Nov. 28, 1944. H. KREISINGER ET AL 2,363,875

COMBUSTION ZONE CONTROL

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Fig. 1

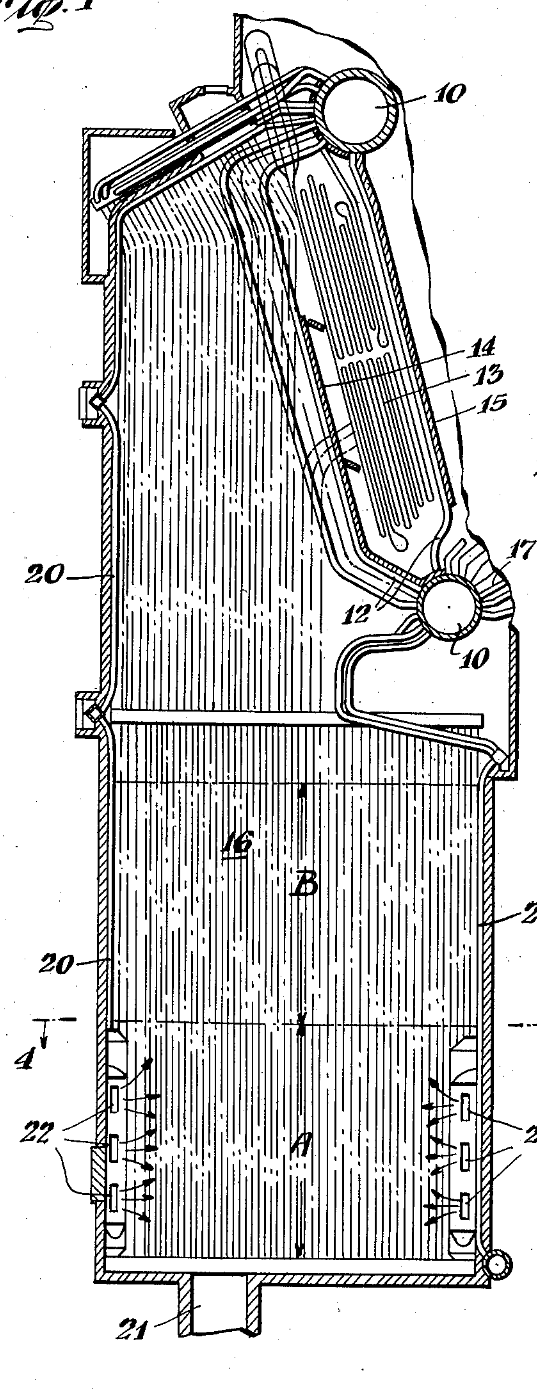

Fig. 2

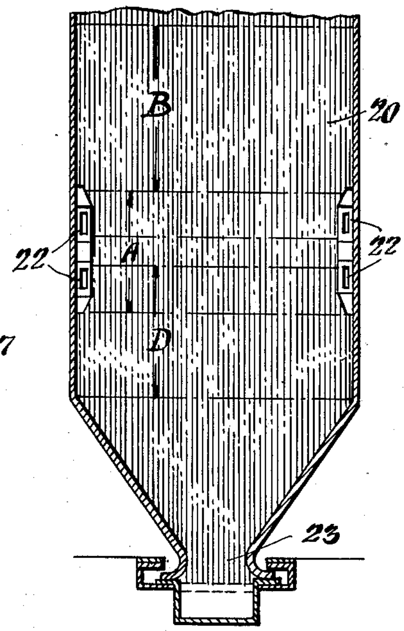

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Fig. 3

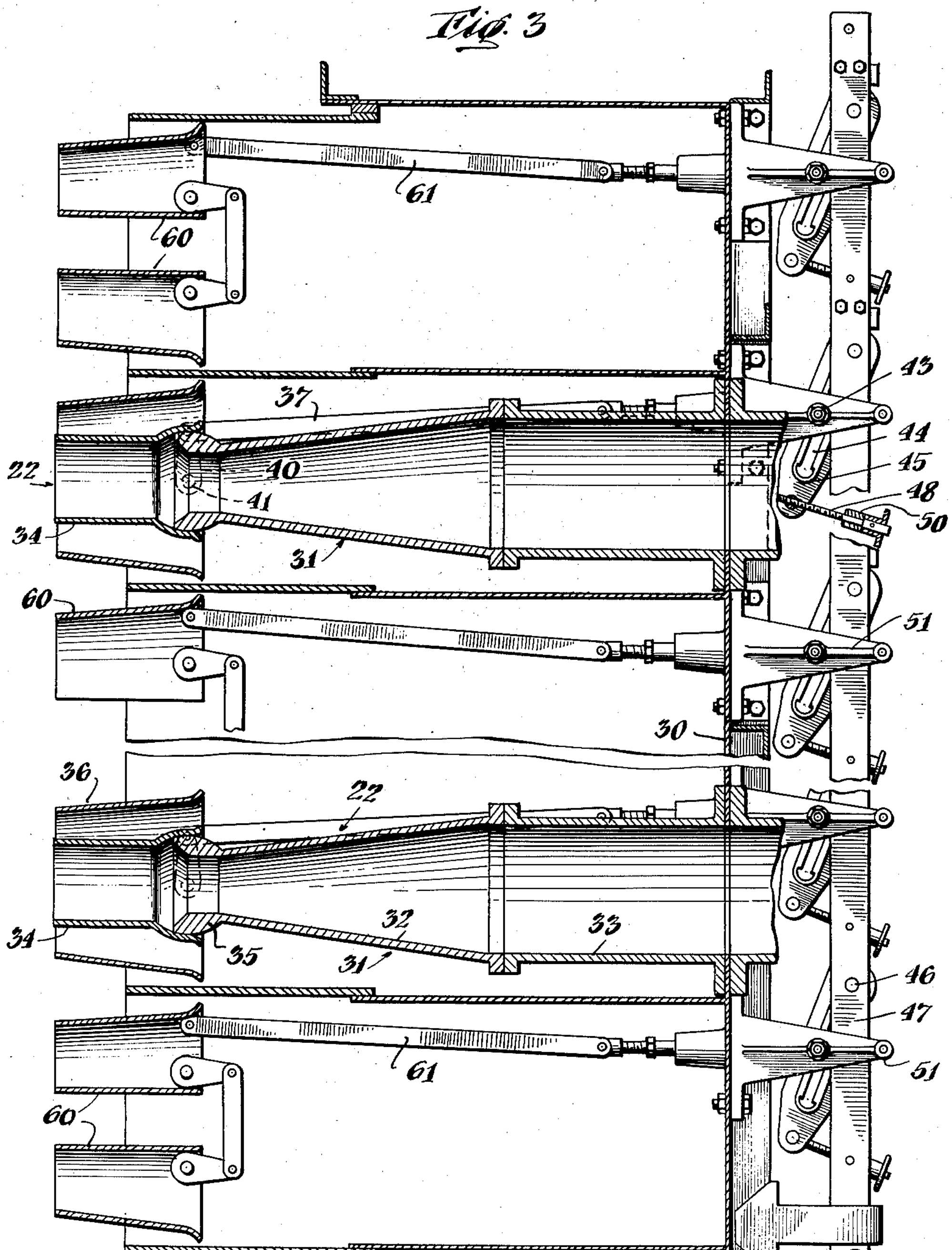

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Fig. 4

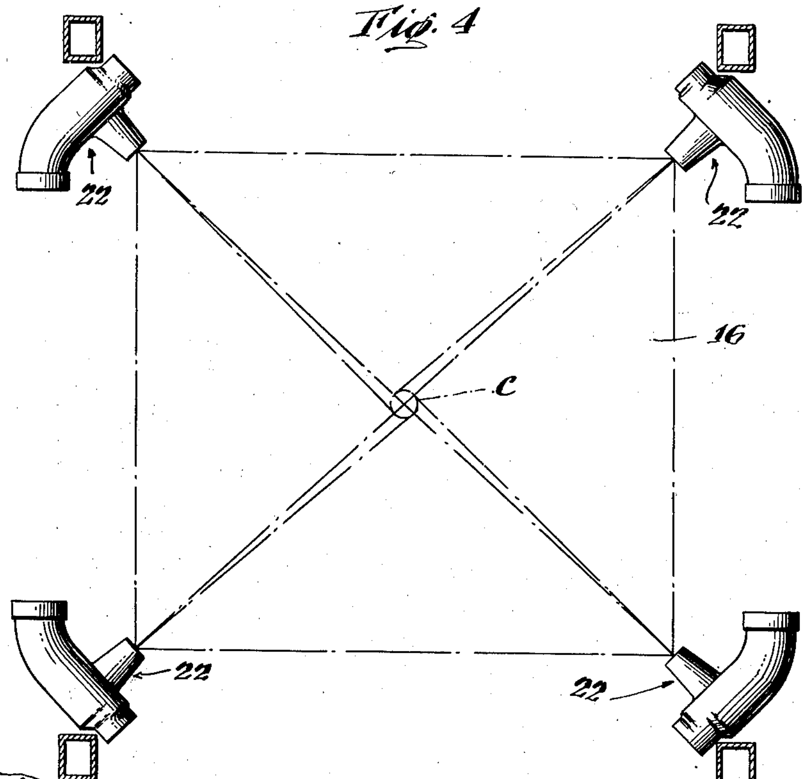
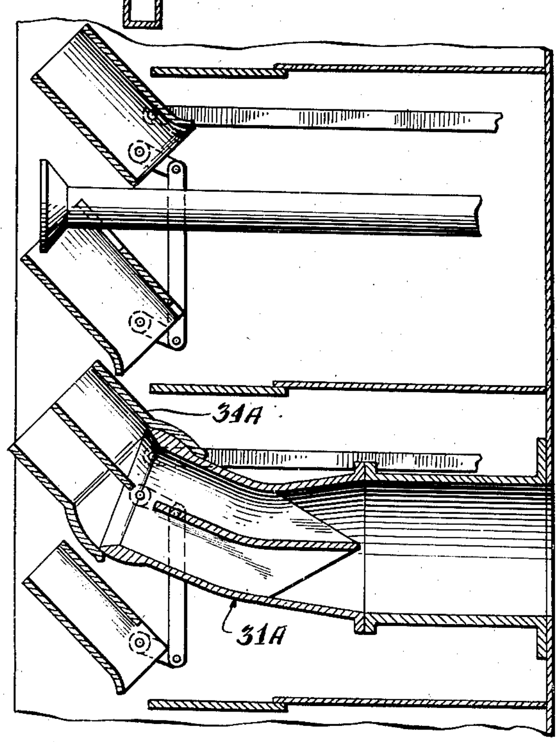


Fig. 5



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COMBUSTION ZONE CONTROL

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Application November 25, 1941, Serial No. 420,356

2 Claims. (Cl. 122—479)

This invention relates to an improvement in the regulation of the temperature of steam leaving a superheater. It is particularly applicable to a superheater so located in a boiler that substantially all of the heating effect is by convection from the products of combustion from a furnace whose walls are lined with water cooled surfaces and in which turbulent firing is employed.

It is well known that in the operation of such a steam generating unit the temperature of the superheated steam varies with fluctuations in steam output, a reduction in superheat occurring with a reduction in rating. Because this is undesirable various means have been devised to correct for steam temperature variations.

One method of regulating the temperature of superheated steam is to cause a variation in the heat absorption within the furnace from the fuel burnt therein so that the gases passed over the superheater surface are at a temperature capable of producing the desired degree of superheat. A method of this nature is disclosed in the patent to Kruger, No. 2,243,909, of June 3, 1941. It has been found, however, that Kruger's method is inadequate to meet the large variations of superheat control now required in boilers of great steam generating capacity and, accordingly, it is an object of this invention to provide an improved method of regulating the heat absorption within the furnace so as to obtain the desired steam temperature from the superheater.

How the foregoing together with other objects and advantages as may hereinafter appear or are incident to our invention are realized is illustrated in preferred form in the accompanying drawings wherein:

Figure 1 is a sectional elevation of a steam generating unit embodying the invention;

Figure 2 is a sectional elevation showing a modified form for the lower part of the furnace of Fig. 1;

Figure 3 is an enlarged vertical sectional view through a typical set of fuel burners shown in Fig. 1;

Figure 4 is a horizontal schematic view, taken through the furnace on the line 4—4 in Fig. 1; and

Figure 5 is a vertical sectional view of a modified form for the burners shown in Fig. 3.

In Figure 1 the boiler illustrated includes a lower water drum 10 and upper steam and water drum 11 interconnected by steam generating tubes 12. A superheater 13 receiving the saturated steam generated is located in the first pass of the boiler and baffles 14 and 15 cause the gases from the offtake of furnace 16 to pass serially over superheater 13, a tube bank 17 and on to the boiler offtake.

In Figure 1 the furnace 16 has its walls lined with water cooled tubes 20. The bottom of the furnace is suitably constructed to retain slag in a fluid condition, the slag overflowing through an opening 21. Near the bottom of the furnace burners 22 are arranged preferably at the corners as illustrated in Fig. 4.

In Figure 2 the lower part of the furnace 16A has two opposed sides sloping toward a throat 23 and faced with water cooled tubes 20. The two remaining side walls also are lined with water cooled tubes extending downwardly to the throat 23. The bottom and side walls above the throat thus form a water cooled hopper into which ash particles, gravitating from the fuel burning within the furnace, fall and, while falling, cool to a state in which they will not adhere to the sides of the hopper. The burners 22 in Fig. 2 are arranged somewhat above the hopper bottom and, as in Fig. 4, preferably at the corners.

Figure 4 shows the burners 22 arranged at the corners of the furnace projecting their streams of fuel and air into the furnace in directions tangential to the surface of an imaginary cylinder "C" located vertically in the furnace, preferably in its center. Each set of burners in Fig. 1 discharges three fuel streams into the furnace while each set of burners in Fig. 2 discharges two fuel streams.

Figure 3 shows a typical burner construction comprising, in general, an air casing or housing 30 and several pulverized fuel nozzles 31 extending therethrough. The air casing is built up of a plurality of sections for convenience of manufacture, but as a whole may be considered as a single member. The fuel nozzles 31 comprise a conduit preferably made in sections 32 and 33, the section 33 nearest the furnace being provided with an end piece or tip 34 rotatable vertically about horizontal supporting bearings 35 on the end of section 32. The tip 34 and section 33 are formed at their juncture into a cylinder and socket joint. The nozzle tip 34 is rectangular and located within and connected to a tubular air deflecting vane 36, the whole, when turned upwardly or downwardly directing the fuel and air stream accordingly. The tip 34 and vane are rotated by means of a rod 37 connected at one end to the tip by an arm 40 fixed to a pin 41.

At its other end rod 37 carries a pin 43 located in the slot 44 of a cam 45. The cam 45 is mounted by a pin 46 on a vertically movable bar 47 so it may rotate. An adjusting screw 48 which holds cam 45 at a suitable angle with respect to bar 47 is fixed in its longitudinal movement by pivot block 50 hinged to the bar 47 by pin 50a. The screw 48 may be adjusted to draw the lower end of cam 45 closer to, or push it away from bar 47, thereby changing the angularity of the cam with respect to the bar. The bar 47 is limited to vertical movement by bearings 51. A change in angularity of the cam 45 changes the movement of related connecting rod 37 and the fuel nozzle tip 34 connected thereto. As shown in the drawings, the pin 43 is in mid-position in slot 44 and the connecting rod 37 holds the tip 34 in position for horizontal discharge of the fuel and air. When the bar 47 is moved down, carrying cam 45 with it, the tip 34 directs the fuel and air stream upwardly. Conversely an upward movement of bar 47 directs the fuel and air stream downwardly. The bar 47 may be moved to adjust the nozzle tip by a motor controlled from the switchboard for firing control.

Above and below each fuel nozzle 31 there are pivoted air deflectors 60 that may be turned to direct the air horizontally, upwardly or downwardly. As shown, deflectors are interconnected in pairs and operating rods 61 are provided, the construction, operation and adjustments for the respective deflectors being the same as that described above for rotating the nozzle tips 34.

Figure 5 shows a modified form of the end section for the nozzle. The nozzle end section 31A itself is formed to direct the fuel and air stream upwardly at half of the maximum angle through which the tip 34A moves from the horizontal. For example, if the tip 34A is movable through 45 deg., the inner end of section 31A is turned upwardly 22½ deg. This construction permits a greater vertical angle of discharge for the fuel and air stream and yet provides a relatively smooth flow through the fuel nozzle for all angles.

The construction shown in Figure 5 may advantageously be used in a slagging bottom furnace such as shown in Figure 1. In this adaptation three fuel burners are shown, the upper two of which may be made adjustable upwardly to an angle of 45 deg. while the bottom one may be adjustable 22½ deg. from the horizontal both upwardly and downwardly as provided for in Figure 3.

It is contemplated that the fuel nozzles may in addition be adjustable horizontally as is shown in the patent to Kruger mentioned above.

In operation when all of the burners are adjusted to project the fuel and air stream in a substantially horizontal direction tangent to the imaginary vertical cylinder C located centrally of the furnace, the burning fuel streams issuing from the four sets of corner located burners impinge upon one another resulting in a turbulent, rotating mixture with a consequent rapid rate of combustion. This rapid combustion produces a very high temperature in a zone A at the level of the burners near the bottom of the furnace so that there is a high rate of heat transfer from the flames to the water cooled wall tubes 20 in this zone both by radiation and by convection. Leaving this zone the hot products of combustion pass upwardly and continue giving off heat to the water cooled walls thereabove and exit from the furnace at a relatively low temperature. When all of the burners are directed upwardly the streams of fuel are still tangent to an imaginary vertical cylinder in the furnace but the impingement of the burning fuel streams upon one another is much less than when the burners are horizontally directed as above described. This results in but relatively little mixing and turbulence and consequent slower or delayed combustion. This delayed combustion occurs in a zone B, that is located higher in the furnace than the zone A, and extends well into the upper part of the furnace. Consequently the temperature of the products of combustion leaving the furnace is relatively high because of the shorter path through which they pass from the combustion zone to the outlet of the furnace and because the heat transfer from the flames to the water cooled walls at the bottom of the furnace is substantially less than with horizontally directed streams. The change in the direction of the fuel streams from the horizontal to an upward inclination results in a rise in the temperature of the gases leaving the furnace which has been found adequate to change the rate of heat absorption by the superheater 13 so that the steam temperature may be raised to that required for satisfactory operation over a greater range of ratings of the steam generating unit than heretofore attainable.

This invention in effect reduces the size of the furnace at the lower ratings of the steam generating unit, where the temperature of the superheated steam is relatively low. For example, at half rating about half of the maximum amount of fuel that may be burned in the furnace is delivered to the furnace near the bottom and burned there in zone A; the products of combustion likewise are about half and dwell within the furnace and are exposed to the cooled walls about twice as long as at full rating. The exit temperature of the gases may then be too low for superheating the steam to the temperature desired. By raising the zone of combustion within the furnace and delaying combustion by decreasing turbulence, the dwell of the products of combustion within the furnace is reduced as is the area of cooled furnace walls exposed to the gases.

In Figure 2 the burners are located higher than in Figure 1 and the zone of most intense combustion may be moved below zone A to zone D, thereby increasing the range through which said zone of combustion may be moved vertically in the furnace.

According to the invention, not all of the burners need be adjusted to a vertical angle; for example, the two upper burners 22 of each set may be so adjusted while the lower burner may be horizontal.

Any or all of the burners may also be made to be both vertically and horizontally adjustable. When the furnace is operated with a layer of molten fluid slag on the furnace floor, it may be advantageous to maintain the bottom burners in position to direct the flame streams horizontally or even downwardly over the slag so as to maintain it in a fluid condition throughout the lower furnace, while the upper burners are used to control the superheated steam temperatures as described above.

At lower ratings than maximum it may be desirable to use only the upper two of the three burners in each group while extinguishing the lower burners, or only the uppermost burners may be used, which will further aid in moving the zone of maximum combustion upwardly into the furnace.

The invention contemplates the use of burners arranged for causing turbulent combustion within the furnace by being directed toward one another but not necessarily producing tangential firing; such burners when directed upwardly rather than directly toward one another effect a similar result to that described above.

What we claim is:

1. The method of regulating temperature of steam from a superheater receiving its heat mainly by convection from gases leaving an outlet at the upper part of a vertical furnace whose walls are lined with water cooled tubes comprising; introducing fuel and air into the lower part of the furnace from a plurality of points remote from the furnace outlet in such directions as to create a turbulent gas mass burning in a zone in the lower part of the furnace to transmit heat to the water tubes therein; maintaining, for a given load, a substantially uniform rate of fuel firing; and altering the angle to the horizontal of the direction of the streams of fuel and air so as to lower or raise the vertical location of the combustion zone along the furnace axis as the superheated steam temperature respectively increases or decreases to thereby alter the length of the path of gas travel through the furnace and the extent to which gases are cooled before reaching the superheater.

2. The method of regulating the temperature of steam derived from a superheater receiving its heat mainly by convection from gases flowing from the outlet at the upper part of a vertical furnace whose walls are lined with water circulating tubes comprising; introducing fuel and air into the furnace from a multiplicity of points near the bottom of the furnace and in directions substantially tangential to an imaginary vertical cylinder located centrally in the furnace for creating a turbulent rotating gas mass in a zone located in the lower portion of the furnace to transmit heat to the water tubes therein; maintaining, for a given load, a substantially uniform rate of fuel firing; and, as the supherheated steam temperature increases, decreasing the vertical angle of the directions of fuel introduction relatively to the furnace walls to thereby increase the extent to which gases are cooled before reaching the superheater.

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