Oct. 30, 1962 A. H. RAWDON 3,060,906

CONTROL OF SUPERHEAT

Filed Oct. 19, 1961

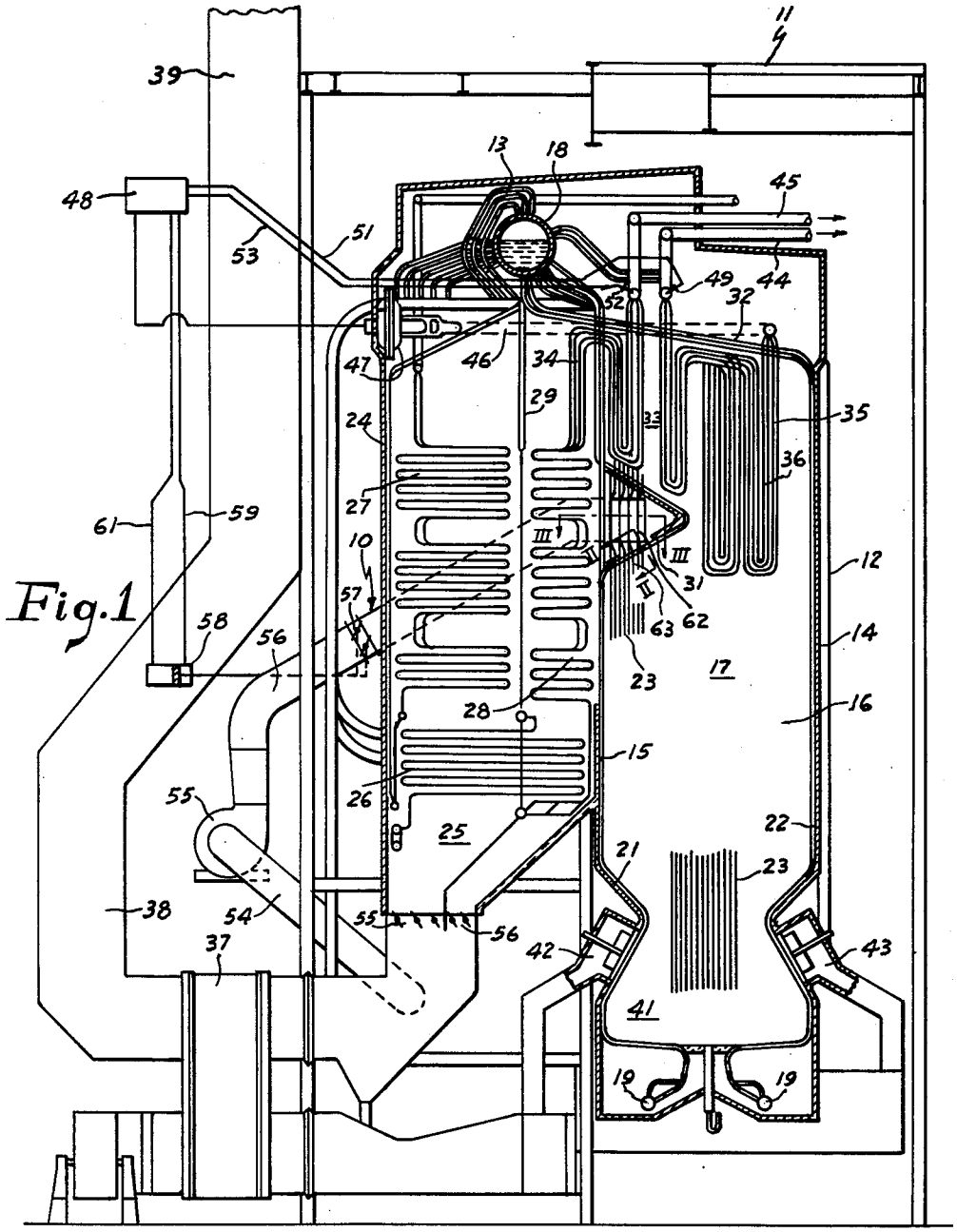


Fig. 1

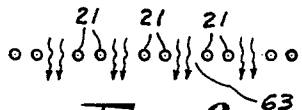


Fig 2



Fig. 3

INVENTOR.
ALBERT H. RAWDON
BY
Norman S. Blodgett

United States Patent Office

3,060,906

Patented Oct. 30, 1962

3,060,906

CONTROL OF SUPERHEAT

Albert H. Rawdon, Shrewsbury, Mass., assignor to Riley Stoker Corporation, Worcester, Mass., a corporation of Massachusetts

Filed Oct. 19, 1961, Ser. No. 164,636
1 Claim. (Cl. 122—478)

This invention relates to the control of superheat and more particularly to apparatus arranged to maintain the temperature of superheated steam in a steam generating unit at a selected level. This application is a continuation-in-part of my patent application Serial Number 698,213, filed November 22, 1957.

In the operation of a steam generating unit, it is quite important that the temperature of the superheated and reheated steam produced by the unit be maintained at a constant predetermined value. This is because the turbine served by the unit is designed for operation most efficiently at at fixed pressure and temperature of steam. It is particularly important that the temperatures of superheat and reheat be maintained despite changes in the load requirements of the unit. Maintaining control of this type is complicated by the fact that, in a convection heat exchanger, the temperature of superheated steam would have a rising characteristic; that is to say, the temperature produced is higher at high loads. On the other hand, a purely radiant heat exchanger has a drooping characteristic, in that the temperature becomes less with increases in load. A further factor complicating the situation in the fact that at high loads the temperature of steam being returned from the turbine to the steam generating unit for reheat is at a higher temperature than it is at low loads, so that less reheating is necessary. One of the methods used in the past to control superheat has been that of recirculating portions of the gas from the back passes of the steam generating unit into the furnace. This method of superheat control has presented a few problems, not the least of which is the fact that it tends to load the gas flow with unconsumed dust from the back passes of the unit. It is true also that the recirculation of gas as it has been practiced in the past tends to inhibit good combustion. These and other difficulties experienced with prior art apparatus have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a control of superheat which improves the furnace operation while giving a desirable regulation of the temperature of output steam from the superheater or reheater of a steam generating unit.

A still further object of the present invention is the provision of a steam generating unit having a high-temperature slagging cell and means for recirculating furnace gases to enhance the operation of the unit.

It is another object of the instant invention to provide apparatus which not only enhances the operation of the furnace, but also provides control of superheat.

A further object of the invention is the provision of a steam generating unit containing optimum combination of gas recirculation and high-temperature, localized combustion to provide slag-free operation and accurate regulation of superheat.

A further object of the invention involves the provision of apparatus for providing control of the superheat by the recirculation of gases in such a manner that combustion is not affected, that promotes good mixing between the main body of gases and the recirculated gases takes place, that is relatively inexpensive to manufacture, that provides for self-cleaning of the recirculation ports, that, because of the provision of water cooling, results in little maintenance, that does not interfere with

the formation of slag in the furnace bottom, and that permits a wide selection of arch construction and positioning in connection with the furnace.

It is another object of the instant invention to provide apparatus which not only enhances the operation of the furnace, but also provides control of superheat.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

The character of the invention, however, may be best understood by reference to one of its structural forms as illustrated by the accompanying drawing in which:

FIG. 1 is a longitudinal, vertical, sectional view of a steam generating unit embodying the principles of the present invention;

FIG. 2 is an enlarged sectional view taken on the line II—II of FIG. 1; and

FIG. 3 is an enlarged sectional view taken on the line III—III of FIG. 1.

Referring to the drawings, the steam generating unit, designated generally by the reference number **10**, is shown in FIG. 1 as comprising a supporting structure **11** on which is mounted a furnace **12** and a boiler **13**. The furnace **12** is of the general type shown and described in the patent of Craig, No. 2,853,059. It consists of a front wall **14**, a rear wall **15**, and side walls **16** defining a combustion chamber **17**. The furnace is provided with a continuous-slag bottom of a well-known type. The boiler **13** consists of a steam-and-water drum **18** connected by a downcomer, not shown, to lower headers **19**. Extending upwardly from the headers **19** are water-wall tubes **21** and **22** covering the rear wall **15** and the forward wall **14** of the furnace, respectively. From the headers **19** also extend side water-wall tubes **23** which cover the side walls **16** of the furnace. A back wall **24** extends vertically of the steam generating unit in spaced relationship to the rear wall **15** of the furnace and defines therewith a back pass **25**. In the back pass resides a tubular economizer **26** extending completely from the wall **15** to the wall **24**. Adjacent the wall **24** is located a low-temperature superheater **27** and adjacent the wall **15** in the back pass is located a low-temperature reheater **28**. The superheater **27** and the reheater **28** are separated by a wall of tubes **29** which are separated at the upper portion to permit the passage of gas.

On the upper part of the wall **15** of the furnace is situated a nose **31** which extends forwardly into the furnace and is lined with tubes **21** of the water-wall. The upper portion of the nose **31** and the roof of the furnace define a horizontal pass **33** which serves to connect the combustion chamber **17** with the back pass **25**. At the back portion of this horizontal pass **33** resides a high-temperature section **34** of the reheater. In the forward portion of the horizontal pass **33** resides a high-temperature superheater **35** partly in the form of pendant platens **36** which reside in the upper part of the combustion chamber **17** and hang somewhat below the apex of the nose **31**.

The lower part of the back pass **25** is connected through a regenerative reheater **37** to a breaching **38** leading to the stack **39**. The lower part of the combustion chamber **17** is provided with a high-temperature cell **41** defined by abutments which extend from the front and rear walls toward the center of the furnace. The abutment in the rear wall **15** is provided with a burner **42**, while the abutment on the front wall **14** is provided with a burner **43**; these burners are of the intertube directional-flame type shown and described in the patent of Craig No. 2,759,460.

The high-temperature superheater **35** has an outlet leading to a superheater steam header **44** while the high-temperature section **34** of the reheater is connected to a

reheated steam header 45. A header 46 leads from the output of the low-temperature superheater 27 to the inlet of the high-temperature superheater 35 and in this conduit is located a desuperheater 47 of the type having a valve for admitting water into the steam flow to decrease the temperature of the steam. The amount of desuperheating done by the desuperheater 47 is controlled by means of a conduit connected to a main controller 48 which, in turn, is connected by a line 51 to a temperature responsive device 49 located in the superheated steam header 44 and by a line 53 to a temperature responsive device 52 located in the reheated steam header 45.

A duct 54 is connected at one end to the lower part of the back pass 25 below a set of dampers 55 and 56. The dampers 55 control the flow of gas through the part of the back pass included between wall 29 and wall 24, while the dampers 56 control the flow through part of the back pass between the wall 29 and the wall 15 of the furnace. The other end of the duct 54 is connected to a fan 55 whose output is connected through a duct 56 to the interior of the nose 31. A set of dampers 57 is located in the duct 56 and the setting of these dampers is controlled by a hydraulic linear actuator 58 which, in turn, is controlled through lines 59 and 61 connected to the controller 48.

Referring now to FIG. 3, it can be seen that the duct 56 is connected to side wall of the furnace and that gases are admitted through tubes 23 of the side wall in the interior of the nose 31. The tubes in the area occupied by the duct 56 are bent alternately rearwardly to form a passage 62 for the flow of gases into the interior of the nose. As is evident in FIG. 2, the water-wall tubes 21 overlying the lower inclined surface of the nose 31 are provided with spaces 63 therebetween; the interior insulating material is removed from the inside of the nose adjacent this lower surface and an opening is provided for the flow of gases into the furnace. The spaces 63 between the tubes 21 are provided, as is evident in FIG. 1, by causing a certain number of the water-wall tubes to continue up the back wall 15 directly to the steam-and-water drum 18 rather than bending them forwardly along the surface of the nose. This means that considerably more refractory is exposed on this nose than in most of the furnace, but this is not detrimental to good operation of the furnace.

The operation of the apparatus will now be readily understood in view of the above discussion. Combustion takes place in the usual manner by the passage of fuel to the burners 42 and 43 into the high-temperature cell 41. In this cell, extreme turbulence takes place and most of the combustion is completed before the gases pass upwardly between the abutments. Radiation takes place between the upwardly flowing gases and the water-wall tubes of the furnace and the gases pass over the high-temperature superheater 35 and the high-temperature reheater 34 as they pass around the nose 31 and through the horizontal pass 33. The gases are divided between the forward and rearward portions of the back pass 25 by the particular settings of the dampers 55 and 56. Some of the gases pass over the low-temperature superheater 27 and part of the economizer 26 while other parts of the gases pass over the low-temperature reheater 28 and the other part of the economizer 26. The gases then pass through the rear header 37 into the breaching 38 and up the stack 39. Some of the gases, however, are withdrawn through duct 54 by the fan 55, and pass through the duct 56 past the dampers 57 into the interior of the nose 31. Gases enter the nose between tubes in the passages 62 provided therefor and, after residing a time in the interior of the nose 31, they pass downwardly through the opening in the lower surface thereof defined by the passages 63 between the tubes 21. Gases introduced into the furnace in this manner are directed downwardly and forwardly of the furnace and strike the upwardly rising gas resulting from the regular combustion. Extreme turbulence takes place and thorough mixing, resulting in a homogeneous mixture of gases in the horizontal pass 33. The introduction of gases in this manner results in a lower temperature of gases passing over the superheater and reheater surfaces, but on the other hand, results in an increase in the mass flow. The temperature to which the steam is raised in these heat exchanger elements is a matter of design and may vary from one installation to another.

The temperature responsive devices 49 and 52 send signals to the controller 48 through the lines 51 and 53, respectively. If the superheated steam varies from the prescribed value, the variance is compensated for either by means of the desuperheater 47 or the dampers 57 acting from a signal from the controller 48 passing through the lines 59 and 61 to produce action through the actuator 58. It is thus possible to maintain the temperature of superheat at a constant preselected value despite changes in load on the unit.

The desirable thorough mixing of the recirculated gas and the normal products of combustion is brought about by the fact that the nose 31 extends a substantial distance across the combustion chamber. This means that a large proportion of the products of combustion rise vertically through the combustion chamber and strike the downwardly-directed lower surface of the nose and are then directed toward the front of the furnace. These gases slide along the surface of the nose and across the opening from which the recirculated gases are emerging. The scrubbing of the normal products of combustion across the opening brings about a thorough mixing with the recirculated gas. Thus, by use of the present apparatus, it is possible to obtain thorough mixing of the gases from the two sources before the resultant mixture passes over the convection superheater surfaces, thus avoiding undesirable stratification. This is very important to the obtaining of stable superheat control, since the fact that the recirculated gas is so much cooler than the gases originating in the burners makes lack of thorough mixing an important problem. At the same time, the cool recirculated gases are not introduced into the high-temperature cell 41 below the abutments; as a result, the temperature in the cell is not reduced by the introduction of cool recirculated gases. This feature is particularly important at low load when the greatest volume of gas is recirculated and, yet, ignition at the burners is hardest to maintain in a stable condition.

In addition, the manipulation of the directional-flame burners 42 and 43 permits the placement of the main flow of products of combustion in a selected position between the front and back of the combustion chamber. It is possible by this method to regulate the impingement of the products of combustion on the lower surface of the nose and, thus, to regulate the ejector action of these gases as they flow transversely across the recirculated gas opening. At high load, for instance, when the recirculated gas will be low in volume, the products of combustion will be low; at that time, mixing of the two gases is less important, and it may be desirable to direct the flame so that the least impingement on the nose takes place. On the other hand, at low load, the recirculated gas will be high in volume and the combustion gases will be relatively low; then, thorough mixing is most important and, because of the high volume of cool gases protecting the nose, impingement is not a problem. The flame would, therefore, be directed up the rear wall at low load.

Certain minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desired to confine the invention to the exact form herein shown and described, but it is desired to include all such as properly come within the scope claimed.

The invention having been thus described, what is new and desired to secure by Letters Patent, is:

A steam generating unit, comprising a vertically-elongated furnace having a slag-tap bottom and a vertical rear wall,

a horizontal pass leaving the upper part of the furnace,

a back pass to which the horizontal pass is connected,

a convection superheater located in the horizontal pass and in the back pass,

abutments formed in the furnace walls to define a high-temperature cell with the furnace bottom, the cell having a relatively narrow exit into the upper part of the furnace,

burners located on the downwardly-directed surfaces of the abutments,

a nose extending horizontally from the rear wall into the furnace in the portion thereof immediately underlying the horizontal pass and forming at least a portion of the bottom thereof,

the said nose extending across the furnace a substantial distance and having an underside which is inclined upwardly toward the center of the furnace, a substantial portion of the said underside overlying a substantial portion of the exit of the said cell,

gases rising upwardly from the high-temperature cell approaching the said underside and flowing upwardly parallel thereto before passing upwardly between the nose and a furnace wall lying opposite it into the horizontal pass,

water-wall tubes lining the rear furnace wall and forming part of the surface of the nose,

a portion of the water-wall tubes being bent upwardly from the plane of the rear wall to form part of the nose,

the remainder of the tubes extending upwardly in the plane of the rear wall to define with the said portion an enclosure extending transversely across the furnace,

the said nose thus having a hollow interior and being provided with a liner of refractory material having openings into the furnace only on the underside between the water-wall tubes,

a duct leading from the back pass into the interior of the said nose,

means regulating the amount of gas which passes through the said duct to provide a broad control of the temperature of steam leaving the superheater, and

a spray-type desuperheater providing a fine control of the said temperature of the steam.

References Cited in the file of this patent

UNITED STATES PATENTS

2,897,797	Koch	Aug. 4, 1959
2,905,155	Grossman	Sept. 22, 1959

FOREIGN PATENTS

724,934	Great Britain	Feb. 23, 1955