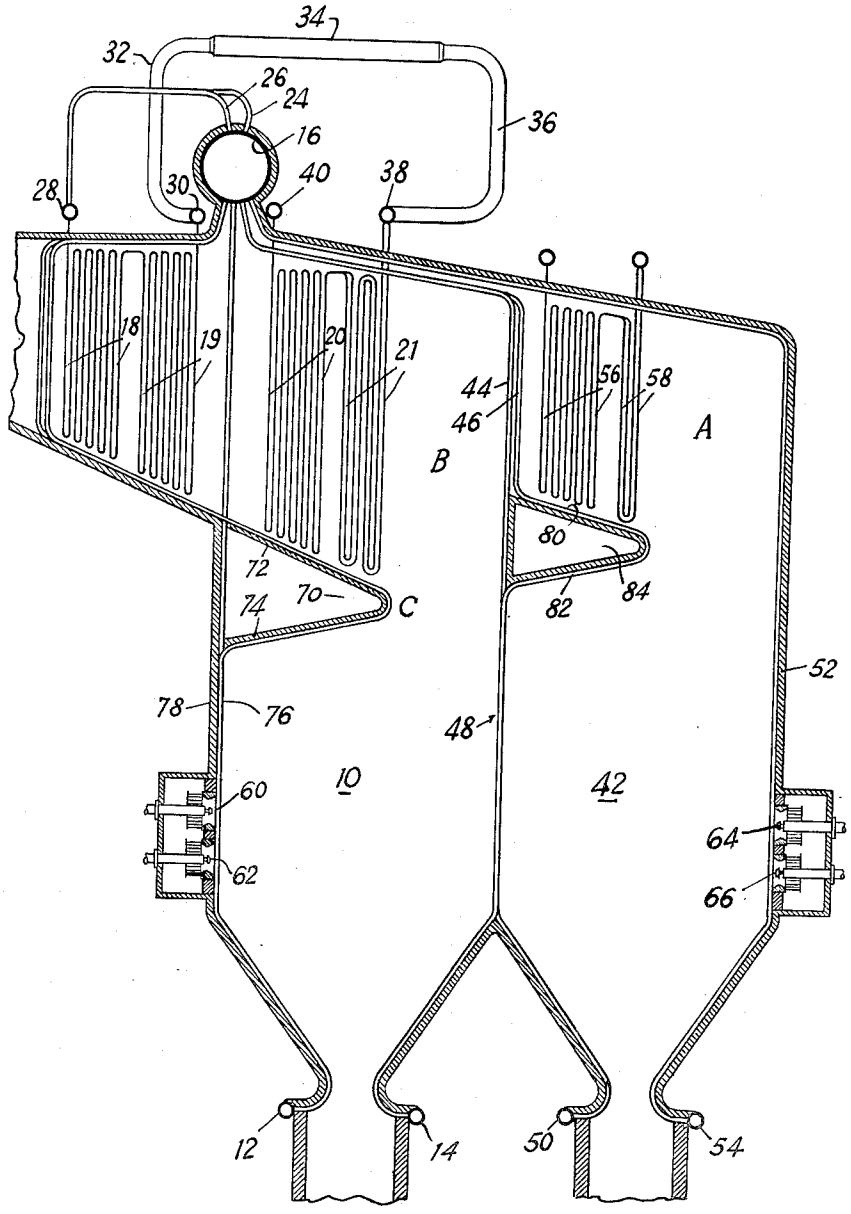
March 30, 1954 W. H. ROWAND ET AL 2,673,553

MULTIPLE FURNACE FLUID HEATING UNIT

Filed March 1, 1950



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Patented Mar. 30, 1954

2,673,553

UNITED STATES PATENT OFFICE

2,673,553

MULTIPLE FURNACE FLUID HEATING UNIT

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Application March 1, 1950, Serial No. 147,102

8 Claims. (Cl. 122—240)

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This invention relates to improvements in steam generators.

The invention more particularly relates to a type of steam generating installation including a superheater, a turbine, and a reheater.

It is an object of this invention to provide a steam generating installation in which the component parts, and particularly the superheater and reheater, are so constructed and arranged that the steam from the reheater is kept at approximately uniform temperature over a wide range of ratings. A further object of the invention is providing a steam generating installation in which the arrangement is such as to provide ample protection against overheating the reheater associated therewith, and to maintain a predetermined steam temperature at the outlet of the reheater.

The invention is exemplified by a steam generating and steam superheating installation in which highly superheated steam at high pressure is expanded through a high pressure turbine and then at the resultant exhaust pressure is returned to the installation for superheating by reheating to a high degree for further expansion through a relatively low pressure turbine exhausting to a condenser.

In installations of this character where the steam is generated at a high pressure (which may be of the order of 1500 p. s. i. to 2500 p. s. i.) both the initial superheating and the reheat superheating is most advantageous if carried out to correspondingly high temperatures of the order of 950° F. or above.

With regenerative heating of the feed water by bleeding steam from selected stages of the steam turbines, the withdrawal of steam for such heating from the high pressure turbine allows only a fraction of the initial steam flow to pass from the exhaust of the high pressure turbine to the steam reheater. In other words the reheater is normally called upon to reheat a smaller quantity of steam than that flowing through the initial or primary superheater.

In order to attain a high degree of reheat superheating it is desirable to subject the reheater to high temperature gases, yet due to the fact that no steam flows through the reheater until the turbine is in operation, provision must be made to avoid overheating the reheater tubes by subjecting them to hot gases prior to steam flow therethrough.

The present invention provides an arrangement of a pair of fuel burning furnaces so related to reheating and superheating surfaces that

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controlled heat input into the respective surfaces may be effected not only in meeting the requirements in starting up when there is no steam flow through the reheater but also in regulating or controlling the delivered temperature of the superheated high pressure steam and the reheated steam to the optimum high value for high thermal efficiency of the turbine.

Two furnaces, each with its complement of fuel burners, are provided. Both furnaces are defined by water cooled walls and the heat absorption of the walls generates the major portion of the steam and reduces the temperature of the products of combustion to a degree related to the fusion temperature characteristics of the ash in the coal, where such fuel is used.

One furnace delivers products of combustion directly to the primary superheater for the high pressure steam. The other furnace delivers products of combustion to the reheat superheater from which they flow into the outlet portion only of the first furnace and then to the primary superheater. Gases from the second furnace thus generate high pressure steam, reheat low pressure steam and contribute to the superheating of the high pressure steam, while gases from the first furnace generate high pressure steam and superheat high pressure steam.

When the furnace volumes and heat absorbing surfaces are so arranged that 70% of the total heat of the fuel is introduced into the second furnace serving the reheater, while 30% is introduced into the furnace serving the primary superheater directly, regulation of the distribution of the relative fuel inputs to the two furnaces as the rate of steam generation of the unit is reduced permits the maintenance of substantially uniform superheat and reheat steam temperatures down to a fractional output rate of the order of 65%.

More specifically, a steam generator embodying the invention involves a furnace having its walls and other boundaries defined by steam generating tubes connected into the water circulation of the installation. A steam and water drum, connected to the upper ends of these tubes receives the discharge of the tubes and the drum is connected to lower headers by downcomer tubes to afford a continuous supply of water to the lower inlets of the steam generator tubes. The pertinent steam generating installation also involves a furnace which is divided by one or more rows of steam generating tubes into two component furnaces. The latter are separately fired, one being fired from the standpoint of the requirements

of reheat control, with the gases flowing through a convection pass across the tubular elements of a steam reheater. Beyond the reheater these gases join the gases from the other part of the furnace. The combined gases then pass through another convection pass in which there is located a convection superheater. The latter may be divided into two sections with the steam flowing from the steam and water drum through the first section of the superheater, and then to an attemperator which is operated to control the final superheat temperature. From the attemperator, the steam flows to the second section of the superheater, and from that section of the superheater to a turbine. From a lower stage of the turbine, steam flows through the tubular elements of the reheater.

The novel features of our invention are pointed out with particularity in the appended claims, but in order that the invention may be clearly understood, it will now be described in detail, in connection with the accompanying drawing showing an illustrative embodiment of the invention.

In said drawing the figure is a diagrammatic view in the nature of a sectional elevation.

The drawing discloses a large volume furnace 10 defined by wall tubes some of which connect the lower headers 12 and 14 to the steam and water drum 16, as illustrated. Similar wall tubes and headers are provided for the remaining furnace walls. The gases pass from the upper part of this furnace to a gas outlet in which are disposed the sections 18–21, inclusive, of a convection superheater.

Steam passes from the steam and water drum 16 through connectors such as 24 and 26 to the superheater inlet header 28. From that header the steam flows through the upright tubes of the superheater section 18, and then successively through the tubes of the superheater section 19 to the intermediate superheater header 30. From that header the steam flows through a conduit 32 to an attemperator 34. From the attemperator, steam flows through the conduit 36 to a second intermediate header 38, and thence through successive superheater tubes of the superheater sections 21 and 22 to the superheater outlet header 40.

Adjoining the furnace 10 is a similar furnace 42, the gases from which are discharged into the upper part of the furnace 10 across the tubular screen formed by the upper sections of tubes 44 and 46. The lower sections of these tubes delineate a furnace separating wall 48 common to both furnaces 10 and 42. Some of the tubes forming the wall 48 are connected at their lower ends to the submerged header 50 and other wall tubes of the furnace 42 along wall 52 connect the submerged header 54 with the steam and water drum 16. The remaining walls of furnace 42 include similar wall tubes and appropriate lower headers, the latter, with the headers 12 and 14 being connected to the drum 16 by suitable downcomers.

The gases from the furnace 42 pass across successive series connected tubes of the reheater sections 56 and 58 and then enter the upper part of the furnace 10 adjacent the superheater.

The furnace 10 is fired by pulverized coal burners such as those illustrated at 60 and 62, and the furnace 42 is fired by similar burners as indicated at 64 and 66.

In the operation of the illustrative installation, the reheater including the sections 56 and 58 is heated only by the gases from the furnace 42, and, consequently, danger of overheating the tubes of the reheater is minimized by so controlling the operation of the furnace 42 that it does not discharge gases across the reheater until steam is passing through the latter.

The reheater receives steam from an intermediate stage of a turbine operated by steam supplied by the steam generator. This steam supply to the reheater is at a pressure lower than the pressure of the steam supplied to the superheater, and with this arrangement there is no steam flow through the reheater until after the turbine is in operation.

When 70% of the total heat input to the installation is being supplied by the furnace 42 and the remaining 30% of the total input supplied by the furnace 10, the illustrative installation will maintain control of superheat and reheat from 90% down to about 65% of total capacity. From 100% capacity down to 90% superheat is controlled by the attemperator indicated at 34 in the drawing.

The invention is particularly applicable to installations operating at superheat and reheat temperatures of the order of 1000° F., where the heat required for superheating and reheating is a high percentage of the total heat.

Each of the steam heaters, the superheater and the reheater, is of the vertical tube type. Furthermore, there is no tubular screen immediately in front of each of the steam heaters.

The furnace gases pass from chamber A, above the combustion chamber 42 across the tubes of the reheater sections 56 to 58 and then across the screen tubes 44 and 46 into the chamber B which acts as a mixing chamber for the gases from the different furnaces to provide a uniform temperature of the gases crossing the superheater sections 18–21, inclusive.

The chamber A is disposed at the top of combustion chamber 42 and has a lateral outlet from which the gases pass to the chamber B and the latter has a side inlet for furnace gases from the combustion chamber 10.

The superheater sections 20 and 21 are protected from radiant heat directly transmitted from the combustion chamber 10 by the arch 70 having the downwardly inclined upper wall 72 and the upwardly inclined lower wall 74. These walls converge at C and are delineated by portions of the wall tubes 76 along the wall 78 of the combustion chamber 10. This arch 70 also acts to prevent cooler gases from the furnace 42 from coming down into the furnace 10.

The screen comprising the tubes 44 and 46 acts to protect the reheater from high temperature furnace gases in the furnace 10 and the tubes 46 have intermediate portions such as 80 and 82 bent to form the arch 84 which extends from the common wall 48 to a position above the midportion of the furnace 42. Thus, by virtue of the arch construction 84 and the screen comprising the tubes 44 and 46, there is very little heat transfer from the furnace 10 to the reheater when only the furnace 10 is in operation.

When the illustrative installation is operating at pressures in excess of 1500 p. s. i. and at superheats of the order of 1000° F., the installation is controlled by varying the operation of the burners of the furnaces 10 and 42 to maintain control of steam superheating and reheating over a wide load range.

Although the invention is described with reference to the details of the particular embodiment

illustrated in the drawings, it is to be appreciated that the invention is not limited to all the details thereof. It is rather of the scope commensurate with the scope of the subjoined claims.

What is claimed is:

1. In a vapor generating, superheating and reheating unit having separately fired superheater and reheater vapor generating furnaces; a vapor and liquid drum adjacent the upper part of the unit; vapor generating wall tubes extending from the drum and forming the roof and other boundaries of separately fired reheater and superheater furnaces and the boundaries of reheater and superheater gas passes leading laterally from the upper parts of the respective furnaces; said boundary vapor generating wall tubes generating at least the predominant proportion of the total vapor generated by the unit; a reheater; a superheater; some of said tubes also presenting a wall common to the furnaces with some of the tubes of this common wall also forming a radiant heat shield interposed relative to the reheater and the major part of the reheater furnace, the reheater gas pass receiving all of the gas generated by the reheater furnace and discharging those gases toward the superheater gas pass and at such a position adjacent thereto as to by-pass the main part of the superheater furnace; fuel burning means disposed in the furnace walls and directing combustion elements along opposite sides of said common wall; and a radiant heat shield defined by parts of said wall tubes and interposed relative to the superheater, on the one hand, and the firing means for the superheater furnace, on the other hand; said fuel burning means normally operating to fire the furnaces independently of each other with the reheater furnace being fired from the standpoint of the requirements of reheat control.

2. In a high pressure steam generating unit, steam generating wall tubes delineating a first combustion chamber or furnace of large volume and constituting the major part of the total steam generating surface of said unit, means for firing the furnace, some of said steam generating tubes being bent into arch forming arrangement to delineate an arch extending over a major part of said combustion chamber, refractory material closing the spaces between the arch delineating tubes and completing the arch, a convection superheater including a bank of series connected upright tubes disposed above said arch and across the path of gas flow in a gas pass leading from said combustion chamber, the disposition of the superheater tubes over the arch being such that the arch affords a radiant heat screen interposed relative to the superheater and the predominating proportion of the combustion chamber, other steam generating tubes delineating a second large volume furnace or combustion chamber having its gas outlet in the upper part of a wall common to both combustion chambers, some of said other tubes delineating said common wall having intermediate parts extending in arch forming arrangement at the upper part of the second combustion chambers, means for separately firing said second combustion chamber, a convection reheater including a bank of series connected upright return bend tubes disposed directly above said last mentioned arch forming tubes and disposed across the path of gas flow in a reheater gas pass leading from the second combustion chamber, and means including a steam and water drum having the upper ends of the steam generating tubes connected thereto and supplying steam for the superheater, the reheater being subject to a minimum of heat absorption while the entire superheater is heated to an operative degree.

3. In a superheater and reheater steam generating unit, first and second furnaces having their boundary surfaces defined by steam generating wall tubes generating substantially all the steam provided by the unit, means forming a single gas outlet passage through which the furnace gases from both furnaces must flow, the entrance to said passage covering only a minor part of one side of the first furnace, convection steam heating means including a reheater and a superheater arranged transversely of the gas flow from the furnaces and in a single gas flow zone offset relative to the major parts of the furnaces, a radiant heat protector baffle means disposed laterally of and extending longitudinally of said zone and interposed relative to the main parts of the furnaces and the steam heating means, a part of the steam heating means constituting a superheater always subject to combined gas flow from the multiple furnaces, a second part of the steam heating means constituting a reheater subject to gas flow from the second of the furnaces only, and fuel burner means for independently firing the furnaces to control superheat and reheat.

4. In a reheater and superheater steam generating unit, steam generating wall tubes defining a plurality of vertically elongated large volume furnace chambers having a common wall formed by some of the wall tubes, one of said furnace chambers being a reheater furnace chamber and the other a superheater furnace chamber, said steam generating wall tubes generating substantially all of the steam produced by the unit, a reheater gas pass leading laterally from the upper part of one furnace chamber to the upper part of the other, a convection reheater in said gas pass and disposed at an elevation above the major part of reheater furnace chamber, a superheater gas pass disposed wholly at an elevation above that of the main part of the superheater furnace chamber and leading laterally therefrom at a position adjacent the gas outlet of the reheater gas pass, a convection superheater in the superheater gas pass subject to a predominant proportion of the total flow of the gases from both furnaces, means conducting steam from the wall tubes to the superheater, and means separately firing said furnace chambers.

5. In a superheater and reheater multiple furnace steam generating unit, multiple furnaces having their boundary surface defined by steam generating wall tubes generating the preponderance of the steam provided by the entire unit, some of said steam generating tubes being disposed so as to define a wall common to first and second furnaces, wall means defining a superheater gas pass and a reheater gas pass, said wall means including a nose baffle for each furnace, a convection superheater with its elements disposed transversely of gas flow through the superheater gas pass leading from outlet of the first furnace, a convection steam reheater with its tubular components disposed transversely of gas flow through the reheater gas pass leading from the gas outlet of the second furnace, said furnaces having their gas outlets disposed in similar offset relation to the main parts of the furnaces so as to co-act with said gas passes to present unidirectional gas flow through both furnace outlets and over both reheater and superheater, the reheater and the gas outlet of the

second furnace being disposed so as to face directly toward the gas outlet of the first furnace, and means for independently firing said furnaces.

6. A fluid heating unit comprising means including vapor generating wall tubes defining a first vertically elongated furnace chamber and a gas pass extending laterally from the upper part of said furnace chamber, vapor superheating tubes positioned in said gas pass, means including other vapor generating wall tubes defining a second vertically elongated furnace chamber having a common wall with said first furnace chamber, means forming a second gas pass extending laterally from the upper part of said second furnace chamber and arranged to discharge heating gases from said second furnace chamber toward and over said vapor superheating tubes, vapor reheating tubes positioned in said second gas pass, means for independently firing said furnace chambers, the firing means directed from opposite furnace chamber walls toward said common wall, the major part of the total steam from the unit being generated in said wall tubes prior to the contact of the furnace gases with the vapor superheating tube surfaces, and means conducting the wall tube generated vapor to the vapor superheating tubes.

7. A steam generating, steam superheating, and steam reheating unit in which substantially all of the steam is generated in wall tubes defining the roofs and walls of separate vertically elongated furnaces, a first steam heater convectionally heated only by the gases from one of said furnace chambers, a second steam heater convectionally heated by the gases from both furnaces, separately controllable sets of fuel burners associated with the respective furnaces and positioned in the lower portions of the furnaces, a predominantly radiantly heated wall common to both furnaces, said wall including a row of closely spaced steam generating wall tubes exposed on opposite sides to the direct radiant heat of the furnaces, means forming heating gas flow passages leading laterally from only the upper portions of said furnaces, both of said gas flow passages being limited to positions adjacent the upper part of the unit, the gas passages and their inlets being so constructed and arranged relative to the fuel burners that the gas flow in the furnaces is mainly upward to the gas inlets and the gas flow through said passages is mainly transverse to the gas flow in the furnaces, means presenting convection steam heating surfaces so arranged with respect to each of said gas outlets that heating gases flow from at least one of said furnaces pass thereover, the convection steam heater surface directly associated with one furnace being predominantly for high pressure steam superheating while the convection steam heating surface associated with the other furnace is predominantly for low pressure steam reheating, the gas flow passage associated with one of the furnace outlets constituting a connecting passage between the furnaces.

8. In a vapor generating unit, a vapor and liquid drum adjacent the upper part of the unit, liquid headers adjacent the lower part of the unit, vapor generating wall tubes extending from the drum to said headers and defining the roof and other boundaries of reheater and superheater furnaces and also defining the boundaries of reheater and superheater gas passes leading laterally from the upper parts of the respective furnaces, a reheater, a superheater, some of said tubes also presenting a wall common to the furnaces with parts of some of the tubes of this common wall also defining a radiant heat shield interposed relative to the reheater and the major part of the reheater furnace, the reheater gas pass receiving all of the gas generated by the reheater furnace, fuel burning means disposed in the furnace walls opposite said common wall and directing combustion elements towards opposite sides of said common wall, and a radiant heat shield interposed relative to the superheater and the firing means for the superheater furnace, said firing means normally operating to fire the furnaces independently of each other with the reheater furnace being fired from the standpoint of the requirements of reheat control.

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