June 23, 1942. J. V. PYLE 2,287,129

STEAM GENERATOR

Filed June 14, 1939 3 Sheets-Sheet 1

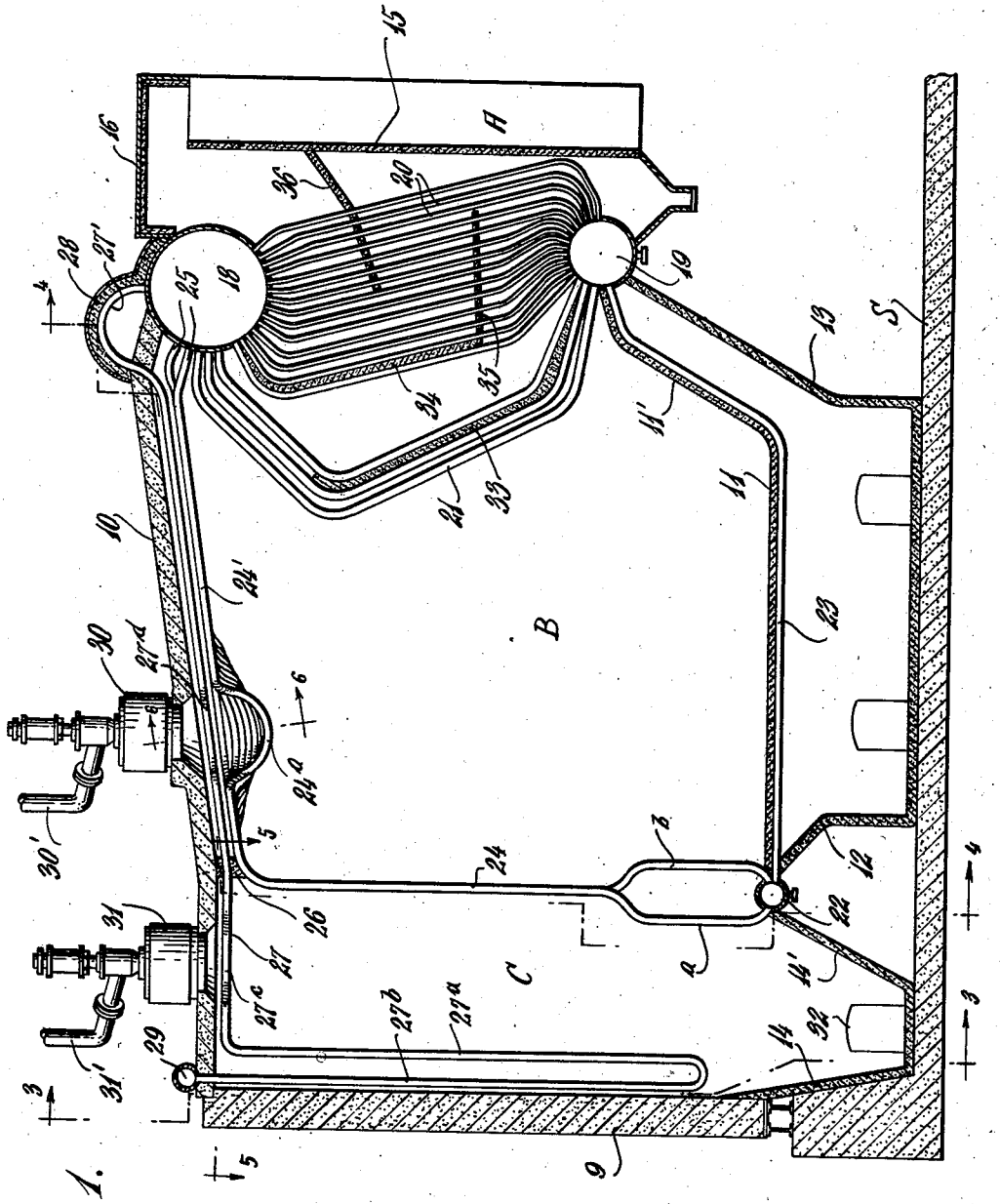


Fig. 1.

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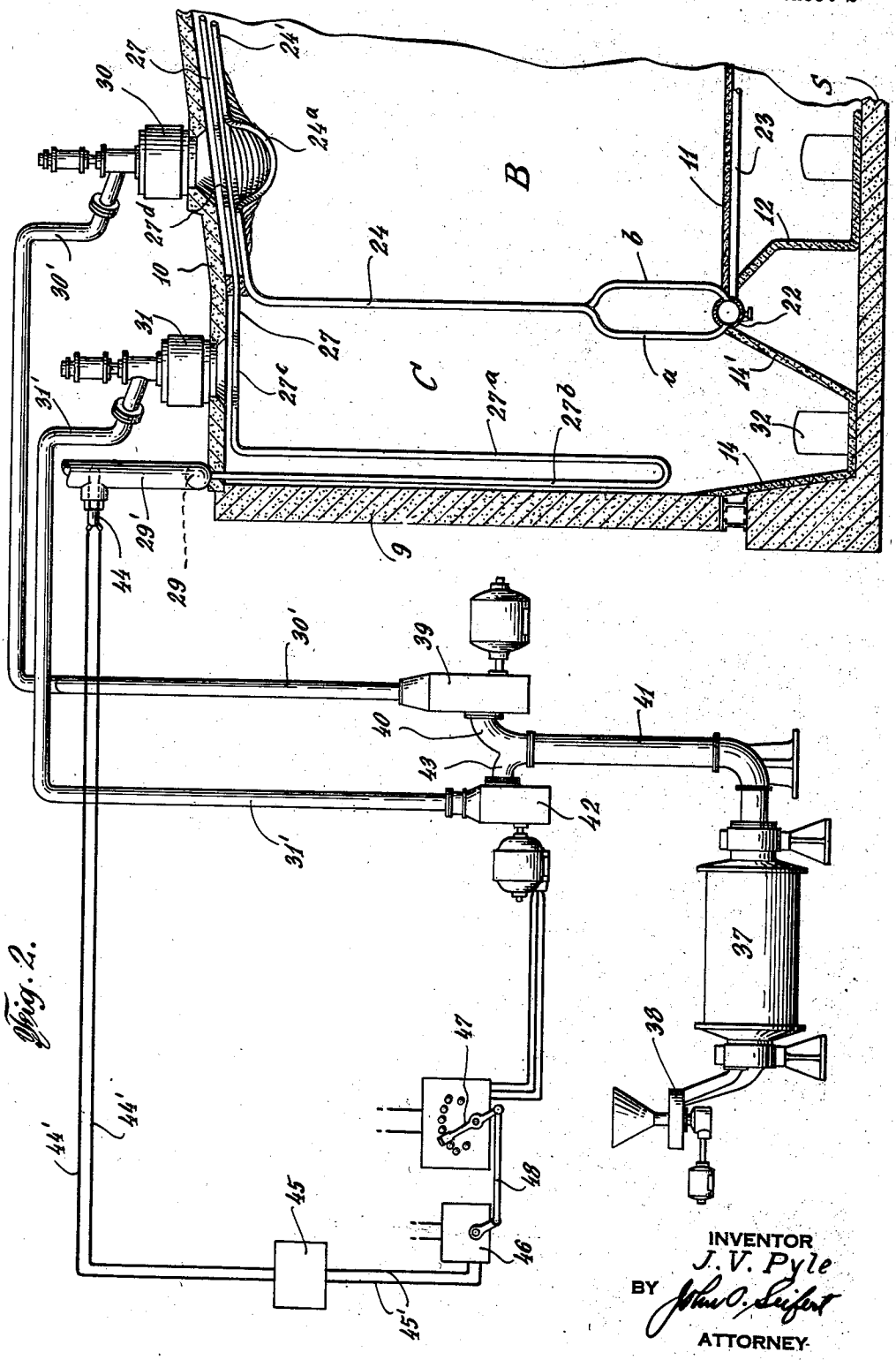


Fig. 2.

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STEAM GENERATOR

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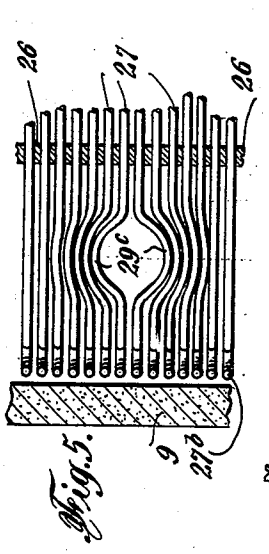


Fig. 5.

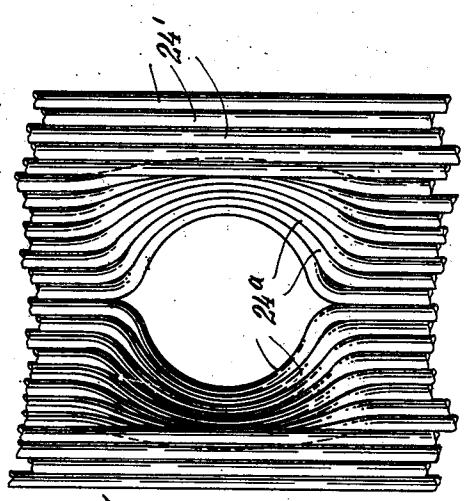


Fig. 7.

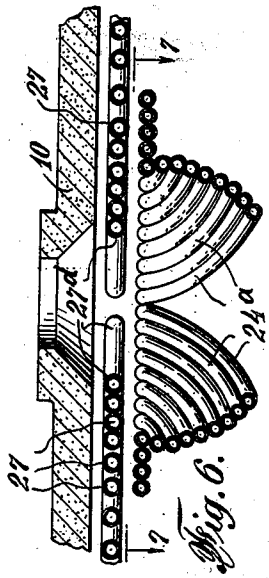


Fig. 6.

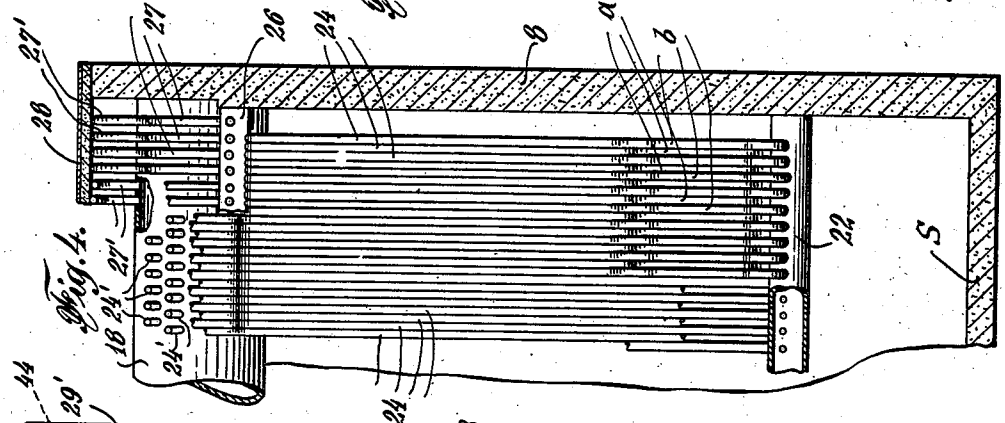


Fig. 4.

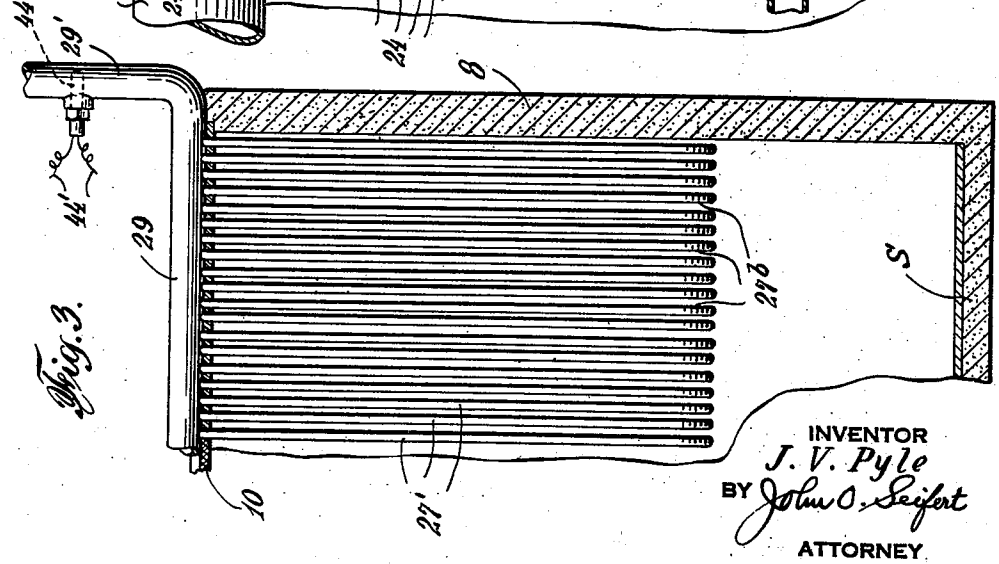


Fig. 3.

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Patented June 23, 1942 2,287,129

UNITED STATES PATENT OFFICE

2,287,129

STEAM GENERATOR

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Application June 14, 1939, Serial No. 279,004

11 Claims. (Cl. 122—478)

This invention relates to steam generating units including a steam superheater and the providing of steam superheated within a predetermined temperature. In the operation of steam turbines, engines, and similar devices, and in the use of steam in process work, it is essential that the temperature of the steam be maintained below or not higher than a predetermined temperature, otherwise it will result in material injury and damage to turbines or engines, or the work being processed. In steam generating units the superheater element or elements are connected to the steam space of a steam drum of a boiler and are disposed relative to the furnace chamber for the boiler to be subjected to the hot gases of combustion flowing relative to the boiler and the superheated steam delivered to the place of use. Should the superheater have a capacity only sufficient to produce superheated steam of a desired temperature when the steam generating unit is operated under high load, it is of insufficient capacity to produce superheated steam of the desired temperature when the steam generating unit is operated under low load. The superheater is, therefore, made of such size and so arranged relative to the flow of the hot gases of combustion from the boiler furnace that superheated steam of the desired temperature will be produced when the steam generating unit is operated under low load, with the result that when the steam generating unit is operated under high load the steam is superheated to a higher temperature than the desired or predetermined temperature.

It is the main object of the present invention to provide an improved construction and arrangement of steam generating unit including a superheater to produce superheated steam of a constant desired predetermined temperature in the operation of the steam generating unit over a wide range of ou put ratings of the steam generating unit.

A further object of the invention is the provision in a steam generating unit of a furnace for the boiler having a main combustion chamber and an auxiliary or superheater combustion chamber having independent fuel burning means and means controlled by the temperature of the superheated steam operative to regulate the fuel supply to fuel burning means for the superheater combustion chamber and produce and deliver superheated steam having substantially a predetermined temperature.

It is another object of the invention to provide an improved construction and arrangement of steam generating unit wherein the boiler furnace is located at one side of a bank or banks of tubes of a two drum steam boiler, and separating the furnace chamber into a main water cooled combustion chamber and a superheater combustion chamber by a row of juxtaposed steam generating tubes disposed transversely of the furnace connected in circulation with the drums and the tubes arranged to provide a passage for the hot gases and products of combustion from the superheater combustion chamber to the main combustion chamber.

Other objects and advantages of the invention will hereinafter appear.

In the drawings accompanying and forming a part of this application, Figure 1 is a longitudinal sectional view of a steam generating unit illustrating an embodiment of the invention.

Figure 2 is a sectional view of a portion of the steam generating unit shown in Figure 1 and showing in elevation means in connection therewith for supplying fuel to fuel burners and means to regulate the operation of the fuel supply means for one burner controlled by the temperature of the superheated steam.

Figure 3 is a fragmentary cross sectional view taken on the line 3—3 of Figure 2 to show the arrangement of the steam superheater elements.

Figure 4 is a fragmentary sectional view taken on the line 4—4 of Figure 1 and showing the arrangement of the row of sidewise arranged tubes separating the furnace into main and auxiliary combustion chambers.

Figure 5 is a sectional view taken on the line 5—5 of Figure 1 showing the arrangement of the superheater elements to adapt the same for firing the superheater combustion chamber.

Figure 6 is a sectional view taken on the line 6—6 of Figure 1, showing the arrangement of tubes of the steam superheater and of the tubes separating the furnace into main and auxiliary combustion chambers for firing the main combustion chamber; and

Figure 7 is a detailed plan view taken on the line 7—7 of Figure 6.

In carrying out the embodiment of the invention illustrated in the drawings the boiler and boiler furnace are arranged on a setting S, the furnace being of substantially rectangular form in horizontal and vertical cross section and formed by opposite side walls 8, a front wall 9, a top wall or roof 10 and a bottom wall or floor 11 arranged with a horizontal portion and an upwardly and rearwardly diverging portion 11'. The floor 11 commences at a point within the

front furnace wall and is spaced above a pit formed by a horizontal wall portion, vertical side walls and end walls having a vertical portion merging in an upwardly diverging portion, as at 12 and 13. The bottom of the furnace forwardly of the floor 11 is arranged of downwardly converging wall portions 14, 14' forming in effect a pit. The rear wall of the furnace is defined by a vertically disposed air preheater A, the inner vertical wall of which air preheater open to the furnace is provided with a facing of a refractory or heat resisting material 15, and a horizontal wall portion 16 connecting the inlet to the top of the air preheater in communication with the furnace.

A two drum boiler is disposed in the rear of the furnace, comprising upper and lower horizontal drums 18, 19, the lower drum having the usual drain outlet and the upper drum the usual water inlet and safety outlet. The upper drum extends transversely of the furnace at the rear of the upper furnace wall, and the lower drum is disposed relative to the rear of the upwardly and rearwardly diverging portion of the furnace floor 11 and the wall 13 of the pit. The drums are connected in water circulation by a bank of vertical tubes 20 connected to the upper drum below the axis thereof and to the lower drum above the axis thereof; the drums are connected by a second bank of steam generating tubes 21 connected at one end to the lower drum above the axis thereof with a portion of the tubes diverging forwardly and upwardly from the lower drum into the furnace and a portion diverging rearwardly connected to the upper drum in the plane of and above and below the horizontal axis of the drum and thereby effecting separation of water from steam delivered by said tubes into said upper drum. The banks of tubes 20, 21 are arranged with one side thereof open to the furnace.

The furnace is separated into a water cooled wall boiler combustion chamber B and an auxiliary combustion chamber C. For this purpose a header or manifold 22 is extended transversely of and intermediate the ends of the furnace, and shown as disposed at the forward end of the furnace floor 11 and is connected in water circulation with the lower drum by a horizontal row of tubes 23 spaced laterally of the furnace, the tubes being arranged below and following the contour of the furnace floor 11, the furnace floor preferably comprising strips of refractory material extending longitudinally of and supported in laterally spaced relation upon the tubes and arranging the same as an ash screen bottom. A row of steam generating tubes arranged in contiguous sidewise relation extends transversely of the furnace, said tubes having a portion 24 extending vertically of the furnace to adjacent the top wall of the furnace and then curved laterally with a portion 24' extending along said top wall and connected to the upper drum above the axis thereof, the ends of the successive tubes being offset alternately in opposite directions; that is, the ends of adjacent tubes being offset laterally in opposite directions, as shown at 25. The vertically extending portions of the tubes separate the furnace into the chambers B and C and the waste hot gases and products of combustion exit from the chamber C to the chamber B. To provide a passage for said gases a portion of successive tubes is offset alternately in opposite directions and thus providing passes between the offset portions of adjacent tubes and from the latter through the air preheater to a stack. As shown, the ends of the vertical portions 24 of the tubes are offset and connected at said offset ends to the header 22, certain of the tubes being offset in one direction, as at *a*, and alternate tubes being offset in the opposite direction, as at *b*. To shut off the chambers B and C through the space between the top wall or roof of the furnace and the portions 24' of the tubes extending along the roof a partition of refractory material is arranged between the bends of the tubes and the top of the furnace, as at 26.

A superheater for the steam connected to the steam space in the upper drum 18 is disposed in the auxiliary or superheater chamber C. As shown, this steam superheater comprises a row of tubes spaced laterally of the furnace having a portion 27 extending along the top of the chamber B, through the partition 26 and along the top of the chamber C. The one end of the tubes is curved upwardly and then downwardly and connected to the upper drum 18 above the axis thereof, as shown at 27', the curved portions of the tubes being enclosed by a heat resisting material 28, which is extended over the top of the drum 18. The opposite end portions of the tubes are arranged to extend transversely to the top of chamber C to adjacent the front furnace wall 9 and extended vertically downward to a point above the bottom of the furnace, as at 27*a*, and then reversely curved in a direction toward the front furnace wall and extended vertically upward in spaced relation to said furnace wall, as at 27*b*, and connected to a header or manifold 29 from which the superheated steam is led to a place of use, such as a turbine or engine or for processing work.

The chambers B and C are individually fired by fuel burning means, shown as burners 30, 31 for fluent fuel, such as pulverized coal in suspension in an air stream, the burners being mounted relative to openings in the top of the furnace and connected by conduits 30' and 31' to means for supplying or delivering fuel to the burners from a source of supply.

By the construction and arrangement described, easy access is afforded, as through an ash removing opening 32, to the superheater elements, as well as to the tubes forming the separating wall of the furnace for installation, inspection and maintenance. Furthermore, by arranging the superheater in a separate combustion chamber or space the possibility of overheating the superheater tubes when the boiler is started up is eliminated since the superheater is protected from the flow of the hot gases of combustion to the boiler. Also, by this arrangement the superheater affords no resistance to the flow of the gases of combustion and therefore there will be substantially less draft loss through the boiler than in the conventional method of locating the heating surfaces of the superheater, thereby effecting a very substantial saving in power required for operating a draft inducing fan and in the use of a stack requiring a smaller stack. By arranging the superheater in a combustion chamber separate from the combustion chamber for the boiler the major portion of the superheater element will be subjected to radiant heat of combustion and thus the heating surface or surfaces of the steam superheater may be less than if heated by convection, and by the arrangement of connecting the superheater combustion chamber with the boiler combustion chamber the heat of the gases exiting from the

superheater chamber is available for generating steam in the boiler combustion chamber and the gas passes of the boiler.

A series of baffles are provided to cause the hot gases of combustion from the boiler combustion chamber B to pass upwardly and longitudinally of the tube bank 21, then downwardly between said tube bank and the tubes of bank 20, and then upwardly relative to said latter tube bank and provide a circuitous passage and three passes for the flow of the gases at substantially a right angle to the tubes of the tube bank 20 through the inlet to the air preheater A. One of the baffles 33 extends from the lower drum 19 between the rear rows of the tubes of the tube bank 21 to adjacent the point at which said tubes diverge rearwardly. A second baffle 34 extends downwardly from the upper drum 18 in the space between the first and second rows of the tubes of the tube bank 20, said baffle following the contour of said tubes and is of a length substantially equal to two-thirds of the length of the tubes, and then is extended rearwardly substantially in a horizontal plane, as at 35, transversely of the tube bank 20 to within the third rear row of the tubes of said tube bank. A further baffle 36 declines from the air preheater and intersects the tubes of the tube bank 20 substantially midway the baffle 35 and the upper drum and extends transversely of substantially one-half of the tubes of said tube bank. This arrangement and proportionment of the baffles increases the mass velocity of the flow of the hot gases as they pass through the successive passes assuring a maximum transfer and absorption of the heat of the gases of combustion by the boiler elements.

The boiler combustion chamber, as in boilers of this character, is provided with water cooling tubes at the side walls for which purpose headers or manifolds connected to the lower drum are disposed below the furnace floor and extending transversely of the side walls, and said headers connected in circulation with the upper drum by tubes connected to said headers disposed relative to the side walls and either directly connected about the opposite ends of the upper drum or to transverse headers disposed relative to the top of the side walls of the furnace and connected to the upper drum, as is usual in this type of boiler furnace.

To prevent the flame from the furnace 31 impinging against the portion of the superheater tubes disposed relative to the top of the furnace the portion of the tubes 27 extending relative to said burner are offset laterally, as shown at 27c in Figure 5. To prevent the flame from burner 30 from impinging against the portion of the superheater tubes 27 disposed relative to the top of the furnace they are also offset laterally similar to the offset portion 27c relative to the burner 31, as shown at 27d in Figure 6, and to prevent the flame from said burner 30 impinging against the portion 24' of the furnace separating tubes 24 the portions of said tubes relative to said burner are offset inwardly and laterally, as shown at 24a in Figure 6, forming an opening substantially as shown in Figure 7.

As stated, it is not only desirable but essential that in the operation of steam turbines and engines and for use in processing work that the superheated steam be maintained within a predetermined temperature. To effect this result means are provided to regulate and control the supplying of fuel to the burner 31 for and firing the superheater combustion chamber C. In the embodiment of the invention illustrated means are shown for pulverizing coal and delivering the same in suspension in air streams to the burners 30, 31; and comprises a tube mill 37 provided with means for feeding coal thereto from a hopper or bin, as shown in a conventional manner at 38. The pulverized coal is drawn from the mill and delivered to the burner 30 in suspension in an air stream by a motor driven fan 39 through the conduit 39' connected to the outlet of said fan, the intake of the fan being connected by a branch conduit 40 to a conduit 41 connected to the outlet of the mill. Pulverized coal in suspension in an air stream is delivered from the mill to the burner 31 through the conduit 31' connected to the outlet of a motor driven fan 42 the intake of which fan is connected through a branch conduit 43 to the conduit 41 connected in communication with the outlet of the mill.

To heat the superheated steam to and maintain it at a substantially constant temperature means are provided to control and regulate the operation of the motor for the fan 42 and thereby regulate the supply of fuel to the burner 31 and firing of the superheater chamber C controlled by the temperature of the superheated steam. For this purpose a temperature responsive member, such as a thermo-coupling or thermo circuit making switch is interposed in the superheater outlet, and shown as mounted in and intersecting the outlet member 29' for the superheated steam from the manifold or heater 29, as shown at 44 in Figure 2. The thermo switch member 44 is electrically connected by conductors 44' to a control device, shown in a conventional manner at 45, and when the steam rises to a predetermined temperature the thermo switch member 44 is actuated to close the circuit of the control device 45 which is connected by conductors 45' to and renders an electrically operated device or motor 46 active to actuate a movable circuit making member 47 of a rheostat device interposed in the electric circuit of the motor for the fan 42 to slow down or stop said motor and thereby reducing or stopping the supply of fuel to the burner 31, the electrically operated device 46 being operatively connected to the circuit maker 47 of the rheostat device by a rod, as shown at 48. The reduction in the supply of fuel to the burner 31 is maintained, or such fuel supply shut off from said burner, until the temperature of the steam is lowered to or below said predetermined temperature when the thermo coupling or switch member 44 is actuated to open the circuit of the control device and thereby render the motor 46 inactive and the movable circuit maker 47 of the rheostat device to assume position to operate the motor for fan 42 at full load. By regulating and controlling the firing of the superheater combustion chamber C by the temperature of the superheated steam the superheated steam will be maintained at or below a predetermined temperature and may be utilized in the operation of turbines and engines as well as used in process work without possible injury or damage by the excessive heat of the superheated steam.

It will be obvious that various modifications may be made in the construction and arrangement of the parts without departing from the scope of the invention, and that portions of the invention may be used without others and come within the scope of the invention.

Having described my invention, I claim:

1. In a steam generating unit, a two drum

boiler comprising upper and lower drums and vertically disposed tubes connecting said drums, a furnace defined by front, side, top and bottom walls and open at the rear to a side of said drum connecting tubes, a row of tubes arranged in contiguous sidewise relation transversely of the furnace connected at one end to the upper drum, said tubes extending along the top of the furnace for a portion of the length thereof and then vertically downward to the bottom of the furnace with a portion of successive tubes adjacent the lower ends offset laterally in opposite directions and connected at said end to the lower drum, said tubes separating the furnace into a boiler combustion chamber at one side of said tubes and an auxiliary combustion chamber between said tubes and the front wall of the furnace connected in communication with the boiler combustion chamber through the spaces between offset portions of the tubes of the row of tubes, a steam superheater connected to the steam space of the upper drum disposed in the auxiliary combustion chamber, and individual fuel burner means opening to the top of each of said chambers.

2. In a steam generating unit a two drum boiler comprising upper and lower horizontal drums and vertically disposed tubes connecting said drums, a furnace defined by front, side and top walls and a bottom and open at the rear to a side of the boiler tubes, a header extending transversely of the bottom of the furnace intermediate the ends thereof, a horizontal row of tubes connecting said header in water circulation with the lower drum, a row of contiguous sidewise arranged tubes connected at one end to said header having a portion extending vertically to the top and a portion along the top of the furnace and connected at the opposite ends to the steam space of the upper drum, the vertically extending portions of said tubes separating the furnace into a boiler combustion chamber at the rear side of said row of tubes open to the one side of the boiler tubes and an auxiliary combustion chamber between the front side of said tubes and the front wall of the furnace and the lower portion of the vertical portion of successive tubes offset alternately to opposite sides to provide passages connecting the auxiliary combustion chamber with the boiler combustion chamber, a row of superheater tubes spaced longitudinally of and connected at one end to the steam space of the upper drum, said tubes extending along the top of the furnace to the auxiliary combustion chamber, then downwardly into and reversely upwardly in the auxiliary combustion chamber, and individual fuel burning means opening to the top of each of said chambers.

3. In a steam generating unit, a furnace defined by side, top and bottom walls, a boiler comprising upper and lower horizontal steam and water drums disposed at an end and the top and bottom of the furnace, a bank of water conducting tubes connecting said drums, a bank of steam generating tubes connected to and projecting from the lower drum into and upwardly into the furnace and connected to the upper drum, a row of contiguous sidewise arranged steam generating tubes connected at one end to the lower drum extending between the bottom and top of the furnace walls intermediate the furnace and then extending along the top furnace wall and connected to the steam space of the upper drum, the vertical portions of said row of tubes separating the furnace into a boiler combustion chamber at one side of said row of tubes open to a side of the steam generating tubes of the boiler and an auxiliary combustion chamber between the opposite side of said tubes and the front wall of the furnace, and portions at the lower end of successive tubes offset alternately in opposite directions providing passages connecting the combustion chambers, a steam superheater disposed in the auxiliary combustion chamber connected to the steam space of the upper drum, and a fuel burner opening to the top of the combustion chambers to individually fire said chambers.

4. A steam generating unit as claimed in claim 3, wherein the steam superheater comprises a row of tubes spaced longitudinally of and connected at one end to the steam space of the upper boiler drum and extending along the top of both the combustion chambers to adjacent the front wall of the furnace, and then extending vertically downward and reversely vertically upward in the auxiliary combustion chamber in spaced relation to the vertical portion of the first row of tubes.

5. In a steam generating unit, a furnace defined by side, top and bottom walls, a two drum boiler at one end of the furnace including upper and lower horizontal drums extending transversely of the furnace and tubes connecting said drums spaced longitudinally of the drums and opening at one side to the furnace, a header extending transversely of the lower portion of the furnace intermediate the ends thereof, a horizontal row of tubes spaced laterally of the furnace connecting said header in water circulation with the lower boiler drum, a row of tubes arranged in contiguous sidewise relation laterally of the furnace connected at one end to and extending vertically from said header to the top of the furnace and connected at the opposite ends to the upper boiler drum, said row of tubes defining with the boiler tubes a steam generating combustion chamber in the furnace at one side of said row of tubes having an outlet for waste gases of combustion at the rear of the boiler tubes and a steam superheater combustion chamber in the furnace at the opposite side of said row of tubes and successive tubes of said row of tubes adjacent the connection thereof with the header having a portion alternately offset to opposite sides to provide passages connecting the superheater combustion chamber in communication with said steam generating combustion chamber, a steam superheater including a row of tubes spaced laterally of the furnace connected at one end in communication with the steam space of and adapted to receive steam from the upper boiler drum and having portions extending vertically downward into and then reversely vertically upwardly in the superheater combustion chamber parallel to and spaced from the side of the first row of tubes, and individual fuel burning means opening to the top of each of said steam generating and superheating combustion chambers.

6. In a steam generating unit, a furnace having an outlet at one end for the products of combustion, a boiler including a bank of steam generating tubes connected in circulation with steam and water drums at the end of the furnace having the outlet and a row of sidewise contacting steam generating tubes spaced from said bank of tubes and separating the furnace into a boiler combustion chamber at one side of said row of tubes opposed to the bank of steam generating tubes and a superheater combustion

chamber at the opposite side of said row of tubes, alternate tubes of said row of tubes having the lower end portions offset laterally to opposite sides providing passages for the flow of gases of combustion from the superheater chamber through the boiler combustion chamber to the furnace outlet in heat transfer relation to the steam generating tubes, a steam superheater in the superheater chamber comprising a row of tubes connected at one end in communication with the steam space of the steam drum of the boiler, and a burner opening to the top of and for independently firing said combustion chambers.

7. In a steam generator, a furnace having an outlet for the products of combustion, a steam superheater and a plurality of groups of steam generating tubes connected in communication with the steam superheater, the tubes of one of said groups of tubes being disposed in contiguous sidewise relation transversely of the furnace intermediate the ends thereof and separating the furnace into a steam generating combustion chamber at one side of said group of tubes opposed to the other groups of steam generating tubes and a superheater combustion chamber at the opposite side of said group of sidewise disposed tubes in which the steam superheater is disposed, alternate tubes of said sidewise arranged group of tubes having a portion at the lower ends offset laterally to opposite sides providing passages for the flow of the gases of combustion from the superheater combustion chamber into the steam generating combustion chamber in heat transfer relation to the groups of steam generating tubes to the furnace outlet, means for firing said steam generating combustion chamber, and means for independently firing said superheater combustion chamber through the top wall thereof.

8. In a steam generator, a furnace, a steam generating unit including a bank of vertically disposed steam generating tubes connected in circulation with steam and water drums and a row of vertical steam generating tubes disposed in contiguous sidewise relation connected in circulation with the steam and water drums and in conjunction with the bank of tubes forming a steam generating combustion chamber in the furnace at one side of said row of tubes having an outlet for the products of combustion and forming a superheater combustion chamber at the opposite side of said row of tubes in the furnace, a row of reversely bent steam superheating tubes connected at one end in communication with the steam space of the steam drum arranged in the superheater chamber in spaced and parallel relation to the row of steam generating tubes, fuel burners opening to the top of and firing each of said combustion chambers, and alternate tubes of said row of steam generating tubes having portions at the lower ends offset laterally providing passes for the flow of the gases of combustion from the superheater chamber through the steam generating combustion chamber to the furnace outlet in heat exchange relation to said bank of steam generating tubes.

9. In a steam generator, a furnace, upper and lower steam and water drums and boiler tubes spaced transversely of an end of the furnace connecting said drums in water and steam circulation, a row of vertical steam generating tubes connected to the lower drum and to the steam space of the upper drum arranged in contiguous sidewise relation transversely of the furnace and defining with said boiler tubes a steam generating combustion chamber in the furnace at one side of said row of tubes having an outlet for the waste gases of combustion rearwardly of the boiler tubes and a superheater combustion chamber in the furnace at the opposite side of said row of tubes, a row of steam superheating tubes connected to the steam space of the upper drum spaced laterally of the furnace and extending into the superheater combustion chamber in parallel spaced relation to said first row of tubes, the lower portion of adjacent tubes of said first row of tubes being alternately offset laterally to opposite sides providing passages for the flow of the gases of combustion from the superheater chamber into and through the steam generating combustion chamber in heat transfer relation to the drum connecting tubes to the furnace outlet, fuel burner means for the steam generating combustion chamber, and fuel burner means opening to the top of the steam superheater combustion chamber.

10. In a steam generator, a furnace, upper and lower drums connected by boiler tubes at an end of the furnace, a row of tubes connected in water and steam circulation with said drums arranged in contiguous sidewise relation transversely of the furnace having a portion extending parallelly of the top of the furnace and a portion extending vertically of and intermediate the ends of the furnace and defining with said boiler tubes a steam generating combustion chamber at one side of said row of tubes having an outlet for waste gases of combustion rearwardly of the boiler tubes and a steam superheater combustion chamber at the opposite side of said row of tubes, the lower portion of alternate tubes of said row of tubes being offset laterally to opposite sides to provide passages for the exhaust of the gases of combustion from the superheater chamber into the steam generating chamber in heat transfer relation to the boiler tubes, a second row of tubes spaced laterally of the furnace connected at one end to the steam space of the upper drum having a portion extending parallelly of and between the top of the furnace and the portion of the first row of tubes extending parallelly of the top of the furnace and terminating in a U-shaped portion extending into the superheater combustion chamber parallel of and spaced from the first row of tubes, and means opening to the top of and independently firing each of said steam generating and superheater combustion chambers.

11. In a steam generator, a furnace having an outlet at one end for the products of combustion, steam and water drums at the end of the furnace with the outlet, groups of tubes connected in water and steam circulation with said drums, the tubes of one of said groups of tubes being disposed in contiguous sidewise relation transversely of the furnace and having a portion extending vertically of the furnace intermediate the ends thereof forming with the other groups of tubes a steam generating combustion chamber in the furnace at one side of the vertically extending portion of said group of sidewise disposed tubes and an auxiliary combustion chamber in the furnace at the opposite side thereof, and an end portion of the vertically extending portion of successive tubes of said group of sidewise disposed tubes offset laterally to opposite sides to provide passages for the flow of gases of combustion from the auxiliary combustion chamber into the steam generating combustion chamber, a steam superheater in the auxiliary combustion

chamber connected in communication with and for passing steam therethrough from the steam drum, and a fuel burner for individually firing each of said combustion chambers, the burner for firing the auxiliary combustion chamber opening to said chamber at the ends of the vertically extending portion of the group of sidewise disposed tubes opposite the ends with the offset portions to cause the gases of combustion in said chamber to flow relative to the steam superheater to the passages formed by the offset portions of said latter group of tubes.

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