovery boiler 1 according to the invention includes a rectangular-section supply manifold 2 through which the hot gases are conveyed from the gas turbines and a branch 3 in the manifold 2 which defines a first duct and a second duct, indicated 4 and 5 respectively, for the hot gases.

The first and second ducts 4, 5 together present a rectangular cross-section to the hot gas flow which conserves the cross-sectional width of the supply manifold 2 while the branch 3 extends upwardly, the first and second ducts 4, 5 being superposed and having a common edge 6 which divides the hot gas flow A horizontally.

The section of the first duct 4 is larger than that of the second duct 5.

The first duct 4 has a first inclined portion 7 extending from the branch 3 and a second horizontal portion 8.

The first inclined portion 7 of the first duct 4 includes a first adjustable baffle shutter 9 comprising a plurality of flow-divider plates.

The second duct 5 which extends horizontally beneath the inclined portion 7 of the first duct 4 has a second adjustable baffle shutter 18 similar to the first.

The boiler 1 includes a main chamber 10 which houses a plurality of tube nests 11 for water and/or steam arranged vertically and connected to a plurality of manifolds 12.

The main chamber 10, which is substantially box-shaped, is bounded by walls 10 and has two open ends, an inlet end 14 and an outlet end 15 respectively, in opposite sides.

The inlet end 14 of the main chamber 10 is divided into an upper inlet portion 16 and a lower inlet portion 17. The first duct 4 is connected directly to the upper inlet portion 16 of the open inlet end 14 of the main chamber 10.

The boiler 1 further includes a pre-chamber 19 intermediate the second duct 5, to which it is connected, and the lower inlet portion 17 of the open inlet end 14.

Thus the pre-chamber 19, which underlies the horizontal portion 8 of the first duct 4, opens to the main chamber 10.

The boiler 1 further includes a burner 20 for the post-combustion of the combustible gas housed in the second duct 5 at the inlet to the pre-chamber 19. Thus the second adjustable shutter 18 in the second duct 5 is located upstream of the burner 20 in the direction of the hot gas flow A.

The combustible gas may be an industrial gas from the petroleum or iron and steel industries.

The pre-chamber 19 houses some 21 of the plurality of tube nests 11. More particularly, the tube nests 21 include a tube nest 22 for super-heating the steam produced in the boiler 1 and a tube nest 23, downstream of the nest 22 in the direction of the flow A, for re-heating steam coming from a stage of the steam turbine supplied by the heat-recovery boiler 1.

The outlet end 15 of the main chamber 10 is connected to a chimney 24 through which the exhaust gas flow is discharged into the atmosphere.

With reference to the appended drawing, the operation of the heat-recovery boiler 1 according to the invention will now be described.

The gas flow A coming from a series of gas turbines or a single gas turbine is conveyed to the supply manifold 2 and from there to the branch 3 where it is divided into two separate gas flows.

The magnitudes of the two flow rates which will pass through the first and second ducts 4, 5 depend on the reciprocal opening of the adjustable shutters 9, 18 in the ducts 4, 5 as well as on the flow cross-sections of the ducts 4, 5 which, with the shutters 9, 18 completely open, are such that the flow through the second duct 5 is less than the flow through the first duct 4.

The shutters are however mutually positioned so as to minimise resistance to the flow.

The hot gases which flow through the first duct 4 flow directly into the main chamber 10 of the heat-recovery boiler 1 and impinge upon the tube nests 11 therein.

The hot gases which pass through the second duct 5 traverse the burner 20 supplied with a regulable flow of combustible gas. Post-combustion of the hot gases thus occurs in the burner 20 and the temperature of the hot gases themselves is thus raised before they flow over the tube nests 21 in the pre-chamber 19.

The presence of the pre-chamber 19 prevents the immediate mixing of the post-combustion gases with the unburnt gases in the first duct 4. Thus, in the pre-chamber 19, the hot gases are kept at a high temperature and are preferably used for superheating steam in the tube nest 22 and for heating steam coming from the turbine which processes the steam from the boiler 1, this steam being withdrawn, for example, from the high-pressure stages.

Only after the post-combustion gases have passed through the entire pre-chamber 19 and have been cooled by means of the surfaces 21 and 22 to a temperature close to that of the unburnt gases, do they mix with these latter and are then allowed to impinge upon the remaining proportion of the tube nests 11.

After passage through the main chamber 11,the hot gases are released through the chimney 24.

In addition to the advantage indicated above, the heat recovery boiler 1 according to the invention is also extremely flexible in use.

Indeed, if the adjustable shutters are adjusted as indicated above, it is possible to make partial use of the gas turbines connected to the heat-recovery boiler and a variation in the oxygen content and/or the temperature of the gases produced. Such variations are inevitable in the working life of a gas turbine.

Such regulation is particularly useful when it is necessary to burn combustible support gases of different qualities, that is, just as they are produced by the petrol or iron and steel industries.

The variations in the flow of hot gases to the burner are accompanied by corresponding variations in the supply of combustible support gas to the burner.

In addition, the boiler according to the invention is simple and economical to manufacture with the use of conventional components in an innovative manner.

The components which are subject to high temperatures are also kept separate from other components so as to facilitate maintenance of the boiler.

Furthermore, the more effective capacity for the temperature control within the heat-recovery boiler according to the invention enables the quantity of toxic compounds discharged through the chimney to be reduced.

In the case of a heat-recovery boiler which burns a valuable combustible support gas, with the heat-recovery boiler according to the invention it is possible to achieve a compromise between the flow rate of the expensive combustible support gas and the acceptable thermal efficiency which depends on the maximum temperature in the boiler.

It is understood that an expert in the art may make numerous variations to the heat-recovery boiler described above in order to satisfy various requirements all of which however fall within the scope of protection of the invention as defined by the appended claims.

Claims

1. A heat-recovery boiler (1) for generating steam from a flow (A) of hot gases, including a supply manifold (2) for the flow (A), a chamber (10) which houses a plurality of tube nests (11) for water and/or steam and at least one burner (20) for the post-combustion of the gases, characterised in that the supply manifold (2) includes a branch (3) which defines a first hot gas duct (4) connected directly to the chamber (10) and a second hot gas duct (5)

which houses the burner (20).

2. A heat-recovery boiler (1) according to Claim 1, in which the first duct (4) presents a flow cross-section to the hot gas flow (A) which is greater than that of the second duct (5).

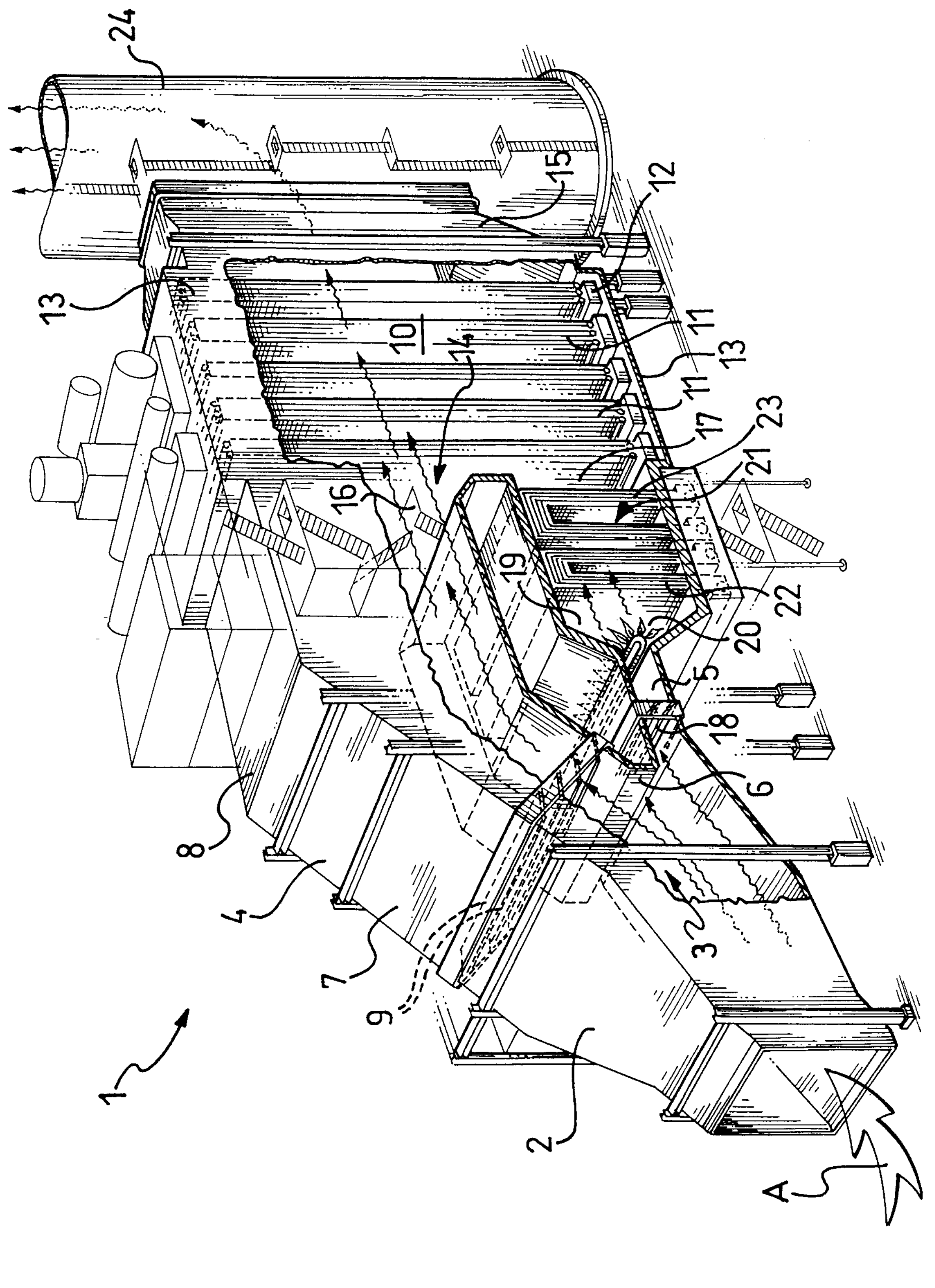
3. A heat-recovery boiler (1) according to Claim 1, in which the first duct (4) includes an adjustable shutter (9).

4. A heat-recovery boiler (1) according to Claim 1, in which the second duct (5) has an adjustable shutter (18) upstream of the burner (20) in the direction the hot gas flow (A).

5. A heat-recovery boiler (1) according to any one of the preceding claims, which includes a pre-chamber (20) connected to the second duct (5) and opening to the chamber (10), which houses some (21) of the plurality of tube nests (11).

6. A heat-recovery boiler (1) according to Claim 5, in which the said some (21) of the tube nests include at least one tube nest (22) for superheating steam.

7. A heat-recovery boiler (1) according to Claim 5, in which the said some (21) of the tube nests include at least one tube nest (23) for re-heating steam from a steam turbine supplied by the heat-recovery boiler (1).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EUROPEAN SEARCH REPORT

Application Number
EP 96 83 0278

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO-A-96 12091 (RICE) * page 19, line 11 - page 20, line 18; figures 8,9 *	1-3,5,6	F22B1/18
X	CH-A-394 248 (WALTHER) * page 2, line 16 - line 68; figure 1 *	1-3,5,6	
X	BE-A-857 109 (SULZER) 25 January 1978 * page 3, last paragraph - page 6, paragraph 1 * * page 7, last paragraph - page 8, paragraph 1; figure 1 *	1-3,5,6	
A	DE-B-11 58 523 (SCHMIDTSCHE HEISSDAMPF) 5 December 1963 * column 3, line 32 - column 4, line 8; figures *	1,2,4,6	
A	FR-A-2 107 449 (SULZER)		
A	US-A-5 461 853 (VETTERICK)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F22B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 October 1996	Van Gheel, J

CATEGORY OF CITED DOCUMENTS

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