United States Patent [19]

Östman

[11] **Patent Number: 4,944,150**

[45] **Date of Patent: Jul. 31, 1990**

[54] **PFBC POWER PLANT**

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[21] Appl. No.: **298,089**

[22] Filed: **Jan. 18, 1989**

[30] **Foreign Application Priority Data**

Jan. 18, 1988 [SE] Sweden 8800140

[51] **Int. Cl.**[5] **F02C 3/26;** F02C 6/18

[52] **U.S. Cl.** .... **60/39.182;** 60/39.464; 122/4 D

[58] **Field of Search** .... 60/39.464, 39.182; 110/263; 122/4 D; 431/170

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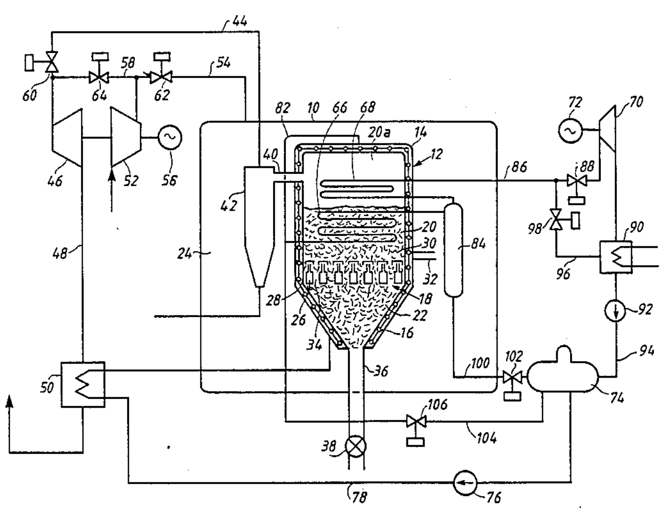
[57] **ABSTRACT**

A power plant burning a fuel at a pressure exceeding the atmospheric pressure includes a combustor formed with cooled walls which form a feed water preheater. A by-pass conduit with a control valve for draining feed water is connected to a feed water conduit between the feed water preheater (the combustor walls) and an evaporator in the combustor. This by-pass conduit may be connected to a feed water tank. At a very low load and in the case of a gas turbine trip, the necessary water flow for cooling the walls of the combustor may exceed the requirement of feed water to the evaporator. Under these operating conditions feed water may be drained off ahead of the evaporator through the by-pass conduit.

4 Claims, 2 Drawing Sheets



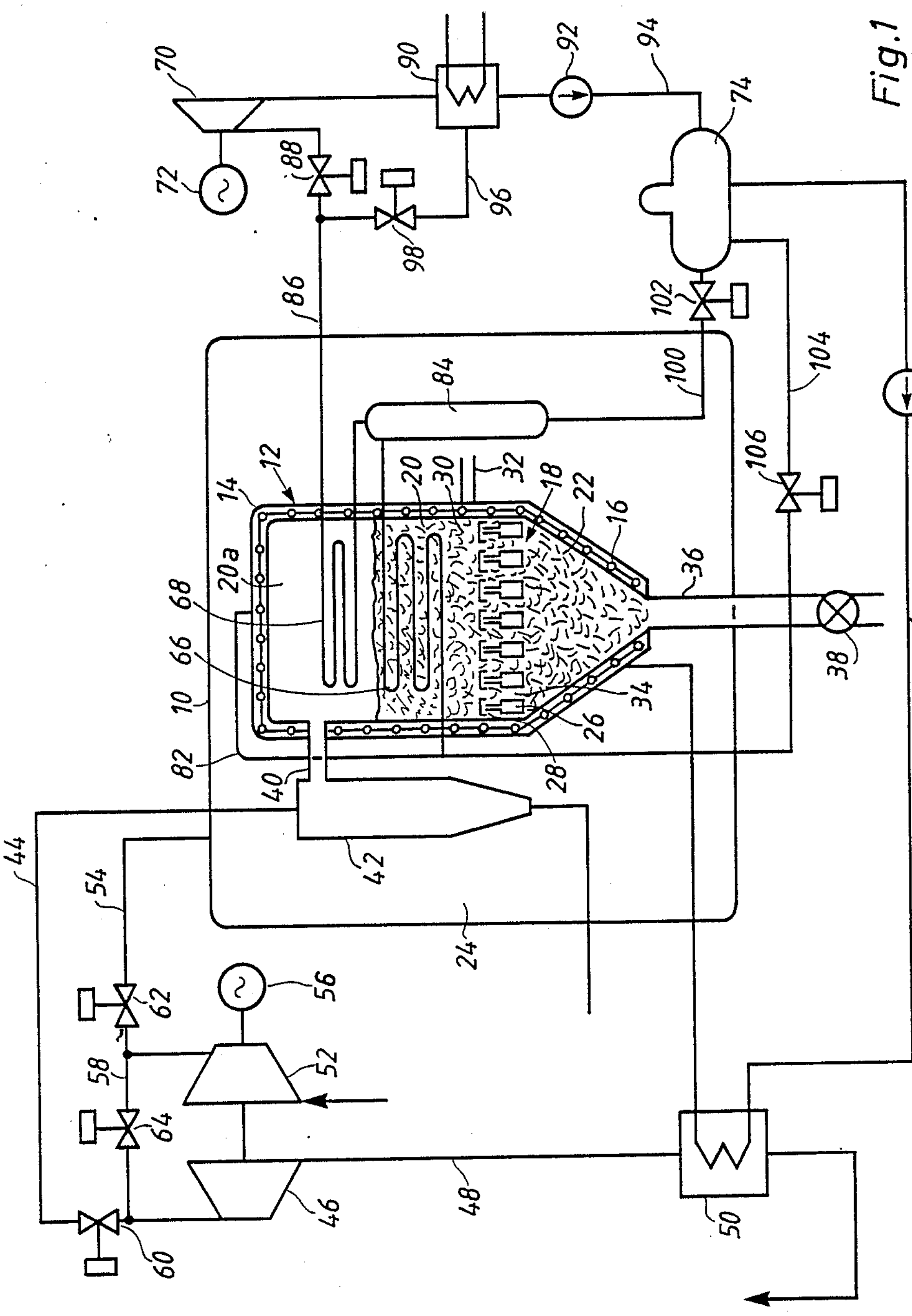

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Fig.1

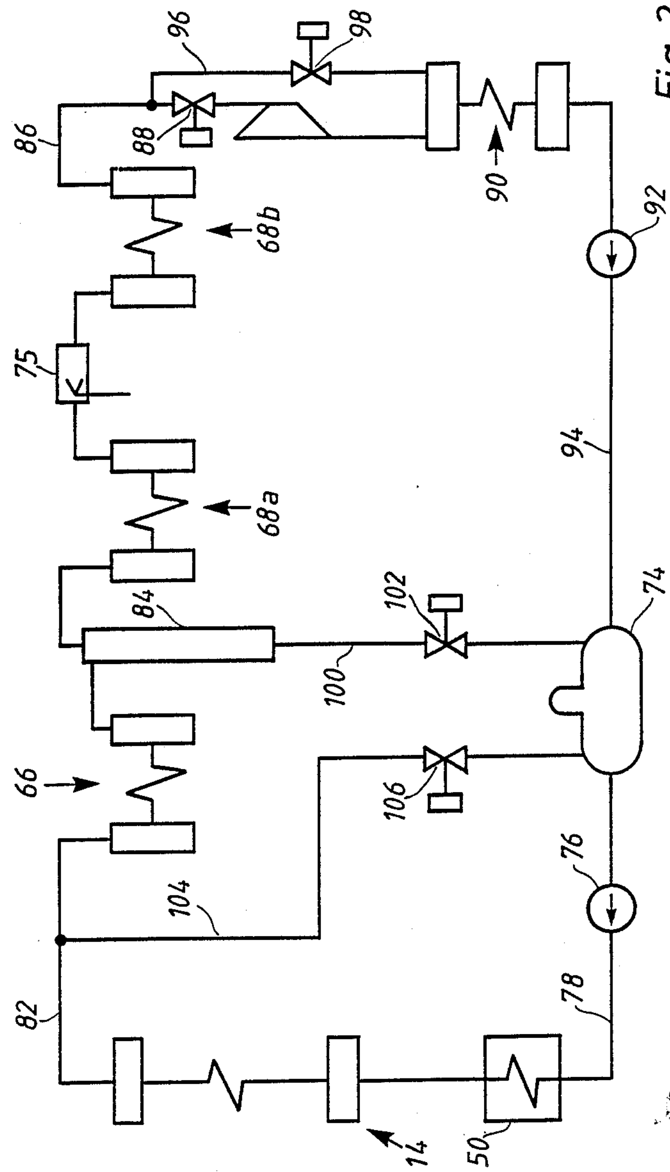
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Fig. 2

PFBC POWER PLANT

BACKGROUND ART

The invention relates to a PFBC power plant with a combustor operating at a pressure exceeding the atmospheric pressure and in which combustion gases drive a gas turbine which drives a compressor compressing combustion air. The walls of the combustor are water-cooled and form at least part of a feed water preheater for an evaporator and a superheater, placed in the combustor, for the generated steam (PFBC are the initial letters of the English expression Pressurized Fluidized Bed Combustion).

In a PFBC power plant, an optimum dimensioning of the feed water preheater, the evaporator and the superheater entails special problems at a very low load. It is advantageous to utilize the cooled walls of the combustor for preheating the feed water. These walls may form the entire feed water preheater or a part thereof. At a very low load, the necessary water flow for cooling of the combustor walls may exceed the water requirement in the evaporator of the plant. This means that too small a proportion of the supplied water is evaporated in the evaporator. The steam flow through the superheater may become insufficient so that its boiler tubes reach too high a temperature and are damaged. Upon a load drop out and a GT (gas turbine) trip, the large heat contents in the bed material of the combustor entail special problems. The water flow required for cooling the walls of the combustor is so great that the same flow through a subsequent evaporator results in very little steam being generated and in the tubes of the superheater not receiving a steam flow necessary for the cooling thereof, with an ensuing risk of these tubes being damaged.

SUMMARY OF THE INVENTION

In a power plant in which the combustor walls form at least part of a feed water preheater, a by-pass conduit with a controllable by-pass valve for feed water is connected to the connection between the feed water preheater and the evaporator in the combustor. By means of the valve in the by-pass conduit, the water flow to the evaporator is controlled such that, in the case of a load drop out or a low load, suitable water flow is achieved in the evaporator and the superheater.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be described in greater detail with reference to the accompanying drawing, wherein

FIG. 1 shows very schematically a PFBC power plant according to the invention, and

FIG. 2 shows a block diagram of such a plant.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

In the drawing, **10** designates a pressure vessel. A combustor **12** with cooled panel walls **14** containing cooling tubes **16** is arranged in the pressure vessel **10**. A distributor **18** for combustion air divides the combustor **12** into a combustion space **20** and an ash chamber **22**. The space **24** between the pressure vessel **10** and the combustor **12** contains compressed combustion air and communicates with the tubes **26** and the nozzles **28** of the distributor **18**. Through these nozzles **28**, the combustion space **20** is supplied with air for fluidization of the material in the bed **30** and combustion of fuel sup-

plied through the conduit **32** from a fuel storage (not shown). Fresh bed material can be supplied together with the fuel. Between the air distributor tubes **26** there are gaps **34** through which consumed material and formed ashes in the bed **30** are able to flow from the combustion space **20** to the ash chamber **22**. From the ash chamber **22**, material is discharged through the conduit **36** and the rotary vane feeder **38**.

The combustion gases generated during the combustion are collected in the freeboard of the combustion space **20** and are led through the conduit **40** to a cleaning plant, symbolized by the cyclone **42**. Cleaned gas is led from there a conduit **44** to the gas turbine **46** and is then forwarded through a conduit **48** to the economizer **50** and finally to a chimney (not shown). The gas turbine **46** drives the compressor **52**, which through the conduit **54** feeds the space **24** with compressed combustion air, and a generator **56** which can also be used as starter motor. Between the conduits **44** and **54** there is a short-circuit conduit **58**. Valves **60, 62, 64** are provided in the conduits **44, 54, 58**. In operation, the valves **60** and **62** are open and the valve **64** is closed. In the event of an operational disturbance resulting in a load drop out and a gas turbine trip, the valve **64** in the short-circuit conduit **58** is opened and the valves **60** and **62** are closed.

The combustion space **20** of the combustor **12** comprises an evaporator **66** and a superheater **68**. The evaporator **66** generates steam for a steam turbine **70** and cools the bed **30**. The superheater **68** superheats the steam. The turbine **70** drives a generator **72**. As shown by the block diagram in FIG. 2, the superheater **68** may be divided into a first part ***68a*** and a second part ***68b***. A water injection device **75** for controlling the steam temperature may be provided between the parts ***68a*** and ***68b***.

Water from a feed water tank **74** is pumped by a pump **76** through the conduit **78**, the economizer **50** and the conduit **80** to the tubes **16** of the combustor wall **14**, which tubes form a feed water preheater. The feed water, heated in the tubes **16** of the wall **14**, is forwarded to the evaporator **66** through the conduit **82**. Between the evaporator **66** and the superheater **68** there is a water separator **84**. From the superheater **68**, the steam is passed through the conduit **86** with the control valve **88** to the turbine **70**. Steam from the turbine **70** is led to the condenser **90**. The condensate is pumped by the pump **92** in the conduit **94** to the feed water tank **74**. Between the steam conduit **86** and the condenser **90** there is a by-pass conduit **96** with a valve **98** through which steam can be dumped to the condenser **90** upon drop out of the load of the generator **72** and closing of the steam control valve **88**. The water separator **84** is connected to the feed water tank **74**, by means of the conduit **100** with the control valve **102**, for drainage of water that has been separated. A conduit **104** with a control valve **106** connects the connection conduit **82** for preheated feed water from the tubes **16** of the combustor wall **14** to the evaporator **66**. A number of transducers for measuring temperatures, water flows, steam flows, and the like, and the operating devices of valves included in the plant are connected to signal processing and control equipment (not shown).

In the event of operational disturbance resulting in a load drop out which causes a turbine trip, control measures are taken which reduce the energy development in the combustor **12**. The fuel supply is interrupted, the bed depth is lowered, the air flow is reduced, and nitrogen gas can be supplied, etc. This means that the heat absorption in the evaporator **66** is reduced. The necessary water flow for cooling the combustor walls **14** is not reduced at the same rate and to the same extent. Water flow which prevents partial boiling and steam generation in the combustor wall **14** results in the steam generation in the evaporator **66** ceasing. The necessary cooling of the combustor walls **14** and the sufficient steam generation in the evaporator **66** are obtained by draining feed water, which has been heated in the walls **14**, from the connection conduit **82** through the by-pass conduit **104** with the control valve **106**. Also, in case of low load operation, a suitable balance between the water flow for cooling the combustor walls **14** and the water flow in the evaporator **66** and the steam flow through the evaporator **68** can be attained by drainage of feed water through the conduit **104** and the valve **106** to the feed water tank **74**. Upon a gas turbine trip, up to about 60% of the water flow in the combustor walls **14** is drained via the by-pass conduit **104**.

I claim:

1. A power plant burning a fuel at a pressure considerably exceeding the atmospheric pressure in a fluidized bed comprising:

a combustor with water-cooled walls which form a feed water preheater;

an evaporator provided within said combustor and having tubes which absorb heat from the fluidized bed and cool said bed;

at least one superheater arranged in said combustor;

a drain conduit connected to a feed water conduit between the preheater wall and the evaporator; and

a drain valve provided in said drain conduit for draining part of the feed water flow, thus maintaining the generation of steam in the evaporator substantially under all operating conditions and in case of a load drop out.

2. A power plant according to claim **1**, wherein a water separator is provided between the evaporator and the superheater.

3. A power plant according to claim **1**, wherein the combustor is connected to a gas turbine which drives a compressor which compresses combustion air.

4. A power plant according to claim **1**, wherein the combustor is enclosed within a pressure vessel and surrounded by compressed combustion air which is generated by said compressor and is supplied to a space between the pressure vessel and the combustor.

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