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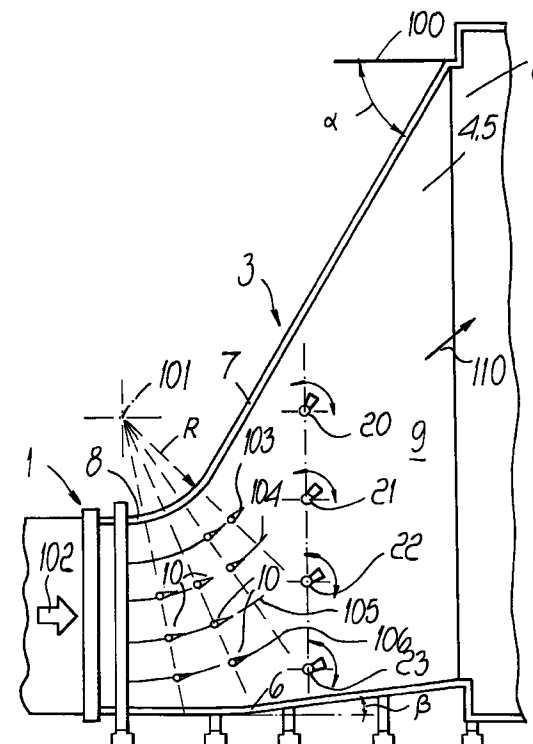
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**(54) Heat-recovery boiler provided with divergent duct**

(57) A heat-recovery boiler provided with a divergent duct that runs from the outlet of a turbine to the inlet of a boiler; the covering wall of the divergent duct, which runs from the top of the boiler to the top of the outlet of the turbine, is inclined at an angle ( $\alpha$ ) which is greater than 45° and up to 75° with respect to the horizontal plane; the divergent duct is connected with the upper part of the outlet of the turbine by means of an arc-shaped wall portion; inside the divergent duct, in the region delimited by the arc-shaped wall, gas stream conveyance profiles are provided which are arranged in succession and in adjacent rows.



*Fig. 1*

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## Description

The present invention relates to a heat-recovery boiler provided with a divergent duct between the outlet of a turbine and the inlet of a boiler.

Boilers of the above type utilize the heat of the exhaust gases from the gas turbine, which are conveyed to the heat-recovery boiler by means of a so-called divergent duct.

Current heat-recovery boilers known from the state of the art are approximately 16 to 20 m high.

A so-called divergent duct, which may be 15 to 20 m long, is provided between the outlet duct of the gas turbine, having a diameter of approximately 5 to 6 meters, and the heat-recovery boiler.

It is easily understandable that the hot exhaust gases exiting from the outlet of the feeder turbine towards the inlet of the heat-recovery boiler should not undergo excessive load losses, which instead occur inside conventional divergent ducts.

Attempts to improve the situation have been made by using relatively long divergent ducts formed substantially by walls which run from the outlet of the turbine to the inlet of the heat-recovery boiler.

These considerably large ducts, however, entail the drawback that they are relatively heavy, owing to the amount of construction material used; moreover, conventional solutions do not allow to effectively decrease the generation of unwanted vortices.

In order to obviate these drawbacks, it has been suggested to install, inside the divergent duct, grids of pipes for deflecting the stream of hot gases.

These flow deflectors allowed to even out, to a certain extent, the stream of hot gases, also partially reducing the formation of unwanted vortices, but high load losses in the gas stream were inevitable and removed pressure which was useful for the effective heat exchange of the heat-recovery boiler.

Accordingly, the aim of the invention is to obviate the drawbacks of the prior art and to provide a new divergent duct having much smaller dimensions which lead to a considerable saving in construction material; an object of the invention is also to provide a divergent duct in which it is possible to provide, between the outlet of the gas turbine and the inlet of the heat-recovery boiler, a current which has no flow recirculations and in which load losses are reduced to an acceptable minimum.

According to the invention, this aim is achieved in that the covering wall of the divergent duct that runs from the top of the boiler to the top of the outlet of the gas turbine has an inclination which forms an angle ( $\alpha$ ) greater than  $45^\circ$  and up to  $75^\circ$  with respect to the horizontal plane, and that the inclined wall of the divergent duct is connected to the top of the outlet of the gas turbine through a wall which is shaped like an arc. Preferably, inside the divergent duct, in the region adjacent to the arc-shaped wall, aerodynamic profiles for conveying

the gas stream are provided which are arranged in succession and in adjacent rows.

Preferably, the angle ( $\alpha$ ) assumes a value between  $62^\circ$  and  $65^\circ$ .

When the plant requires a reheating system, it is advantageous to install burners which can be orientated and adapted with respect to the direction of flow of the hot gas stream inside the divergent duct and downstream of the aerodynamic profiles that are optionally present.

Advantageously, the aerodynamic conveyance profiles have an arc-like configuration on their leading edge, and the part of the metal plates directed towards the inlet of the heat-recovery boiler is formed by converging conduction plates which cover an angle ( $\gamma$ ) of approximately  $20^\circ$ .

Preferably, the bottom wall of the divergent duct is inclined with respect to the horizontal plane.

Advantageously, the metal plates of the aerodynamic profile have a concave/convex shape in order to efficiently open out the stream of hot gases directed towards the boiler.

Further characteristics of the invention will become apparent from the dependent claims.

With a divergent duct of this kind a considerable saving in construction material is achieved, the structure of the divergent duct is considerably shorter and the flow profile of the hot gases is uniform over the entire inlet front of the heat-recovery boiler.

The device according to the present invention is now described in greater detail and illustrated by means of an embodiment given only by way of example in the accompanying drawings, wherein:

Figure 1 is a schematic view of the divergent duct conceived according to the invention and arranged between the outlet of a gas turbine and the inlet of a heat-recovery boiler;

Figure 2 is a schematic sectional view of an aerodynamic conveyance profile according to the present invention;

Figure 3 is a sectional view of an aerodynamic conveyance profile having a concave/convex profile; and

Figure 4 is a schematic view of the flow lines of the hot gases inside the divergent duct according to the present invention.

As shown in Figure 1, the outlet of a gas turbine is connected to the inlet 2 of a heat-recovery boiler, by using for this purpose a divergent duct, generally designated by the reference numeral 3.

The divergent duct 3 is advantageously provided by means of a frame-like structure.

Vertical side walls, designated by the reference numerals 4 and 5, form, together with a bottom wall 6 and a covering wall 7, the internal space 9 of the divergent duct.

The hot gases are fed from the outlet 1 of the turbine in the direction indicated by the arrow 102 in order to enter the heat-recovery boiler 2 in the direction indicated by the arrow 110.

The bottom wall 6 is inclined with respect to the horizontal plane by an angle ( $\beta$ ) of approximately 15° in order to join with the inlet of the heat-recovery boiler.

The covering wall 7 has an angle ( $\alpha$ ) which is greater than 45° and up to 75°, preferably approximately 62-65° with respect to the horizontal plane 100.

A portion 8 made of metal plate and having an arc-like shape is provided between the outlet 1 and the inclined covering wall 7.

Tests have shown that advantageously the radius of curvature R of the arc-shaped wall 8 corresponds to a value of 0.5-0.8 times the vertical dimension of the inlet of the divergent duct.

The internal internal space 9 of the divergent duct 3 accommodates, proximate to the region formed by the arc-shaped plate 8, a plurality of aerodynamic conveyance profiles designated by the reference numeral 10.

Advantageously, the aerodynamic conveyance profiles 10 that run through the internal space 9 are arranged along arc-shaped segments having the same center 101 as the radius of curvature that forms the profile of the arc-shaped plate 8.

The aerodynamic profiles 10 are arranged in groups and sequentially along arc-like paths 103, 104, 105 and 106 whose radii increase from the center 101 in order to uniformly diffuse the stream of hot gases in the divergent duct.

Advantageously, the aerodynamic conveyance profiles 10, which run lengthwise along the internal space 9, are supported by the walls 4 and 5 so as to allow an angular adjustment, allowing to adapt the angle of attack of the profile with respect to the stream, so as to achieve the different degrees of deflection of the hot fumes in the entire divergent duct.

Downstream of the aerodynamic profiles 10, inside the internal space 9, reheaters 20, 21, 22 and 23 are provided and, according to the invention, these burners can be adjusted angularly in an operating position, so that their flame is aligned with the lines of flow of the hot gas stream, as defined by the conveyance profiles 10.

In this manner, the burner 20 is arranged so that its centerline axis is at approximately 57° with respect to the horizontal plane, while the axis of the burner 21 is arranged at 45° with respect to the horizontal plane and the axis of the burner 22 is arranged at 31° with respect to the horizontal plane.

As shown in Figure 2, the conveyance profiles 10 are composed of a tube 30 having a circular cross-section, the rounded part 31 whereof is directed towards the incoming gas stream, designated by the reference numeral 102.

The remaining part of the tube 30 is covered by two conduction plates 32 and 33, the free ends whereof are joined at the point 34. The plates 32 and 33 are sized so

as to cover an angle ( $\gamma$ ) of approximately 20°.

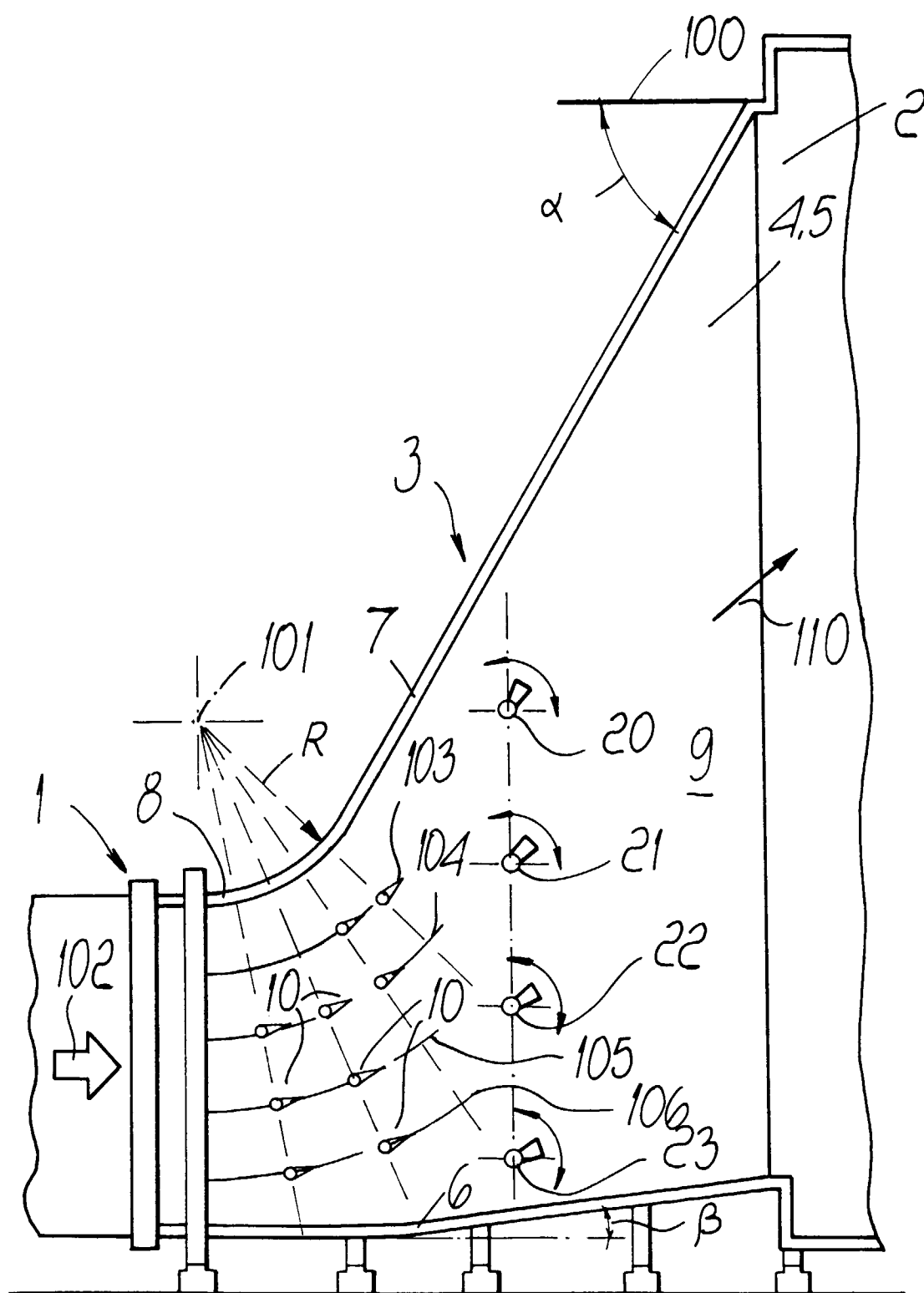
For some conveyance profiles 10, it is more advantageous to adopt a concave/convex shape for the edges 200, 201, so as to accordingly achieve a greater stream deflection capability for an equal angle of attack and a lower pressure loss due to wake eddies.

## Claims

1. A heat-recovery boiler provided with a divergent duct which runs from the outlet of a turbine to the inlet of a boiler, characterized in that the covering wall (7) of the divergent duct (3), which runs from the top of the boiler (2) to the top of the outlet of the gas turbine (1), is inclined at an angle ( $\alpha$ ) which is greater than 45° and up to 75° with respect to the horizontal plane (100), and in that the inclined wall (7) of the divergent duct (3) is connected to the top of the outlet (1) of the gas turbine by means of an arc-shaped wall (8).
2. A heat-recovery boiler according to claim 1, characterized in that on the inside (9) of the divergent duct (3), in the region lying adjacent to the arc-shaped wall (8), aerodynamic gas stream conveyance profiles (10) are provided which are arranged in succession and in adjacent rows (103, 104, 105, 106).
3. A heat-recovery boiler according to one or more of the preceding claims, characterized in that the angle ( $\alpha$ ) is between 62° and 65°.
4. A heat-recovery boiler according to one or more of the preceding claims, characterized in that on the inside (9) of the divergent duct (3) and downstream of the sets of aerodynamic conveyance profiles (10) a plurality of burners (20, 21, 22, 23) is provided, and in that the burners (20, 21, 22, 23) are provided so that their angular position can be adjusted.
5. A heat-recovery boiler according to one or more of the preceding claims, characterized in that the aerodynamic conveyance profiles (10) have an arc-like shape (30, 31), on the edge (102) first affected by the hot gas stream, and in that the wall of the plates (10) that is directed towards the inlet (110) of the heat-recovery boiler (2) is formed by converging conduction plates (32, 33) covering an angle ( $\gamma$ ) of approximately 20°.
6. A heat-recovery boiler according to one or more of the preceding claims, characterized in that the conveyance profiles (10) have a concave/convex shape for their edges (200, 201).
7. A heat-recovery boiler according to one or more of the preceding claims, characterized in that the radius of curvature (R) of the arc-shaped wall (8)

corresponds to a radius which is 0.5-0.8 times the height of the inlet of the divergent duct (3).

8. A heat-recovery boiler according to one or more of the preceding claims, characterized in that the aerodynamic conveyance profiles (10) are arranged along arc-shaped segments (103, 104, 105, 106) which have a single center (101) for their radius of curvature (R) and in that the different paths (103, 104, 105, 106) have progressively greater curvature radii.
9. A heat-recovery boiler according to one or more of the preceding claims, characterized in that the conveyance profiles (10) cross the internal space (9) of the divergent duct (3) along its width and in that the aerodynamic profiles (10) are supported by the walls (4, 5) so as to allow angular adjustment and orientation.
10. A heat-recovery boiler according to one or more of the preceding claims, characterized in that the aerodynamic conveyance profiles (10) are composed of a tube (30) having a circular cross-section and the round part (31) whereof is directed towards the incoming gas stream (102), and in that the remaining part of the tube (30) is covered by two conducting plates (32, 33), whose free ends are joined and cover an angle ( $\gamma$ ).



*Fig. 1*

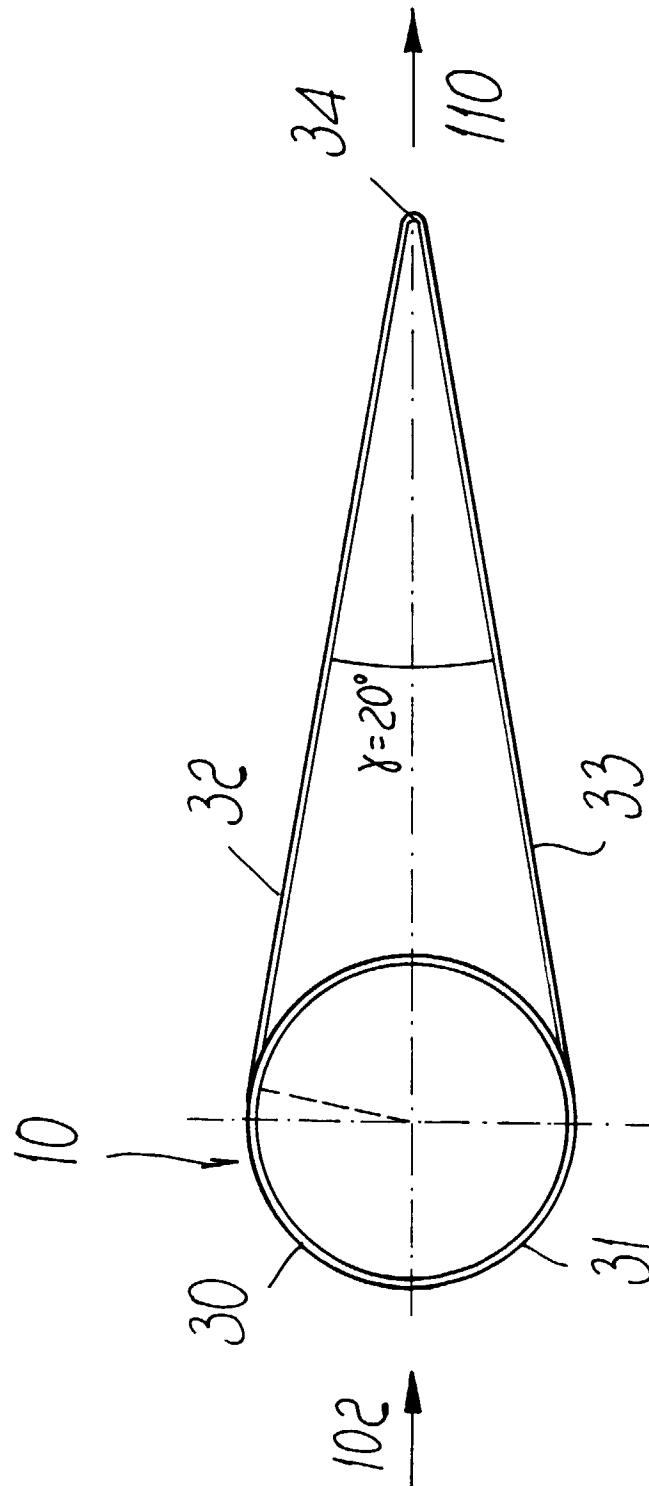


Fig. 2

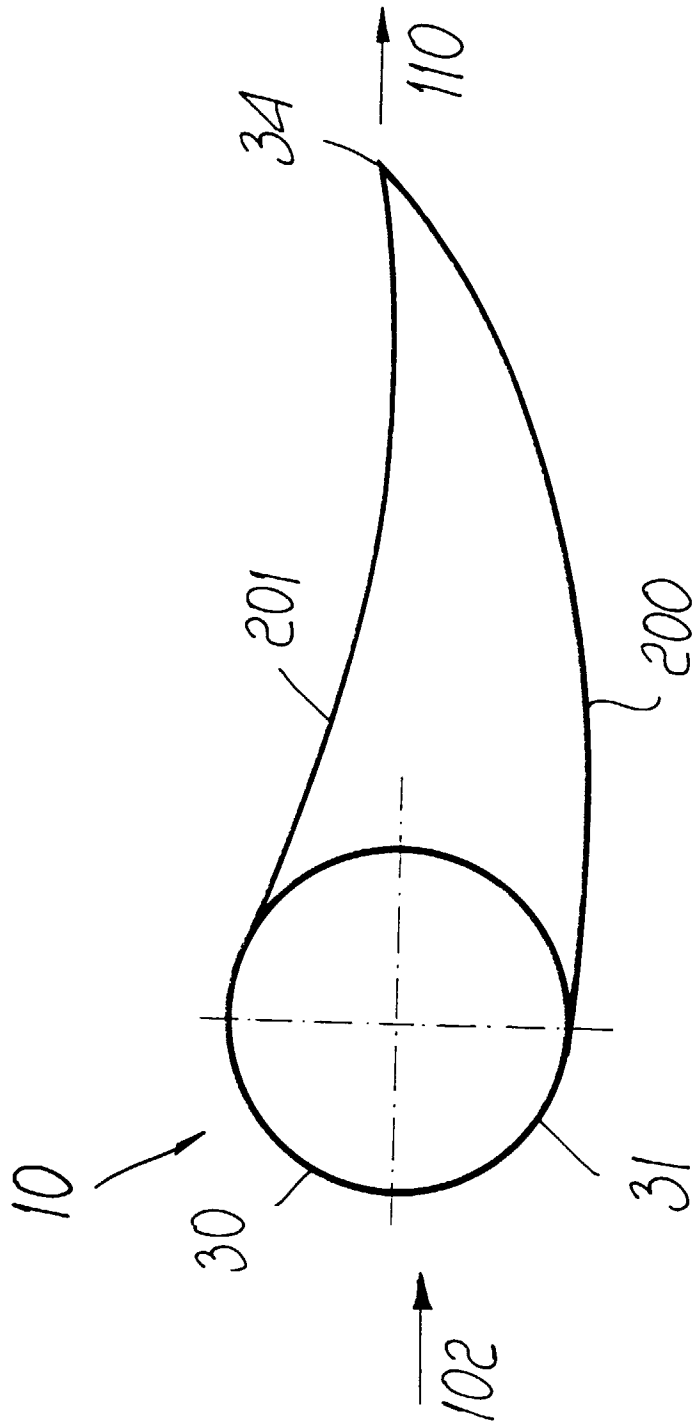


Fig. 3

FIG. 4

