FURNACE FOR COMBUSTION OF SOLID FUELS

FIG. 1

FIG. 2

Filed June 11, 1965

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The present invention relates to furnaces for smokeless combustion of solid fuels having a relatively high content of volatile matter, such as coal, peat or wood.

In hitherto known furnaces for smokeless combustion of solid fuels the smoke gases have not been ignited and burned to a satisfactory extent due to the fact that part of the volatile matter expelled from the fuel does not reach the temperature for ignition. The normally visible exhaust gases may of course be diluted by the introduction of additional air and thereby become less visible, but this does not solve the real problem, that is to save fuel and avoid fouling of the ambient atmosphere.

The general object of the present invention is therefore to provide a furnace in which all volatile matter expelled from the fuel is mixed with the proper quantity of air before the temperature of this mixture is raised to such a temperature that it ignites.

To this end, the present invention relates to a furnace for burning solid fuel having a volatile content, wherein the fuel is burned as it advances from the first to a second combustion zone, and the ashes are provided which leads from the first combustion zone to the second combustion zone, to direct volatile matter given off by the fuel in the first combustion zone through the fuel burning in the second combustion zone. Within this general principle the invention provides a new and improved furnace constructed as defined in the appended claims.

When the furnace is in operation, the normal chimney draught will be sufficient to provide the flow of air and gases so that no forced draught is needed. Further, the formation of clinker on the grate is avoided in the furnace according to the invention.

A suitable embodiment of the invention is shown in the drawings.

FIG. 1 is a central vertical section through a preferred embodiment of the furnace. FIG. 2 is a plan view, and FIG. 3 is a front longitudinal view.

The furnace shown is constructed for burning black coal supplied from supply duct or hopper 1. In operation the furnace is partly inserted into a boiler 2, the front wall of which is being indicated by the dotted lines. According, the furnace may be employed as a pre-furnace to a boiler, a kiln or other object to be heated. However, the furnace may also be incorporated as an integral part of the boiler.

As will be seen from FIGS. 1 and 2 the furnace has a substantially vertically extending degassing chamber or shaft 3 and a substantially horizontally extending combustion chamber 4. As will appear hereinafter the chamber 3 is for conducting smoke gases of relatively low temperature, whereas the chamber 4 is a combustion chamber for conducting burning gases to the outlet end 5 of the furnace, through the boiler or other object to the heated and further to a chimney which provides the natural draught required for the operation of the furnace. It is a basic feature of the invention that no blowers are necessary.

The two chambers 3 and 4 are located between two spaced longitudinal refractory side blocks 6 and 7 supported by a frame 8. The side blocks support a transverse refractory block 9 forming the upper wall of the combustion chamber 4 and the rear wall of the chamber 3. The side blocks and the transverse block may be integral.

The front wall of the chamber 3 includes an inspection hatch 10 lined with heat insulating material. In the upper end of wall 11 of the chamber 3 is an opening 12 for admitting coal 13 from the hopper 1, to drop into the chamber 3.

In a casing 14 on the top of the chamber 3 the fuel 15 passing from the hopper 1 to the opening 12 is fed to the opening 12 by a plunger 16 which is driven forth and back by a mechanism 17 at a speed determined by the speed of the fuel bed, to drop coal through the opening 12. Any other known feeding device may be used for providing a controlled and adjustable supply of fuel to the inlet opening 12 in order to drop or sprinkle the fuel down onto the fuel bed 18 supported by a moveable, substantially horizontal guide 19 which forms the bottom in chamber 3 as well as in chamber 4.

The grate 19 is preferably of the known construction which comprises a plurality of parallel grate bars spaced by transverse pieces 20, 21, 22 to form two vertical through flow passages 23 and 24. Each grate bar is formed with projections 25, 26 which are intermittently engaged by corresponding projections 27 on a shaft 28 rotated by an electric motor 29. Upon rotation of shaft 28 all grate bars are intermittently moved from their rearward end position shown to their forward end position, as indicated with dotted lines, to move the fuel bed rearwardly, and thereafter the grate bars are preferably individually one after another or in groups retracted to their original position leaving the fuel bed in its displaced position. The feeding movement of the grate bars is then repeated.

The grate 19 is slidably supported by a number of cross bars 30, 31 and 32 extending between the side blocks 6, 7.

The free space between the grate 19 and the lower edge 33 of the transverse block 9 is denoted by H and forms a gate opening determining the height of the fuel bed entering into the combustion chamber 4. This gate opening is accordingly completely filled out with fuel so that the major part or substantially all of the smoke gases generated in the fuel bed 18 will pass upwardly in the chamber 3 whereas only a small part passes through the gate opening.

From FIG. 1 it is to be noted that the effective length of the grate 19 forming the bottom of the chamber 3 is denoted by A and extends from the lower end portion 34 of the front wall of the chamber 3 to the gate opening. The remaining length of the gate to its free rear end is denoted by B and forms the bottom of the combustion chamber 4. The length A is about equal to the width of the passage 23, and the length B is about equal to the width of the passage 24. Further, the intermediate space pieces 21 are located approximately straight beneath the gate opening at H.

In accordance with the invention the length B should be greater than the length A and preferably at least 2A. Further, the height H or the height of the gate opening should preferably be less than the length A.

The ash pit space beneath the grate 19 has three transverse partitions or flaps 35, 36 and 37 which are built into the bottom 38 and the side blocks 6 and 7 form two separate chambers which form a primary ash pit 39 and a secondary ashpit 40. As indicated in the drawing, the intermediate space pieces 21 leave a free space for the upper surface of the grate to form restricted communication passages 41 between the channels 23, 24 and thus between the chambers 39, 40.
The flap 37 forms an adjustable air intake. At the upper end of the chamber 3 is an opening 42 communicating with a return flow duct 43 which extends to both sides of the furnace and is connected at both ends with inlet openings 44 in the side walls (refractory blocks 6, 7) of the secondary ashpit 40. As shown, the inlet openings 44 are preferably located close below the rear end of the grate 3.

Ash and any clinker which fall from the rear end of the grate will drop into a trough 45 and may be removed by a screw 46 or similar conveyor. Also, any ash falling into the ashpits 39 and 40 may easily be removed by opening flaps 37, 36 so that the ash may be pushed against flap 45 for opening the same and falling into the trough 45. This cleaning operation should not be necessary to make more often than once a day.

In operation the fuel bed on grate 19 may be ignited by means of a gas poker or any other known means. In continuous operation the fuel bed has preferably the cross-section illustrated in FIGURE 1, that is a constant height in chamber 3 which is somewhat greater than H but preferably less than length A of the primary grate section. The constant height of bed 18 is maintained by adjusting the speed of the feeder mechanism 17 relative to the actual feeding speed of the grate 19.

From the grate opening at H the fuel bed tapers towards the rear end of the grate where the thickness of the fuel bed is practically nil as shown.

The natural draught in the flue or chimney provides a suction in chamber 4 which is primarily and mainly effective through the relatively thin fuel bed at the rear end portion of the fuel bed on the secondary grate section, whereas a relatively small portion of this suction is effective through the fuel mass in the gate opening due to the greater resistance to gas flow therein. Accordingly, greater part of the suction from the natural draught in the flue or other flow passage will be effective in the ashpit 40 and the return flow duct 43 to suck away smoke gases from the chamber 3.

In conventional furnaces of the kind under consideration, the ideal quantity of excess air for obtaining combustion of coal is about 50% but in most underground fed furnaces this excess air may be as high as 100-300%. Such an excess of air is effected by means of one or more blowers and is employed in order to obtain a satisfactory combustion. However, the great amount of excess air hitherto necessary results in a reduced efficiency. The degree of unburned volatile matter is also still too high.

In contrast to prior furnaces of the kind under consideration the furnace according to the invention is so constructed and adjusted, that the excess air through the primary grate section A will be considerably less than 50%. Hereby, only the bottom layer of the fuel bed 18 in the chamber 3 will become incandescent, whereas the top layer of the fuel bed 18 is kept relatively cold. In fact, the temperature at the surface of the top layer may not be higher than about 75° C so that the temperature of the smoke gases (volatile matter) driven off from the fuel bed 18 is not higher than about 50° C. In the chamber 3. Accordingly, the bottom and top layers forming the primary fuel bed 18 may be referred to as a low temperature combustion or degassing zone of the furnace.

In this connection it should be pointed out that the low temperature in the chamber 3 and of the furnace membrane results in that very little heat is lost through radiation in this portion of the furnace. Instead, practically all heat of the fuel will be released in the combustion chamber 4 at the rearward end thereof for heating the boiler tubes or other object to be heated.

The volatile matter in the form of smoke gases leaving the top layer of the fuel bed 18 flows through the chamber 3 and the duct 43 to enter the secondary ashpit 40 close below the rear end 47 of the grate 19. The second air to be added to the smoke gases to obtain a combustible mixture is preferably added to the gases in connection with their entrance into the secondary ashpit 40. To this end there may be provided two shutter controlled secondary air intakes 48 connected to the lower ends of the duct 43 as shown in FIGS. 2 and 3. However, secondary air may also be admitted through the passages 41 formed between the grate bars at the intermediate spacers 21. Alternatively, the passages 41 may be omitted by having spacer pieces 21 extending to the top surface of the grate, which means that practically all secondary air is taken through the intakes 48. However, the air flowing through the passages 41 will be preheated by radiation from the incandescent fuel bed and this will favourably increase the efficiency.

The combustible mixture of smoke gases and air passes through the rear end of the fuel bed at 47 where the temperature is of the order of 800° C. At a height of 1 to 3 centimeters above the grate bars, the smoke gases will have reached ignition temperature and when ignited they reach a temperature of the order of 1300 to 1500° C. Any clinkers formed at this high temperature will be pushed over the free rear end of the grate into the trough 45 by the continuously moving fuel bed 18 on the grate 3. If the clinker formation is concentrated to the rear end of the grate, it is prevented that clinker adheres to the grate and obstruct the passages between the grate bars.

The degasing of the fuel bed 18 is accurately controlled by maintaining a substantially constant and relatively low height of the fuel bed 18 on the primary grate section. The speed of the fuel bed moving through the gate opening at H and the supply of secondary air to the secondary grate section B is so adjusted that the fuel will be completely burnt out when reaching the outlet end 47 of the grate. This control is obtained by conventional control means for adjusting the speed of the motor 29, the opening of the air inlet 37, the rate of the fuel feeding device 17 and the opening of the secondary air intakes 48.

Due to the fact that the fuel is dropped or sprinkled from the upper end of the chamber 3 at an adjustable and controlled rate, the fuel is evenly distributed over the top surface of the bed 18 so that the degasing of the fuel will be completely controlled. The formation of so-called gas pockets, which may result in explosions, is accordingly avoided.

The above combustion of the fuel and the smoke gases will result in a completely smokeless combustion. Besides that this means a considerably improved efficiency of combustion and practically no fouling of the ambient atmosphere, it also means less deposits of soot and other combustion particles on the object to be heated, for instance the tubes of the boilers.

Various modifications of the furnace shown may be made within the scope of the invention. The fuel feeding device 17 may for instance be replaced by a rotatable wheel with radial wings moving in the opening 12, the speed of the wheel being synchronized with the speed of the grate. The movable grate 19 may for instance be of the endless chain type.

I claim:

1. A furnace for burning solid fuels having a relatively high content of volatile matter, comprising a substantially horizontal movable grate located in a casing, said casing having side walls on opposite sides of the grate and transverse walls to define a degasing chamber above a primary section of the effective length of the grate and a combustible chamber above the rest of the grate, the said transverse walls forming a secondary grate section, one of said transverse walls having its lower edge disposed at a predetermined height above the grate in the vicinity of the outlet end of the primary grate section to form a gate opening defining the height of the fuel bed moved from the fuel in the degasing chamber into
the combustion chamber, the height of the gate opening and the length of the primary grate section being each less than the length of the secondary grate section, said transverse walls including partitions which define a primary and a secondary ashpit located beneath the primary and secondary grate sections respectively, a gas passage formed by the upper portion of the degasing chamber, the secondary ashpit and a duct which connects said upper portion and the secondary ashpit, said duct connecting the top of said degasing chamber with said secondary ashpit below the outlet end of said secondary grate section, inlets for admitting primary air to be passed upwards through the primary grate and for admitting secondary air to said gas passage for mixing with the gases passing therein to form a combustible mixture the temperature of which, when passing incandescent fuel on the secondary grate section, being raised to the ignition point, and means for feeding fresh fuel to the primary grate in relation to the speed of the moving fuel bed in order to maintain a substantially constant fuel bed level in the degasing chamber.

2. A furnace as defined in claim 1, in which the grate comprises a number of parallel spaced longitudinal grate bars slidable on transverse supporting members extending between the side walls of the casing, and a driving mechanism for moving all bars at the same time from a forward end position to a rearward end position to move the fuel bed and thereafter retracting the bars individually one after another, to leave the fuel bed in the rearward end position, the fuel bed abutting with its forward end against a transverse wall located at the inlet end of the primary grate section and having its lower edge disposed adjacent the grate surface.

3. A furnace as defined in claim 2, in which said grate bars have transverse spacer members defining two separate through-flow passages, one for the primary and one for the secondary section of the fuel bed.

4. A furnace as defined in claim 3, in which the spacer members separating the two through-flow passages are formed to provide communication passages between the primary and secondary ashpits for part of air admitted to the primary ashpit.

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