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(54) **Heat-recovery boiler**

Abhitzekessel

Chaudière de récupération

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Description

[0001] 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.

[0002] 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.

[0003] 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.

[0004] 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.

[0005] 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.

[0006] 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.

[0007] 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.

[0008] 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.

[0009] 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.

[0010] 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.

[0011] CH-A-394 248 discloses a heat-recovery boiler according to the preamble of claim 1 with a branch at the supply manifold which defines a first hot gas duct containing several evaporators and a second hot gas duct containing several superheaters.

[0012] 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.

[0013] This problem is resolved by a heat-recovery boiler as set forth in claim 1.

[0014] 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.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] The section of the first duct 4 is larger than that of the second duct 5.

[0020] The first duct 4 has a first inclined portion 7 extending from the branch 3 and a second horizontal portion 8.

[0021] The first inclined portion 7 of the first duct 4 includes a first adjustable baffle shutter 9 comprising a plurality of flow-divider plates.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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.

[0027] Thus the pre-chamber 19, which underlies the horizontal portion 8 of the first duct 4, opens to the main chamber 10.

[0028] 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.

[0029] The combustible gas may be an industrial gas from the petroleum or iron and steel industries.

[0030] 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.

[0031] 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.

[0032] With reference to the appended drawing, the operation of the heat-recovery boiler 1 according to the invention will now be described.

[0033] 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.

[0034] 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.

[0035] The shutters are however mutually positioned so as to minimise resistance to the flow.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] After passage through the main chamber 11,the hot gases are released through the chimney 24.

[0041] In addition to the advantage indicated above, the heat recovery boiler 1 according to the invention is also extremely flexible in use.

[0042] 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.

[0043] 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.

[0044] 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.

[0045] In addition, the boiler according to the invention is simple and economical to manufacture with the use of conventional components in an innovative manner.

[0046] The components which are subject to high temperatures are also kept separate from other components so as to facilitate maintenance of the boiler.

[0047] 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.

[0048] 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.

[0049] 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 supplying the flow (A) of hot gases to a chamber (10) which houses a plurality of tube nests (11) for water and/or steam, the supply manifold (2) housing at least one burner (20) for the post-combustion of the gases, characterized in that the supply manifold (2) is constitued by a first hot gas duct (4) and a second hot gas duct (5) defined by a branch (3) and opening into the chamber (10), the first hot gas duct (4) being connected directly to the chamber (10) for the direct flow of the hot gases to the chamber (10), the second hot gas duct (5) housing at least one burner (20) and, downstream the burner (20), a pre-chamber (19) opening to the chamber (10) and housing some (21) of the plurality of tube nests (11) including at least one tube nest (22) for superheating steam and at least one tube nest (23) for re-heating steam from a steam turbine supplied by the heat-recovery boiler, a temperature of post-combustion gases passed through the pre-chamber (19) being close to a temperature of unburnt gases passed directly through the first hot gas duct (4).

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).

Patentansprüche

1. Abhitzekessel (1) zur Erzeugung von Dampf aus einer Strömung (A) heißer Gase mit einem Einspeiserohr (2) zur Einleitung der Strömung (A) heißer Gase in eine Kammer (10), die mehrere Rohrbündel (11) für Wasser und/oder Dampf beherbergt, wobei das Einspeiserohr (2) wenigstens einen Brenner (20) für die Nachverbrennung der Gase enthält,
   dadurch gekennzeichnet,
   daß das Einspeiserohr (2) aus einer ersten Heißgasleitung (4) und einer zweiten Heißgasleitung (5) besteht, die von einer Verzweigung (3) begrenzt sind und sich in die Kammer (10) öffnen, daß die erste Heißgasleitung (4) für den direkten Zufluß der heißen Gase in die Kammer (10) direkt mit der Kammer (10) verbunden ist und daß die zweite Heißgasleitung (5) wenigstens einen Brenner (20) und auf der stromabwärtigen Seite des Brenners (20) eine Vorkammer (19) enthält, die sich in die Kammer (10) öffnet und einige (21) der mehreren Rohrbündel (11) enthält, darunter wenigstens ein Rohrbündel (22) zur Dampfüberhitzung und wenigstens ein Rohrbündel (23) für die Wiedererhitzung von Dampf aus einer von dem Abhitzekessel gespeisten Dampfturbine, wobei die Temperatur der Nachverbrennungsgase, die die Vorkammer (19) durchlaufen haben, in der Nähe der Temperatur von unverbrannten Gasen liegt, die die erste Heißgasleitung (4) direkt durchlaufen haben.

2. Abhitzekessel (10) nach Anspruch 1, bei dem die erste Leitung (4) einen Durchflußquerschnitt für die Strömung (A) heißer Gase hat, der größer ist als derjenige der zweiten Leitung (5).

3. Abhitzekessel (10) nach Anspruch 1, bei dem die erste Leitung (4) ein einstellbares Verschlußorgan (9) enthält.

4. Abhitzekessel (10) nach Anspruch 1, bei dem die zweite Leitung (5) auf der in Richtung der Strömung (A) heißer Gase stromaufwärtigen Seite des Brenners (20) ein einstellbares Verschlußorgan (18) aufweist.

Revendications

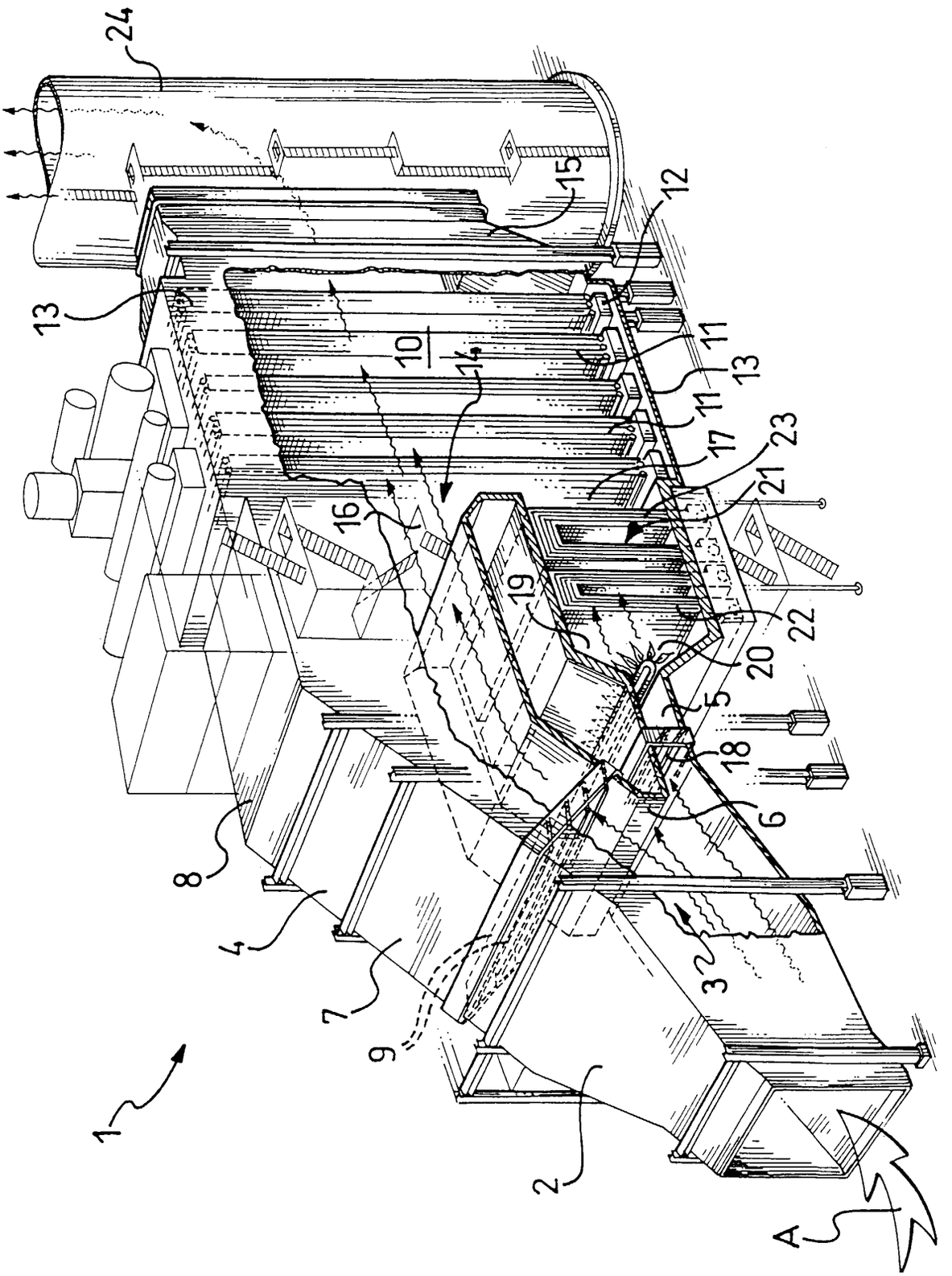
1. Chaudière à récupération de chaleur (1) destinée à générer de la vapeur à partir d'un écoulement (A) de gaz chauds, comprenant un distributeur d'alimentation (2) destiné à fournir l'écoulement (A) de gaz chauds à une chambre (10) qui loge une pluralité de faisceaux de tubes (11) destinés à de l'eau et/ou de la vapeur, le distributeur d'alimentation (2) logeant au moins un brûleur (20) destiné à la post-combustion des gaz, caractérisée en ce que le distributeur d'alimentation (2) est constitué par un premier conduit de gaz chauds (4) et un second conduit de gaz chauds (5) définis par une ramification (3) et une ouverture dans la chambre (10), le premier conduit de gaz chauds (4) étant relié directement à la chambre (10) en vue de l'écoulement direct des gaz chauds vers la chambre (10), le second conduit de gaz chauds (5) logeant au moins un brûleur (20) et, en aval du brûleur (20) une préchambre (19) débouchant dans la chambre (10) et logeant un certain nombre (21) de la pluralité des faisceaux de tubes (11) comprenant au moins un faisceau de tubes (22) destiné à surchauffer la vapeur et au moins un faisceau de tubes (23) destiné à réchauffer la vapeur en provenance d'une turbine à vapeur, fournie par la chaudière à récupération de chaleur, une

température des gaz de postcombustion passant au travers de la préchambre (19) étant proche d'une température des gaz imbrûlés passés directement à travers le premier conduit de gaz chauds (4).

2. Chaudière à récupération de chaleur (1) selon la revendication 1, dans laquelle le premier conduit (4) présente une section transversale d'écoulement pour l'écoulement des gaz chauds (A) qui est supérieure à celle du second conduit (5).

3. Chaudière à récupération de chaleur (1) selon la revendication 1, dans laquelle le premier conduit (4) comprend un registre réglable (9).

4. Chaudière à récupération de chaleur (1) selon la revendication 1, dans laquelle le second conduit (5) comporte un registre réglable (18) en amont du brûleur (20) dans le sens de l'écoulement des gaz chauds (A).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