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CYCLONE FURNACES

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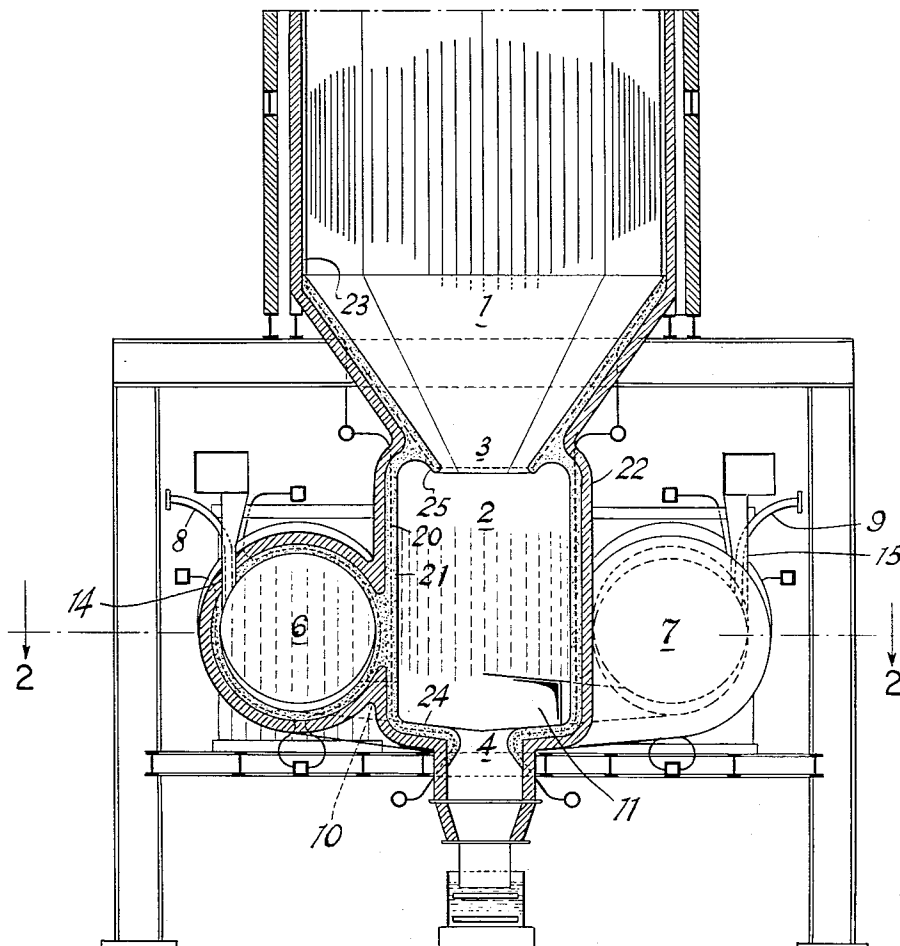


FIG. 1

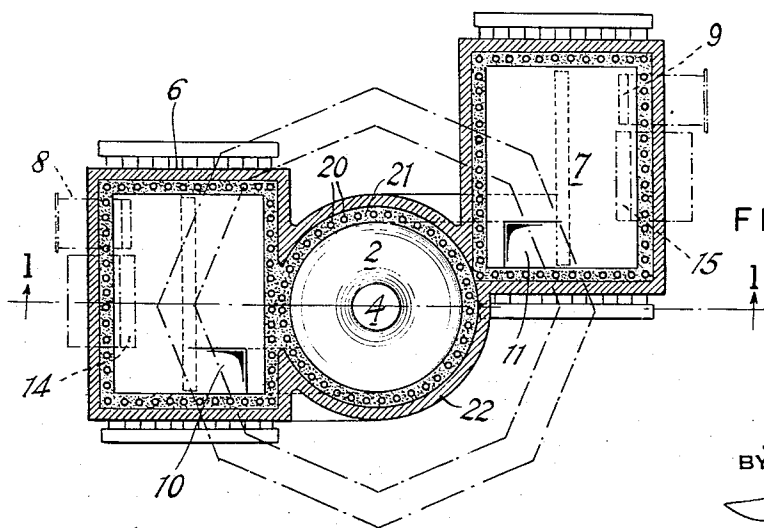


FIG. 2

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CYCLONE FURNACES

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8 Claims. (Cl. 110—28)

The present invention relates in general to a method of and apparatus for burning ash-containing solid fuels which are characterized by a high output of high temperature gaseous products of combustion which are substantially free of entrained slag or ash particles.

In practicing the invention, the combustion constituents are introduced into a combustion chamber of the cyclone type, generally similar to the cyclones disclosed, for example, in the U. S. patent of Bailey 2,357,301, issued September 5, 1944, and the high temperature combustion products developed therein are introduced into a succeeding combustion chamber of a similar type, wherein the combustion is substantially completed and a separation of the gaseous products and molten slag particles is substantially effected.

In accordance with the invention, a granular ash-containing solid fuel, in a high velocity stream of superatmospheric pressure carrier air, or other suitable gaseous medium, is directed tangentially into a fluid cooled cyclone chamber adjacent one end thereof and caused to follow a helical path of travel longitudinally therein, with secondary combustion air in regulable quantity also being admitted tangentially, from whence the products of combustion are discharged tangentially from a point adjacent the opposite end into a second similar fluid cooled cyclone chamber which in accordance with the present invention is arranged with its longitudinal axis at right angles to the axis of the first chamber.

More particularly, the invention involves one or more primary cyclone type combustion chambers positioned with horizontally extending axes, having a tangential fuel and air inlet at or adjacent one end thereof and a tangential outlet for gaseous products of combustion and a slag at or adjacent their opposite end portion arranged to discharge tangentially into an upright cyclone chamber at a position intermediate a top outlet therein for gaseous products of combustion and a bottom outlet for separated molten slag.

The invention relates more particularly to a cyclone furnace unit consisting of one or more water cooled refractory cylindrical primary cyclone combustion chambers with helical flame guidance and the draining of molten slag into a secondary cyclone combustion chamber, followed by a radiant heat absorption chamber, the volume of the secondary combustion chamber being smaller than the sum of the volumes of the primary combustion chambers.

In the cyclone furnace unit of the invention, the major portion of the slag is separated in the primary cyclone chamber, most of the remaining slag is separated in the secondary chamber and a small portion passes through the steam generator to the stack. The primary and secondary cyclone combustion chambers are relatively arranged and interconnected in such a way that slag is discharged from the unit at only one point.

However, the solution of the several problems interfere with each other. For example, the secondary combustion chamber has as its aim to burn out the flame or complete

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the combustion, to separate the liquid slag contained in the products of combustion, to maintain the slag sufficiently hot for it to drain without disturbance, and to do all this at the lowest permissible partial load.

On the other hand it is also the function of the secondary combustion chamber to cool the furnace gases discharged through tubes of a slag screen so they are reduced below the melting temperature of the slag and thereby give no rise to slag depositions in the subsequent radiant heat absorption chamber and connected convection heating surfaces.

In prior cyclone furnace units the volume of the secondary combustion chamber is usually a multiple of the volume of the cyclone combustion chamber and hence at partial load there is a high degree of cooling of the furnace gases so that the permissible partial load is necessarily set high. The two aforementioned problems are best solved when the slag outlet of the secondary combustion chamber is positioned at its hottest point, i. e. in the vicinity of the furnace gas inlet from the primary cyclone chamber, while the slag removal screen is substantially removed therefrom.

The present invention associates one or more primary cyclone combustion chambers with one or more secondary combustion chambers of a cyclone type in a manner to insure completion of combustion, maintenance of slag fluidity for discharge and high degree of slag removal from the discharged high temperature heating gases.

The various features of novelty which characterize this invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which a selected embodiment of the invention has been illustrated and described.

Of the drawings:

Fig. 1 is a transverse sectional elevation through the main axis of a multi-cyclone chamber furnace constructed in accordance with the invention, as indicated by line 1—1 in Fig. 2; and

Fig. 2 is a sectional plan view of the multi-cyclone chamber furnace, taken in a plane perpendicular to the plane of Fig. 1, as indicated by line 2—2 in Fig. 1.

As shown in the drawings, a vertically elongated cylindrical secondary combustion chamber 2, which has walls with cooling tubes 20 provided with a refractory composition 21 on the inner or fire side and an outer insulating jacket and metal shell 22 is arranged coaxially below a radiant chamber 1. Chamber 1 is designed similar to the combustion chamber of a radiant steam generator having its walls lined with cooling tubes 23 connected to the fluid circulation of the generator. The gas discharge opening 3 connecting the upper end of chamber 2 and the radiant chamber is of octagonal configuration conforming to the octagonal arrangement of the wall of the radiant chamber 1. However the opening 3 may have a circular or other form symmetrical to the vertical axis of chamber 2.

Two horizontally elongated cylindrical primary cyclone chambers 6 and 7 are positioned laterally and at opposite sides of the chamber 2, with their axes extending horizontally. These cyclone chambers have disc type closures at both ends, and tangentially arranged outwardly extending outlet passages 10 and 11 respectively connected to the secondary chamber 2. The cylindrical and end walls of the primary chambers are provided with cooling tubes which are connected into the circulation of the vapor generator.

A fuel-primary air mixture is supplied tangentially to the two cyclone primary combustion chambers 6 and 7 adjacent one end through respective feed conduits 8 and

9 from suitable sources of prepared fuel and air under superatmospheric pressure. The secondary combustion air is supplied as required by longitudinally extending nozzles 14 and 15, being likewise introduced tangentially with the same direction of rotation as the corresponding primary air and fuel. The resulting flame and products of combustion move in a helical path along the cylindrical wall of the cyclones and develops a temperature above the fuel ash fusion temperature so that the ash of the fuel melts to a slag. The slag flows with the furnace gases outwardly through passages 10 and 11 entering tangentially into the secondary combustion chamber 2 over the inwardly sloping bottom 24. The relative arrangement of the passages 10 and 11 is such as to cause the same direction of rotation of the gases and suspended slag particles therefrom in the secondary chamber 2. Slag flowing along the bottom of passages 10 and 11 can pass directly to the outlet 4. The flame and products of combustion move upward along the walls of the cylindrical secondary combustion chamber in helical paths. Slag particles in suspension are separated by centrifugal force and deposited on the chamber walls. The refractory faced wall with its coating of slag is maintained at a temperature which is above the melting point of the slag by the residual combustion therein. The molten slag particles on the vertical walls drain downwardly by gravity to flow in molten form over the downwardly sloping floor 24 to slag outlet 4. The inclined bottom of the secondary chamber includes water cooling tubes and refractory facing thereon, the tubes being extensions of the tubes 20 about the cylindrical portion of chamber 2. These tubes are connected into the circulation of the generator.

In order that the helical path of the gases will continue into the radiant chamber 1, the customary slag screen of spaced tubes has been dispensed with and it has been replaced with the constricted gas discharge opening 3. The upper end wall of the secondary chamber 2 embracing the central opening 3 is formed with a downwardly extending lip 25 which contributes to the retention of the slag particles within the chamber 2, to the end that the gases passing into radiant chamber 2 and thereafter through the associated steam generator will carry a minimum of entrained slag or fly ash.

As it is contemplated that the primary cyclone chambers 6 and 7 will operate at substantially superatmospheric pressure in order that the gaseous products of combustion will enter the secondary chamber 2 through passages 10 and 11 at substantial velocities, chamber 2 may operate at a pressure substantially different from that of the atmosphere. Accordingly a water sealed slag granulating and discharge device 5 is positioned beneath the slag opening 4.

The internal volume of the cylindrical secondary combustion chamber 2 is less than the combined volumes of the primary cyclone chambers 6 and 7. While the secondary cyclone chamber may be cooled below the melting point of the slag during a partial load or fuel burning rate when one cyclone chamber is taken out of service, the lower portion thereof will remain at a high temperature, which is important for the undisturbed discharge of slag, because of the discharge of hot gases from the operating primary cyclone chamber into the lower portion of the secondary chamber in proximity to the slag outlet 4.

It is therefore practical to lower the permissible partial load to the extent that it is still possible to keep the slag on the bottom of the secondary cyclone chamber 2 fluid. Conditions will be more favorable, the smaller the volume of the secondary combustion chamber 2 and the greater its length in relation to its diameter. It is preferable if each primary cyclone chamber has a separate secondary combustion chamber coordinated with it, when considered solely from the partial load standpoint. However it is more desirable as regards the arrangement of the

ash or slag disposal equipment if the slag is discharged from only one point in the installation, and it will therefore be preferable to coordinate several primary cyclone combustion chambers with one secondary combustion chamber.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form and mode of operation of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

I claim:

1. A cyclone furnace unit for burning ash-containing solid fuel which comprises a primary cyclone chamber of substantially circular cross-section arranged with its longitudinal axis substantially horizontal, means for introducing a stream of air and ash-containing fuel in suspension into said chamber and effecting a helical path of travel thereof along the circumferential wall of said chamber, said primary chamber having an outlet passage for products of combustion opening therefrom in tangential relation to said wall, a secondary cyclone chamber of substantially circular cross-section arranged with its longitudinal axis substantially vertical and having an inlet passage forming a continuation of said outlet passage and arranged tangentially of said secondary chamber for developing a helical gas flow stream along the circumferential wall of said secondary chamber, a slag discharge opening from the lower portion of said secondary chamber, and a gas outlet formed at the upper end of said secondary chamber.

2. A cyclone furnace unit as defined in claim 1 wherein said inlet passage is positioned closely adjacent the lower end of said secondary chamber adjacent said slag discharge opening.

3. A cyclone furnace unit as defined in claim 1 wherein the lower end of said secondary chamber has a water tube cooled bottom through which said slag opening extends, and said inlet passage is positioned closely adjacent said bottom.

4. A cyclone furnace unit as defined in claim 1 wherein the gas outlet opening from the upper end of the secondary chamber is of lesser transverse dimension than the diameter of the secondary chamber and has a depending lip associated with its margin.

5. A cyclone furnace unit as defined in claim 1 wherein the gas outlet from the upper end of the secondary chamber is connected to the lower end of an elongated upwardly extended fluid cooled radiant heat absorbing chamber of a vapor generator.

6. A cyclone furnace unit for burning ash-containing solid fuel which comprises a plurality of primary cyclone chambers of substantially circular cross-section arranged with its longitudinal axis substantially horizontal, means for introducing a stream of air and ash-containing fuel in suspension into each of said chambers and effecting a helical path of travel thereof along the circumferential walls of said chambers, said primary chambers having outlet passages for products of combustion opening therefrom in tangential relation to their walls, a secondary cyclone chamber of substantially circular cross-section arranged with longitudinal axis substantially vertical and having a plurality of inlet passages forming continuations of corresponding outlet passages and arranged tangentially of circumferentially spaced portions of said secondary chamber, a slag discharge opening from the lower portion of said secondary chamber, a gas outlet from the end of the secondary chamber opposite the slag outlet, said inlet passages being positioned closer to the slag discharge opening than to the gas outlet.

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7. A cyclone furnace unit as defined in claim 6 wherein the volume of the secondary cyclone chamber is less than the combined volumes of the primary cyclone chambers.

8. A cyclone furnace unit as defined in claim 6 wherein the axial length of the vertically extending secondary cyclone chamber is greater than the axial lengths of the horizontally extending primary cyclone chambers.

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6**References Cited in the file of this patent****UNITED STATES PATENTS**

2,357,303	Kerr et al.	Sept. 5, 1944
2,395,103	Clausen et al.	Feb. 19, 1946

FOREIGN PATENTS

925,264	France	Mar. 24, 1947
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