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Schwartz

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[54] **MIXING HEADER**

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[52] **U.S. Cl.** ..... **122/7 R,** 122/479 R, 122/487

[51] **Int. Cl.** **F22d 1/00**

[58] **Field of Search** ..... 122/7 R, 459, 487, 479 R

[56] **References Cited**

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[57] **ABSTRACT**

An elongated tubular header disposed on the discharge end of a superheater for a waste heat boiler, the header having a plurality of inlet ports for superheated steam disposed lengthwise along one side thereof, inlet ports for saturated steam disposed at the ends of the header and a steam outlet port disposed in a central portion of the header, whereby a regulated quantity of saturated steam enters the ends of the header and mixes with the superheated steam to control the temperature of the superheated steam leaving the header via the outlet port.

4 Claims, 2 Drawing Figures

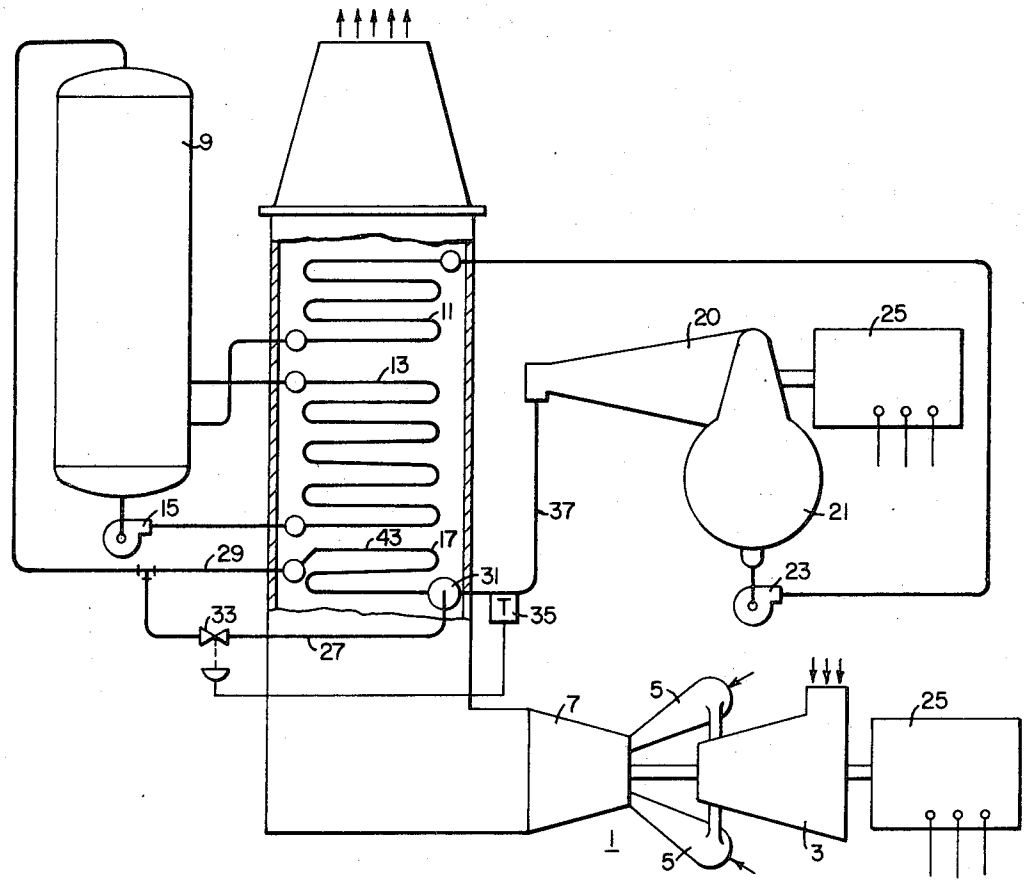


FIG.1

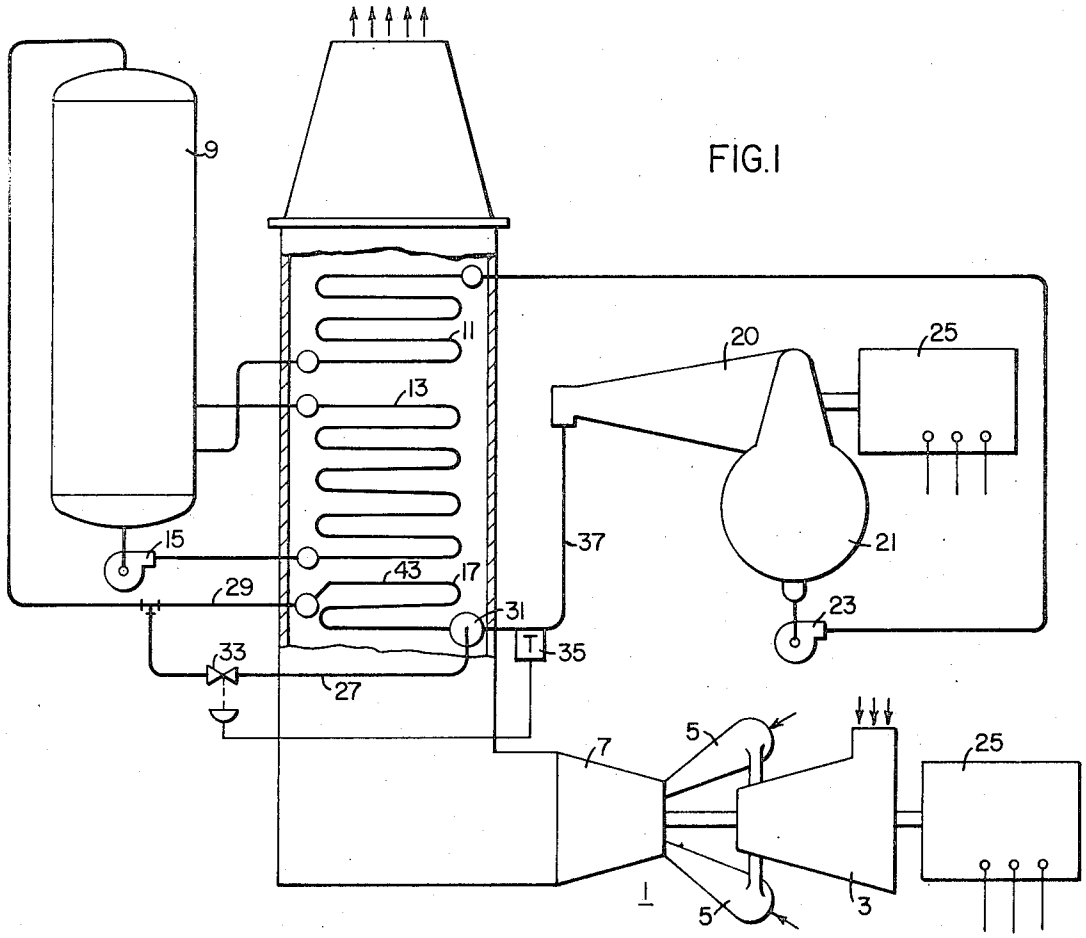
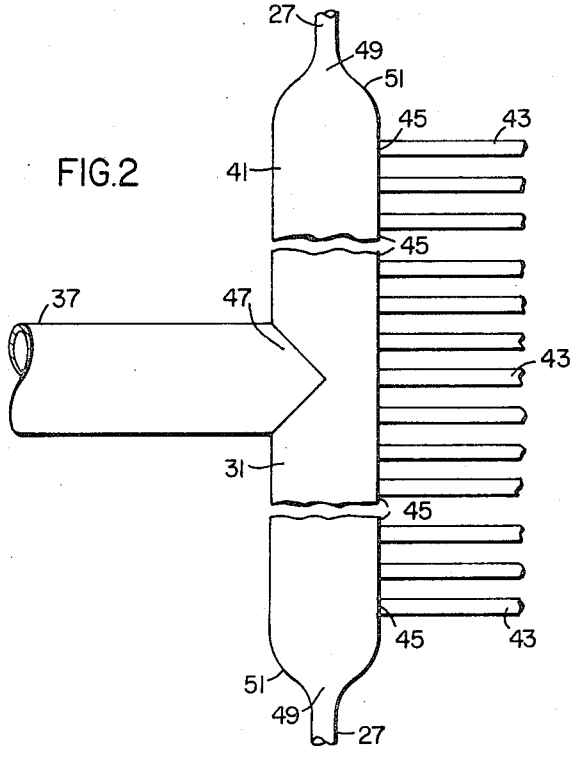

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FIG.2


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MIXING HEADER

BACKGROUND OF THE INVENTION

This invention relates to waste heat boilers, and more particularly, to a superheater outlet header for such boilers utilized to control the temperature of the superheated steam produced thereby.

Waste heat boilers such as those utilized to extract heat from the exhaust gases of a gas turbine may bypass saturated steam around the superheater and mix the saturated steam with superheated steam to control the temperature of the superheated steam entering the steam turbine. However, such a superheater temperature control system is not free from operating problems. Uneven mixing can cause temperature stratification in the downstream piping which could persist until after the steam enters the turbine. This would result in uneven heating of the turbine and high thermal stresses.

Another problem associated with such a superheater temperature control is that to maintain steam temperature, under cerain conditions, a large quantity of steam must bypass the superheater. This results in low steam flows and high temperature in the superheater tubes and outlet header, necessitating the use of thick walls and expensive alloys in the superheater header. The ends of the header of such a system are particularly subjected to high temperatures as the flow is at a minimum in these areas and the metal temperaure approaches that of the exhaust gas. In addition, as the loads on the steam and gas turbines change, the outlet steam temperature must be held constant, causing the header to experience rapid changes in wall temperature, which result in severe thermal stresses.

SUMMARY OF THE INVENTION

In general, a waste heat boiler, when made in accordance with this invention, comprises a duct for channelling the waste heat, means disposed in the duct for producing steam, means for separating moisture from the steam to provide essentially dry saturated steam, and means disposed in the duct for superheating the dry, saturated steam to produce superheated steam, and means for mixing the dry, saturated steam with the superheated steam to control the temperature of the superheated steam, irrespective of the flow through the superheating means.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and advantages of this invention will become more apparent from reading the following detailed description in connection with the accompanying drawings, in which:

FIG. 1 is a schematic diagram of a combined cycle steam and gas turbine plant having a waste heat recovery system made in accordance with this invention;

FIG. 2 is an enlarged plan view of a superheater outlet header for the waste heat recovery system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, FIG. 1 diagrammatically shows a waste heat recovery system for recovering heat from an exhaust of a gas turbine **1**, wherein air enters a compressor **3**, is compressed, and the pressurized air flows to a plurality of combustion

chambers or combustors **5**, wherein the air is mixed with a fuel such as natural gas or fuel oil, is ignited and burned, raising the temperature of the mixture. The high temperature mixture or motive fluid is then expanded in a gas turbine unit **7**. The exhaust gases leaving the gas turbine unit **7** still contain a large quantity of heat energy, and if exhausted to the atmosphere, this heat energy would be wasted. The other equipment shown forms the heat recovery steam generator portion of the system and comprises a vertical steam drum **9**, an economizer heat exchanger **11** for heating feed water or condensate being fed to the drum **9**, an evaporator heat exchanger **13** for evaporating water pumped from the drum **9** by a circulating pump **15** and a superheater heat exchanger **17** for superheating steam flowing from the drum **9**.

The steam produced in the evaporator **13** is saturated steam; however, it contains a large quantity of mositure carried over from the boiling process; therefore, to protect the superheater **17** from premature failure caused by scaling, which results from dissolved solids in the steam being carried over with the water and deposited on the walls of the tubes forming the superheater **17**, it is necessary to remove as much moisture as possible from the steam before it enters the superheater. To accomplish this, the steam drum **9** is deposited vertically and has moisture separators (not shown) disposed therein. For a more detailed description of such a system, reference may be made to the P. F. Sokolowski U.S. Pat. No. 3,751,886 issued Aug. 14, 1973, and assigned to the same assignee.

Superheated steam produced in the superheater **17** flows to a steam turbine **20**, and the exhaust steam from the steam turbine **20** is condensed in a condenser **21**. A condensate pump **23** pumps the condensate back through the economizer **11** to the steam drum, forming a closed cycle.

FIG. **1** also shows a generator **25** coupled to each turbine; however, the turbines can be coupled to a single generator by providing gearing or other connecting means between the turbines.

The gas turbine shown in FIG. **1** has an open cycle, that is, motive fluid is not recirculated therethrough.

To control the temperature of the superheated steam supplied to the steam turbine **20**, a superheater bypass line or conduit **27** is disposed to bypass saturated steam from an inlet pipe or conduit **29** to an outlet superheater header **31**. A valve **33** is disposed in the bypass line **27** to regulate the flow therethrough. The valve **33** is controlled by a controller **35**, responsive to the temperature of the superheated steam being supplied to the steam turbine **20** via conduit **37**, which connects the superheater **17** to the steam turbine **20**.

As shown in FIG. **2**, the superheater outlet header **31** has an elongated tubular shell **41** which provides a header for the tubes **43** which constitute the heat transfer surface of the superheater **17**. The tubes **43** are in fluid communication with a plurality of superheater inlet ports **45**, which are disposed lengthwise along one side of the shell **41**. A discharge port **47** is disposed on the opposite side of the shell **41** and in fluid communication with the conduit **37** supplying superheated steam to the steam turbine **20**. An inlet port **49** for saturated steam is disposed on each end of the shell and each port **49** is in fluid communication with the bypass conduit **27**. The saturated steam inlet ports **49** are disposed in reducers **51** which form transition members

which increase in cross-sectional area gradually from the cross-sectional area of the saturated steam inlet port **49** to the cross-sectional area of the shell **41,** allowing saturated steam to be admitted along with the superheated steam to keep the temperature of the ends of the header **31** generally lower than the temperature of the superheated steam leaving the tubes **43** or being supplied to the turbine **20** by eliminating stagnant areas normally associated with the ends of such headers.

The header **31,** hereinbefore described, advantageously provides excellent mixing as a plurality of small quantities of superheated steam enter at right angles to the flow of saturated steam, eliminating temperature stratification, which can occur when there is improper mixing of two different temperature fluids. The header temperature also remains generally constant and cooler, allowing the use of thinner walls and less costly materials in the construction thereof.

What is claimed is:

1. A waste heat boiler comprising a duct for channelling the waste heat, means disposed in said duct for producing steam, means for separating moisture from said steam to produce essentially dry, saturated steam and means disposed in said duct for superheating said dry, saturated steam to produce superheated steam and means for mixing said dry, saturated steam with said superheated steam to control the temperature of said superheated steam, irrespective of the flow through said superheating means, said mixing means being a part of said superheating means and comprising an elongated tubular shell having a plurality of inlet ports for superheated steam disposed lengthwise along the shell, an inlet port for saturated steam disposed at each end of the shell, and an outlet port disposed adjacent a central portion of said shell, and the ends of said shell forming transition means which increase in cross-sectional area gradually from the cross-section of the saturated steam inlet port to the cross-section of the shell.

2. A waste heat boiler as set forth in claim **1,** wherein the inlet ports for superheated steam are disposed at regular intervals lengthwise along the shell.

3. A waste heat boiler as set forth in claim **1,** wherein the outlet port is generally the diameter as the shell and is disposed at the mid-point of the shell.

4. A waste heat boiler as set forth in claim **1,** wherein the outlet port is diametrically opposite at least one superheated steam inlet port.

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