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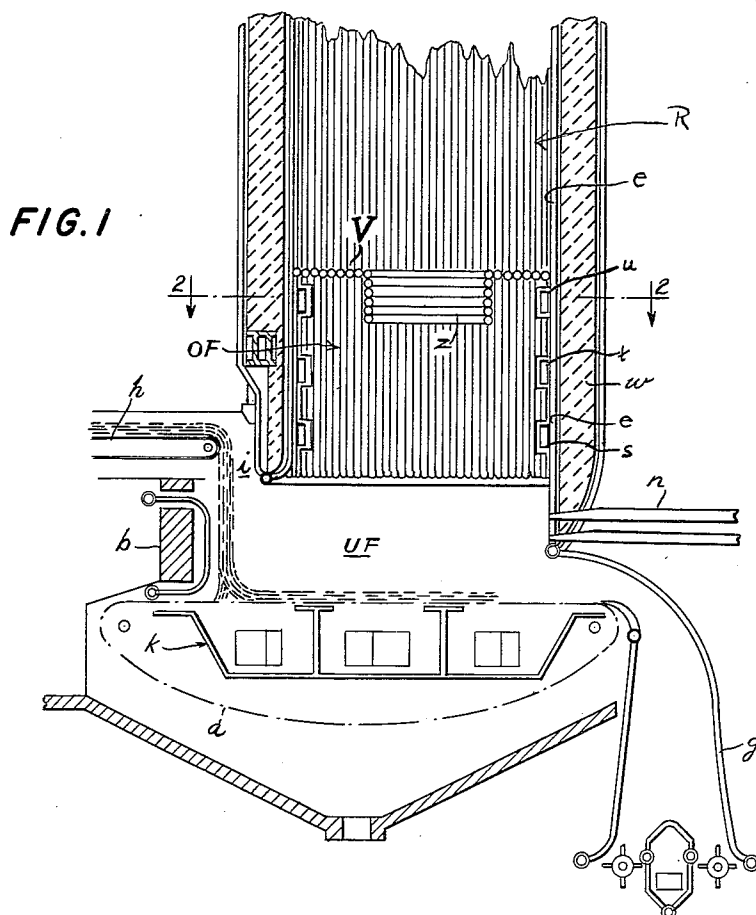
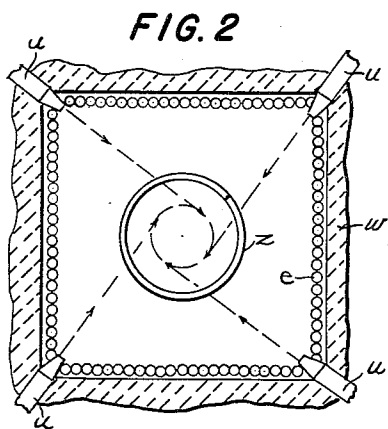
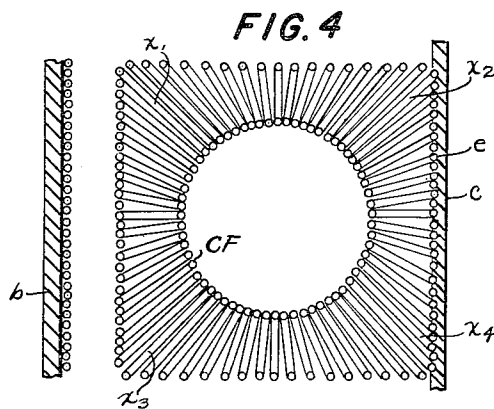
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APPARATUS FOR BURNING SOLID FUEL

Filed June 19, 1950

2 Sheets-Sheet 1



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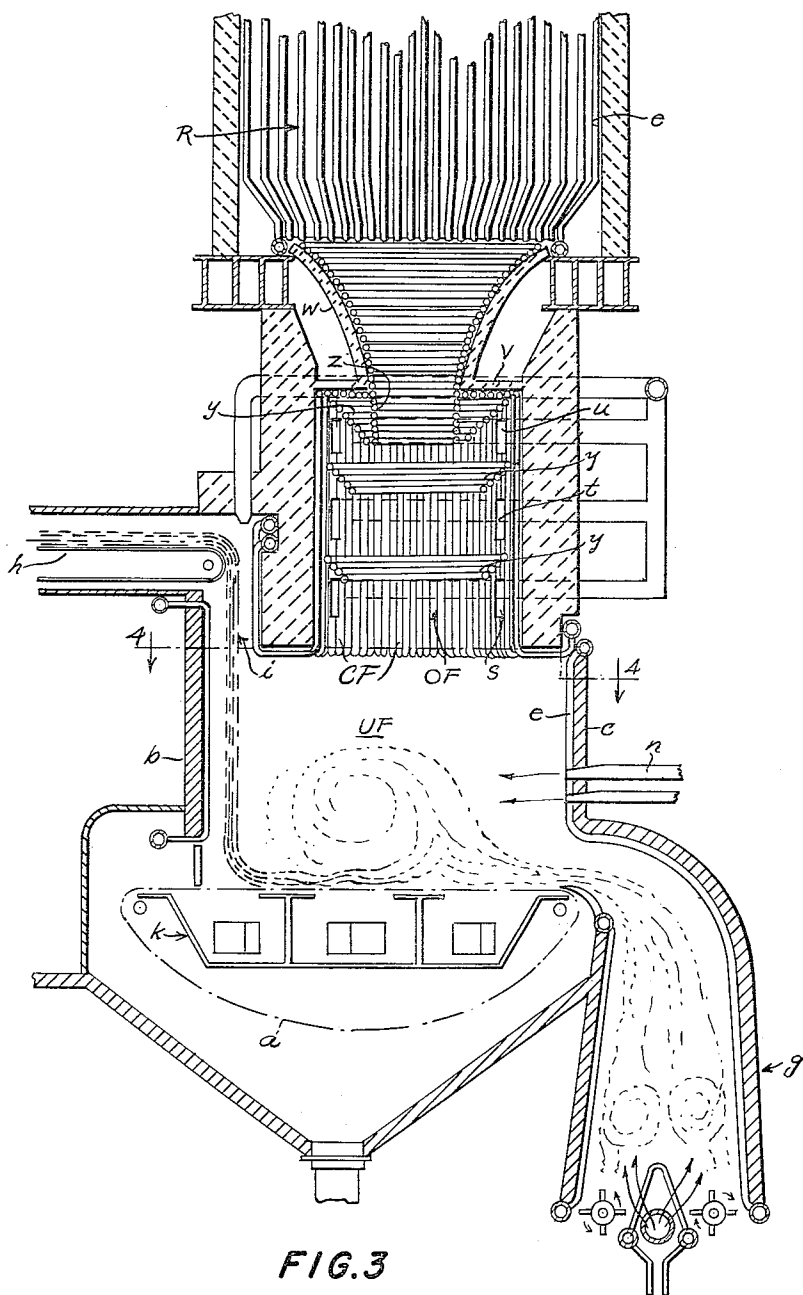


FIG. 3

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APPARATUS FOR BURNING SOLID FUEL

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Claims priority, application Germany July 11, 1949

14 Claims. (Cl. 122-4)

This invention relates to improvements in or modifications of a furnace operating in accordance with the method of burning solid fuel described and claimed in co-pending application Serial Number 123,515 filed October 25, 1949.

In the above-referred to co-pending application I have described a method of burning solid fuel in a vertically extending combustion zone which includes delivering fuel by gravity from substantially midway of the height of the zone upon the front portion of a fire bed moving on a travelling grate travelling from front to rear of the zone and including three longitudinally aligned portions. Oxidizing medium is introduced from beneath the bed under all the portions and the pressure of the introduced medium being increased successively from front to rear so that the coal is fluidized under the middle portion and under the rearmost portion incandescent particles are picked up and flung from the bed toward the front of the zone to intermingle with the incoming fuel.

Accordingly, the present invention has for an object to improve the construction and operation of a furnace of the afordescribed character and more specifically provides partition means within the furnace space to separate the furnace space into a fire box region or zone and an upper region or zone to constitute a radiation section.

More specifically the partition means includes a central opening of circular cross section through which combustion gases are discharged into the radiation section of the boiler or furnace. This partition, in combination with tertiary air tuyeres as described in the above identified co-pending application, providing a cyclone action to separate fuel and fume-borne ash particles.

A more specific object is to provide a depending circular sleeve extending downwardly from the edges of the opening in the partition and an additional specific object is to provide a diffuser outlet extending upwardly into the radiation section of the boiler or furnace.

An additional specific object is to provide ash-deflecting surfaces superjacent each row of tuyeres.

While it is known in the art to provide cyclone-type furnaces as, for example, in Patent 2,357,302 to Kerr the present arrangement affords specific improvements thereover and in combination with a furnace in which solid fuel is initially burnt on a travelling grate and as the operation proceeds with fuel fluidization and elevation of particles of fuel from the rear of the grate, a burning in suspension effect exists in the zone or region of the furnace or fire box that is beneath the partition. In connection with this application, solid fuel as utilized is generally larger in particle size than pulverized fuel or coal dust, although it may contain some of the latter.

Further and more specific objects and features of the invention are apparent from the following description when taken in connection with the accompanying drawings in which:

Figure 1 is a longitudinal sectional view through a furnace that embodies the invention,

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Figure 2 is a cross-sectional view taken along lines 2-2 of Figure 1;

Figure 3 is a view similar to Figure 1 but illustrating a modified form of furnace construction, and

Figure 4 is a cross-sectional view taken along lines 4-4 of Figure 3.

In the drawings like reference numerals denote the same or equivalent parts. The furnace constructed in accordance with this invention includes wall means that define a vertically disposed combustion zone and a radiation section or zone coaxially thereabove. At the bottom of the combustion zone is a travelling grate, denoted diagrammatically at *a*, the grate traveling from front to rear of the combustion zone and being adapted to support and move a fire bed. The front wall of the furnace includes a lower portion *b* so related with respect to an upper portion of the front wall as to provide a fuel inlet passage or orifice *i*. A conveyor *h* forwards all fuel through the inlet passage, so that the fuel falls by gravity upon the grate at the front portion of the combustion zone.

As set forth in complete detail in my above referred to application, the region beneath the grate, denoted generally at *k*, includes three longitudinally aligned portions through which oxidizing medium is introduced, the oxidizing medium flowing upwardly through the fire bed on the grate with the pressure of the introduced medium increasing toward the rear of the grate so as to fluidize fuel upon the middle portion of the grate and to elevate fuel and incandescent particles from the rear of the grate. Additional oxidizing medium is introduced through nozzles *n* which project through the rear wall *c* at a level above the grate. This additional medium entrains and projects the elevated fuel and incandescent particles across the bed to the front of the combustion zone so that they are intermingled with the incoming fuel. Protecting tube walls *e* are embodied in the combustion zone and in the radiation section and a shaft or channel *g* is disposed at the rear of the grate for completing combustion of particles of coke adhering to the slag.

The combustion space or zone of the furnace includes a portion UF constituting a lower fire box that extends immediately above the grate and a portion OF constituting an upper fire box. A plurality of spaced, superposed tiers of tuyeres *s*, *t* and *u* project through the walls *w* defining the upper fire box OF. These tuyeres are directed, as indicated in Figure 2, to provide a whirling action about the vertical axis of the upper fire box. The tuyeres constitute means for furnishing a tertiary supply of oxidizing medium.

The region above the upper fire box is a water tube lined radiation section R. In accordance with the invention, this section is separated from the upper fire box OF, where the gases are subjected to the whirling action. To accomplish this separation or division, there is provided a horizontal partition arranged above the uppermost bank or tier of tuyeres. The horizontal partition has a central circular opening therein through which gases are discharged into the radiation space of the boiler. It is convenient to extend the edge of this opening downwardly so as to form a cylindrical sleeve. In this way in the upper part of the furnace a cyclone action arises and a good separation of fuel and fume-borne ash particles is effected so that under certain conditions a fume filter and a conduit for returning the fume-borne ash particles separated therein to the furnace can be omitted. In the drawings V is the partition and z is the downwardly extending cylindrical sleeve, and in both examples both the partition and the sleeve are shown as of tubular construction.

According to the invention it is further found advantageous to make the upper part of the furnace of cylin-

drical formation as a result of which a cyclone is formed, which cyclone has a different action however from that of a previous proposal in which a cyclone having a horizontal axis or an axis very slightly inclined to the horizontal, acts as combustion and ash-melting zone.

The transition from the cylindrical part CF of the upper firebox to a rectangular opening at the bottom over the grate necessitates tube systems x_1 , x_2 , x_3 and x_4 at the corners as shown in Figure 4.

In order to utilize the whirling energy for the flow through the boiler, according to the invention the combustion gases are discharged through a diffusor-like enlargement expanding to the cross-section of the radiation space of the boiler which is situated above the upper fire box. Figure 3 shows at W such a diffusor-like enlargement of the short cylindrical sleeve z which opens out into the radiation space of the boiler, and in the example this diffusor is shown of tubular construction.

The partitioning off of the upper part of the furnace and the further improvements described, bring about a considerable increase in the efficiency of the whole combustion process which can be still further increased by forced working, that is by working the furnace and the adjoining boiler heated thereby under pressure, in the manner known per se.

Under these conditions owing to the reduction by the partition of the discharge passage for the combustion gases the furnace temperatures may easily exceed the ash melting point. Accordingly there is a danger of the tertiary air supply tuyeres s , t , u leading into the upper furnace space being clogged up by slag formation. To avoid this danger, according to the invention downwardly and inwardly inclined ash-deflecting surfaces shown at y in Figure 3 are arranged above the tuyeres s , t and u respectively. These deflecting surfaces extend over the whole circumference of the upper furnace space. For the reason that these surfaces extend over the whole of the circumference, their inner edges have a great peripheral length so that the ash particles to be discharged are also better distributed over the whole circumference. If these surfaces were but short and localised over the tuyeres s , t , u , deposits could not be prevented from accumulating around the openings of the tertiary air supply tuyeres. Moreover, down-flowing ash could possibly pass over the wall areas between the inlets for the tertiary air supply tuyeres and might lead to heavy slag deposits on these areas which are occupied by radiation tubes. According to the invention it is advantageous to widen these deflecting surfaces upwardly so that the lowermost openings for the tertiary air supply are covered by the narrowest deflecting surface and the uppermost openings are covered by the widest deflecting surfaces, as a result of which the deflected ash particles are distributed over a wide area. This widening is shown in Figure 3.

To avoid interference with the whirling action due to these deflecting surfaces according to the invention it is furthermore advantageous to construct them as indicated in Figure 3 as continuous helical convolutions in the same direction as the whirling action.

It is believed clear, therefore, that the present invention provides in a boiler furnace, the combination of wall means that define a vertically disposed combustion zone and a radiation section coaxially thereabove. A traveling grate a is movable from front to rear in the lower portion of the combustion zone. Means are provided for forwarding fuel to fall by gravity upon the grate in the front portion of the zone including the fuel conveyor h and a fuel inlet orifice in the front wall that is above the front portion of the grate. It is to be noted that the combustion zone includes one portion providing a lower fire box UF and an upper fire box OF. The fuel inlet orifice is located between the fire boxes. Water tubes are provided that bound the upper radiation section that is above the upper fire box and tuyeres arranged in a plurality of spaced rows s , t and u extend into the upper fire box

for injecting combustion supporting medium such as air thereinto. As referred to previously, these tuyeres are directed so as to provide a whirling action about the vertical axis of the fire box. Water tubes are arranged to provide a horizontal partition located above the tuyeres for dividing the upper fire box from the radiation section at a level closely superjacent the tuyeres. This partition has a central opening therein to permit discharge of combustion gases into the radiation section. A short cylindrical sleeve extends downwardly from the partition from the edge of the opening therethrough into the upper fire box. Furthermore, this sleeve also extends above the partition into the radiation section and increases in diameter upwardly to define a diffusing means through which gases are discharged into the radiation section.

All the walls of the furnace structure described are formed by tube systems such as e through which water is positively passed or circulated, and no detailed description of this is necessary.

I claim:

1. In a boiler furnace, the combination of wall means defining a vertically disposed combustion zone and a radiation section coaxially thereabove, a traveling grate movable from front to rear in the lower portion of said zone, said wall means including a front wall having fuel inlet orifice therein above the grate, means for forwarding fuel through the inlet orifice to fall by gravity upon said grate at the front portion of said zone, said combustion zone including a first portion providing a lower fire box immediately above said grate and a second portion providing an upper fire box extending above said lower fire box, said fuel inlet orifice being disposed between the fire boxes, water tubes bounding the radiation section above the upper fire box, tuyeres extending through the walls of the upper fire box for injecting air thereinto, said tuyeres being so directed as to provide a whirling of injected air and furnace gases about the vertical axis of the fire box, a horizontal partition above the tuyeres for dividing the upper fire box from the radiation section at a level closely superjacent the tuyeres, and said partition having a central opening therein for the discharge of combustion gases into said radiation section.

2. In a boiler furnace, the combination of wall means defining a vertically disposed combustion zone and a radiation section coaxially thereabove, a travelling grate movable from front to rear in the lower portion of said zone, said wall means including a front wall having a fuel inlet orifice therein above the grate, means for forwarding fuel through the inlet orifice to fall by gravity upon said grate at the front portion of said zone, said combustion zone including a first portion providing a lower fire box immediately above said grate and a second portion providing an upper fire box extending above said lower fire box, said fuel inlet orifice being disposed between the fire boxes, water tubes bounding the radiation section above the upper fire box, tuyeres extending through the walls of the upper fire box for injecting air thereinto, said tuyeres being so directed as to provide a whirling of injected air and furnace gases about the vertical axis of the fire box, a horizontal partition above the tuyeres for dividing the upper fire box from the radiation section at a level closely superjacent the tuyeres, said partition having a central opening therein for the discharge of combustion gases into said radiation section, and also including a short cylindrical sleeve extending downwardly from the edge of the opening of the partition into the upper fire box.

3. In a boiler furnace as defined in claim 1, wherein the upper fire box is of cylindrical formation.

4. In a boiler furnace as defined in claim 1, and further including circumferential downwardly and inwardly inclined ash-deflecting surfaces arranged above said tuyeres.

5. In a boiler furnace as defined in claim 4, in which the tuyeres are arranged in a plurality of spaced super-

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posed rows, a downwardly inclined circumferential ash-deflecting surface above each row of tuyeres, and the said surfaces defining sets of separate conical surfaces each increasing upwardly in diameter and the superposed sets of surfaces respectively increasing in slant height from the lowermost to the uppermost.

6. In a boiler furnace as defined in claim 1, and also including water tubes defining a sloping circumferential ash-deflecting surface above the tuyeres, said last mentioned water tubes each being of contiguous helical conformation and having their helical axes lying in the surface of an inverted cone and following the direction of the whirling action produced by said tuyeres.

7. In a boiler furnace, the combination of wall means defining a vertically disposed combustion zone and a radiation section coaxially thereabove, a travelling grate movable from front to rear in the lower portion of said zone, means for forwarding fuel to fall by gravity upon the grate at the front portion of said zone, said zone including a portion providing a lower fire box above said grate and an upper fire box superjacent the lower fire box, said fuel forwarding means including an inlet orifice between the fire boxes, said inlet orifice being at the front of the zone, water tubes bounding the upper radiation section above the upper fire box, tuyeres extending into the upper fire box for injecting air thereinto, said tuyeres being so directed as to provide a whirling action about the vertical axis of the upper fire box, means providing a horizontal partition above the tuyeres for dividing the upper fire box from the radiation section at a level closely superjacent the tuyeres, said partition having a central opening therein, a short cylindrical sleeve extending downwardly from the edge of the opening into the upper part of the fire box and said sleeve extending above the partition into the radiation section and increasing in diameter upwardly to define a diffusing means through which gases are discharged into the radiation section.

8. In a boiler furnace, the combination of wall means defining a vertically disposed combustion zone and a radiation section coaxially thereabove, said wall means including a front wall, a travelling grate movable from front to rear in the lower portion of said zone, means including a fuel inlet orifice in the front wall above the grate for forwarding fuel to fall by gravity upon the grate at the front portion of said zone, said zone including a portion providing a lower fire box above said grate and an upper fire box superjacent the lower fire box, said fuel inlet orifice being between the fire boxes, water tubes bounding the upper radiation section above the upper fire box, tuyeres extending into the upper fire box for injecting air thereinto, said tuyeres being so directed as to provide a whirling action about the vertical axis of the fire box, water tubes defining a horizontal partition above the tuyeres for dividing the upper fire box from the radiation section at a level closely superadjacent the tuyeres, said partition having a central opening therein, water tubes defining a short cylindrical sleeve extending downwardly from the edge of the opening into the upper part of the fire box and water tubes extending from said sleeve above the partition into the radiation section and defining a diffuser of increasing diameter upwardly and outwardly and terminating with the uppermost tubes adjacent the water tubes bounding the upper radiation section.

9. In a boiler furnace, the combination as claimed in claim 8 in which the tuyeres are arranged in a plurality of spaced superposed tiers and water tubes defining a sloping circumferential ash-deflecting surface above each tier of tuyeres, said last mentioned water tubes each being of continuous contiguous helical conformation and having their helical axes lying in the surface of an inverted cone and following the direction of whirl produced by said tuyeres.

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10. A boiler furnace comprising wall means defining a vertically disposed combustion zone and a radiation section coaxially thereabove, said combustion zone including a fire box the upper part of which is of cylindrical formation, water tubes bounding the radiation section above said fire box, tuyeres arranged in superposed rows and extending through the walls into the upper cylindrical portion of the fire box for injecting air thereinto, said tuyeres being so directed as to provide a whirling of air and gases about the vertical axis of the fire box, a partition above the uppermost row of tuyeres for dividing the upper cylindrical portion of the fire box from the radiation section at a level closely superjacent the uppermost row of tuyeres, said partition having a central circular opening therein, a short cylindrical sleeve extending downwardly from the edge of said opening part way into the upper cylindrical portion of the fire box, and means defining a downwardly and inwardly sloping circumferential ash-deflecting surface above each row of tuyeres.

11. A boiler furnace as claimed in claim 10, in which the respective ash-deflecting surfaces are separate conical surfaces each increasing upwardly in diameter and the slant height of each surface increasing from the lowermost to the uppermost surface.

12. A boiler furnace as claimed in claim 11, in which water tubes constitute each of the said surfaces, said last mentioned water tubes of each surface being of contiguous helical conformation and having their helical axes lying in the surface of an inverted cone and following the direction of the whirl produced by said tuyeres.

13. A boiler furnace as claimed in claim 1, in which water tubes constitute said horizontal partition.

14. In a boiler furnace, the combination of wall means defining a vertically disposed combustion zone and a radiation section coaxially thereabove, a travelling grate movable from front to rear in the lower portion of said zone, said wall means including a front wall having a fuel inlet orifice therein located above the grate, means for forwarding fuel through the inlet orifice to fall by gravity upon the grate at the front portion of said zone, said zone including a portion providing a lower fire box above said grate and an upper fire box superjacent the lower fire box, said fuel inlet orifice being between the fire boxes, tuyeres extending into the upper fire box for injecting combustion supporting medium thereinto, said tuyeres being directed so as to provide a whirling action about the vertical axis of the fire box, means providing a horizontal partition above the tuyeres for dividing the upper fire box from the radiation section at a level closely superjacent the tuyeres, said partition having a central opening therein, a short cylindrical sleeve extending downwardly from the edge of the opening into the upper fire box, said sleeve extending above the partition into the radiation section and increasing in diameter upwardly to define a diffusing means through which gases are discharged into the radiation section, and circumferential downwardly and inwardly inclined ash-deflecting surfaces arranged above said tuyeres.

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