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54 A fluid-bed reactor.

57 The combustion chamber (1) of the fluid-bed reactor is composed of an upper furnace chamber (3) and a reactor chamber (4) centrally located beneath the furnace chamber and whose cross-sectional area is considerably smaller than the cross-sectional area of the furnace chamber, preferably not exceeding one third thereof. Around the reactor chamber and adjacent thereto one or more vertical ducts (5) are located which are open at their top towards the superposed furnace chamber and at the bottom include blockable discharge openings to the bottom of the reactor chamber. Reactor heat surfaces (26) are inserted in the ducts (5) and may include a final superheater for the steam generated in the reactor.

During operation of the reactor the mixture of inert vortex layer material and combustible in the reactor chamber is kept fluidized to such a degree that material from the chamber is continuously blown up into the furnace chamber together with the flue gases. Due to the sudden increase of the cross-section above the chamber the gas rate decreases correspondingly, and the major portion of the entrained material drops down into the ducts where it is cooled by the incorporated heat surfaces and subsequently recycled to the reactor chamber.

The effected internal recycling of the hot vortex layer material provides inter alia for arranging convection heat surfaces (17) between the furnace chamber and a succeeding cyclone

separator (19) which may thus be more simply structured, made less expensive and provided with a higher efficiency than prior reactors with external recycling.

Description

Fluid-Bed Reactor.

This invention relates to a fluid-bed reactor of the type comprising, on one hand, a vertical combustion chamber in which a vortex layer of inert material during operation of the reactor is kept fluidized to such a degree that a considerable part thereof is entrained by the discharging flue gases and after separation from the gases is recirculated to the combustion chamber and, on the other hand, a heat exchanger in which the working medium of the reactor absorbs heat from recycling vortex layer material.

US patent No. 4 111 158 discloses a reactor of said type comprising two circuits for recycling vortex layer material including ash particles and possibly unburnt combustibles. The first circuit includes a cyclone separator in which the major portion of the particles entrained by the flue gases discharging from the combustion chamber is separated from the gases and from which the particles are fed back to the combustion chamber. The said heat exchanger in which the energy generated by the combustion is utilized forms part of a second circuit in which the particles are removed from the bottom of the vortex layer in the combustion chamber and after cooling in the heat exchanger positioned externally of said chamber are fed back to an area at a higher level in the combustion chamber.

A reactor according to the present invention differs from the prior art reactor in that the combustion chamber comprises an upper furnace chamber and a lower reactor chamber in which the combustion is effected, that the reactor chamber is centrally located beneath the furnace chamber and has a substantially smaller cross-sectional area than said furnace chamber and that the heat exchanger is incorporated in one or more vertical ducts arranged around and adjacent the reactor chamber and which at their top are open towards the furnace chamber.

Various considerable advantages are obtained according to the invention and will be explained in the following general description of the operation of the reactor.

In the reactor chamber located at the bottom of the combustion chamber the major portion of the supplied combustible burns by reaction with the fluidization and combustion air injected at the bottom of the chamber, the flow quantity of which is so high that the particles in the vortex layer, including ash particles and possibly unburnt combustible, extensively is entrained upwards by the flue gases into the superjacent furnace chamber. The dividing-up of the combustion chamber, characteristic of the invention, into the just mentioned lower reactor chamber and the superjacent furnace chamber having a substantially larger cross-sectional area, causes a correspondingly sudden reduction of the flow rate of the gases when passing from the reactor chamber into the furnace chamber. As a consequence, the conveying influence exerted by the flue gases on the particles ceases rapidly and the particles move outwardly towards the walls of

the furnace chamber, where the gas rate is zero or approximately zero. The particles finally drop down into the open duct or ducts, from the bottom of which they are fed back to the bottom of the reactor chamber after having transferred heat to the working medium.

Due to the fact that the amount of hot particles in the flue gases has been considerably reduced, it is possible to incorporate convection heat surfaces in the flue gas duct immediately after the furnace chamber, thereby reducing the flue gas temperature to a value at which a succeeding cyclone separator may be made from steel without requiring coating with high temperature- and wear-resistant materials necessary in the cyclone separator according to the above mentioned US patent. This entails, on one hand, a higher degree of separation as the separator may be provided with a central gas discharge tube, the length of which may be adjusted to a predetermined degree of separation and, on the other hand, a lower weight and lower costs of manufacturing. The positioning of the duct or ducts against the central reactor chamber with common, intermediate walls offers a good heat economy, low thermal stresses in the intermediate walls and a simple structure. The comparatively low flue gas temperature at the outlet from the combustion chamber also entails that, apart from the reactor chamber, a cementing with fire-resistant material on the whole becomes superfluous. The resulting reduction of the heat accumulating ability of the reactor provides for a quicker start-up period and a shorter shut-down period of cooling in case of interruption of operation. As the weight of the reactor proper is hereby lowered so is the weight of its supporting structure and the demands on reactor bases.

The invention will now be explained in more detail with reference to the schematical drawings, in which

Fig. 1 is a vertical partially sectional view along the line I-I in Fig. 2 of an embodiment of a reactor according to the invention,

Fig. 2 is a sectional view along the line II-II in Fig. 1, and

Fig. 3 is a simplified diagrammatical view of the reactor corresponding to the view in Fig. 1,

The reactor illustrated in the drawings is supposed to be constructed as a reactor container with natural circulation and its combustion chamber generally designated 1 is defined by vertical, gastight tubular walls, the riser pipes of which extend in a traditional manner into an upper drum 2 via appropriate headers while being connected at the bottom with distributor boxes, not shown. The combustion chamber 1 is divided into an upper section 3, in the following designated the furnace chamber of the reactor, and a section 4 centrally - or coaxially - located beneath the furnace chamber and constituting the reactor chamber of the reactor in which the major part of the combustion is effected. The reactor chamber which is open at the top towards the furnace chamber has a substantially smaller cross-

sectional area than the furnace chamber, in the illustrated embodiment about 25% of the cross-sectional area of the furnace chamber.

Two vertical ducts 5, the total cross-sectional area thereof being in the illustrated embodiment substantially equal to the area of chamber 4, are located along the two opposite lateral walls of chamber 4. On the three other sides each duct 5 is defined by an insulated thermal external wall as illustrated in Figs 1 and 2. The external walls of the reactor chamber 4, two of which consequently constitute partition walls for the ducts 5, are constructed as gastight tubular walls whose tubes at the bottom are charged from distributor boxes (not shown) while extending outwardly at the top towards and as a part of the vertical tubular walls of the furnace chamber 3.

As illustrated in Figs 1 and 2 the tubing system at the transition from reactor chamber 4 to furnace chamber 3 is carried out so that every other tube 6 is displaced vertically relative to every other tube 7, and since at the same time the sheet parts connecting the successive tubes in the tubular walls are left out here, flow passages are provided between reactor chamber 4 and the walls of furnace chamber 3 for the particulate material that is blown out above reactor chamber 4 and subsequently, due to the reduced velocity of gas in furnace chamber 3, drops down into ducts 5. At the bottom of each duct there is provided an adjustable slide valve, not shown, capable of controlling the recycling of particulate material to the bottom area of reactor chamber 4.

As it will most clearly appear from Fig. 3 a wind chamber 8 having an inlet 9 for fluidization and combustion air is located beneath reactor chamber 4. Air is blown into reactor chamber 4 through chamber 8 and a principally traditional grate or nozzle bottom 10 at a flow quantity sufficient to ensure that the particulate material accommodated in the chamber is not only whirled forcibly up, thereby causing the combustion to be more efficient, but is entrained, as regards the major part, by the flue gases generated during combustion, when said gases discharge from the upper opening of the reactor chamber (so-called pneumatic conveyance). Fig. 3 also purely schematically shows inlet conduits 11 and 12 for comminuted combustible and vortex material, resp., adapted to compensate for the loss of material during the working of the reactor.

Furnace chamber 3 which in the illustrated embodiment has substantially the same height as reactor chamber 4 is completed at the top by an inclined tubular wall 13 providing, in comparison with the remainder of the cross-section of the furnace chamber, a substantially narrowed area of the outlet opening 14 for flue gases. A short, upwardly extending convection passage 15 and a substantially longer downwardly extending convection passage 16 are located after outlet opening 14 in immediate abutment against one of the lateral walls of furnace chamber 3. Convection heat surfaces generally designated 17 are shown in said two gas passages 15 and 16 and constitute, in a manner traditional per se, for instance pre-superheaters, air pre-heaters or economisers. A channel 18 extends from the lower

end of gas passage 16 upwardly into a cyclone separator 19 in which most of the still remaining particles are separated from the flue gas and collected through a discharge conduit 20 at the bottom of the separator by a container 21 from which they may fully or partially be fed back to one of ducts 5 through a return conduit 22 and/or removed from the system. The purified flue gases discharge from the separator through a conduit 23 which as illustrated in Fig. 1 may pass the flue gasses to additional convection heat surfaces 24 and therefrom to a dust separator 25, e.g. a bag filter or an electro filter. A draught blower, not shown, blows the flue gases from dust separator 25 to a chimney.

Besides the already mentioned convection heat surfaces and the water-flowed tubular walls in reactor chamber 4 and furnace chamber 3 the reactor includes heat surfaces 26 accommodated in the two ducts 5. Said heat surfaces which, as it will best appear from Fig. 2, may be formed as tubular helices, at least as regards some of them, are exposed to the highest temperatures in the reactor, and it is therefore obvious that said heat surfaces, or at least part thereof, constitute the final superheater of the reactor, provided the reactor be adapted to supply overheated steam, for example to a turbo generator.

It was briefly mentioned above that the recycling of particulate material from ducts 5 to reactor chamber 4 may be controlled by adjustable slide valves. Said slide valves may be used to control the heat absorption of the working medium in heat surfaces 26 and to control the temperature of the vortex layer in reactor chamber 4, dependent on the injected quantity of combustible. In a manner more or less known, it is further possible to control the steam temperature of an associated turbine by water injection and the steam pressure may be used as a controlling parameter for regulating the load quantities of combustible and air. At low load, the quantity of air necessary for the combustion may in itself be too small to sufficiently fluidize the material in reactor chamber 4 and in such circumstances, part of the flue gas is recycled to the reactor chamber through bottom 10 of said chamber.

Claims

1. A fluid-bed reactor of the type comprising, on one hand, a vertical combustion chamber (1) in which a vortex layer of inert material during operation of the reactor is kept fluidized to such a degree that a considerable part thereof is entrained by the discharging flue gases and after separation from the gases is recirculated to the combustion chamber and, on the other hand, a heat exchanger (26) in which the working medium of the reactor absorbs heat from recycling vortex layer material, characterized in

that the combustion chamber (1) comprises an upper furnace chamber (3) and a lower reactor chamber (4) in which the combustion is

effected,

that the reactor chamber (4) is centrally located beneath the furnace chamber (3) and has a substantially smaller cross-sectional area than said furnace chamber,

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and that the heat exchanger (26) is incorporated in one or more vertical ducts (5) arranged around and adjacent the reactor chamber (4) and which at their top open towards the furnace chamber (3).

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2. A fluid-bed reactor as claimed in claim 1, characterized in that the ratio between the cross-sectional areas of the furnace chamber (3) and the reactor chamber (4) is at least 3:1.

3. A fluid-bed reactor as claimed in claim 1 or 2, characterized in that the furnace chamber (3) has a substantially constant cross-sectional area up to a discharge opening (14) for flue gases positioned at the top of the chamber.

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4. A fluid-bed reactor as claimed in claim 3 and having a downwardly extending convection passage (16) succeeding the furnace chamber and which includes heating surfaces (17), characterized in that the convection passage (16) at the bottom terminates approximately at the level of the openings of the reactor chamber (4) and the ducts (5).

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5. A fluid-bed reactor as claimed in any of claims 1 to 4, characterized in that the height of the reactor chamber (4) and the ducts (5) is approximately half the total height of the combustion chamber (1).

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6. A fluid-bed reactor as claimed in any of claims 1 to 5, characterized in that the heat exchanger incorporated in the duct or ducts (5) includes a final superheater (26).

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7. A fluid-bed reactor as claimed in any of claims 1 to 6, characterized in that the reactor chamber (4) is free of inserted heat exchanger surfaces.

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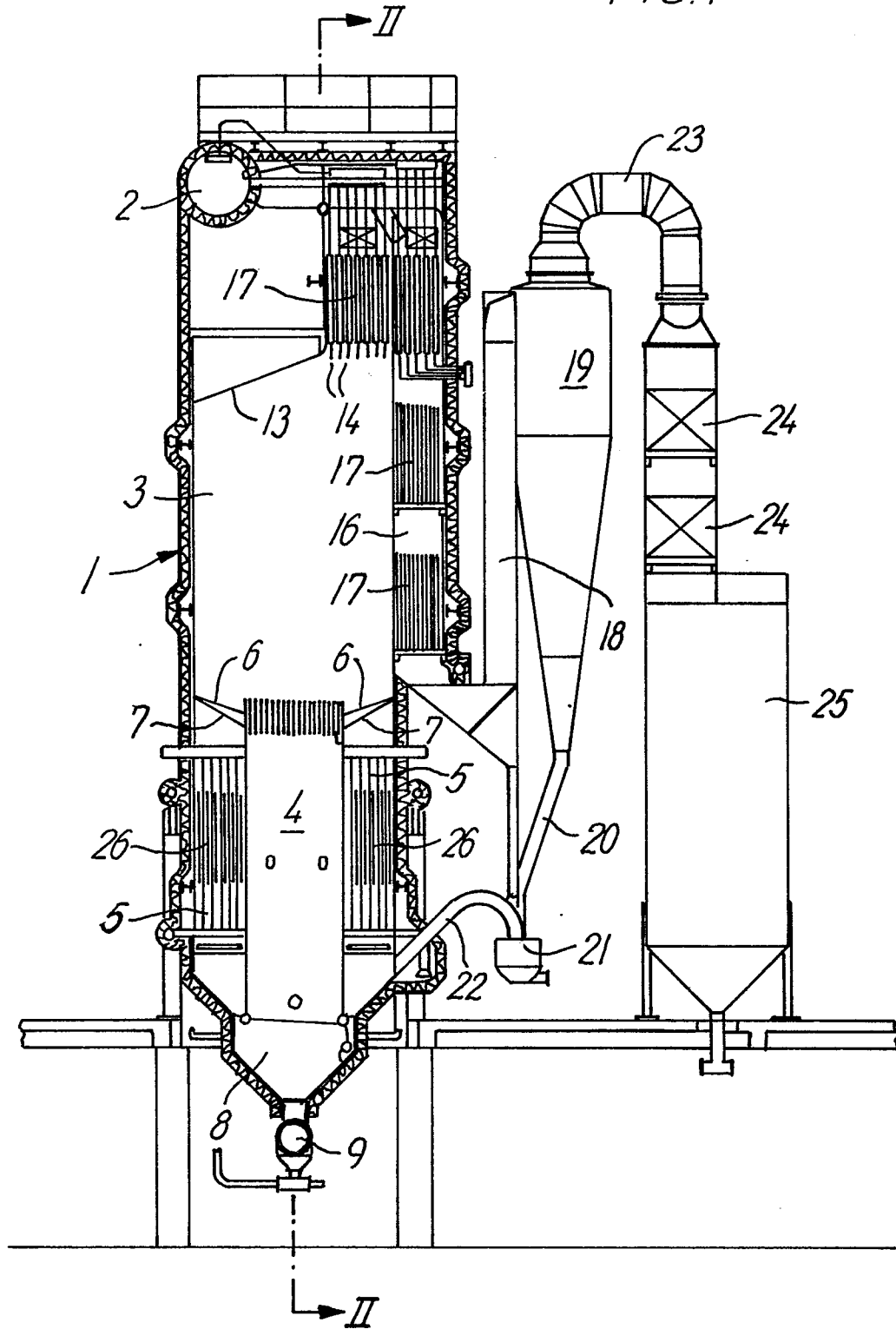
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FIG. 1



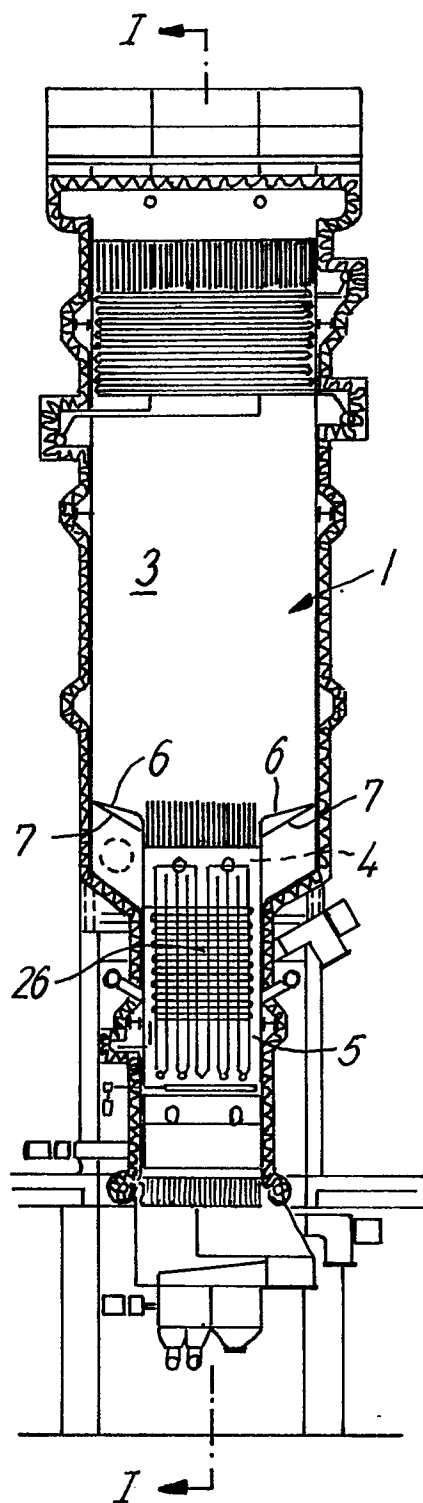


FIG. 2

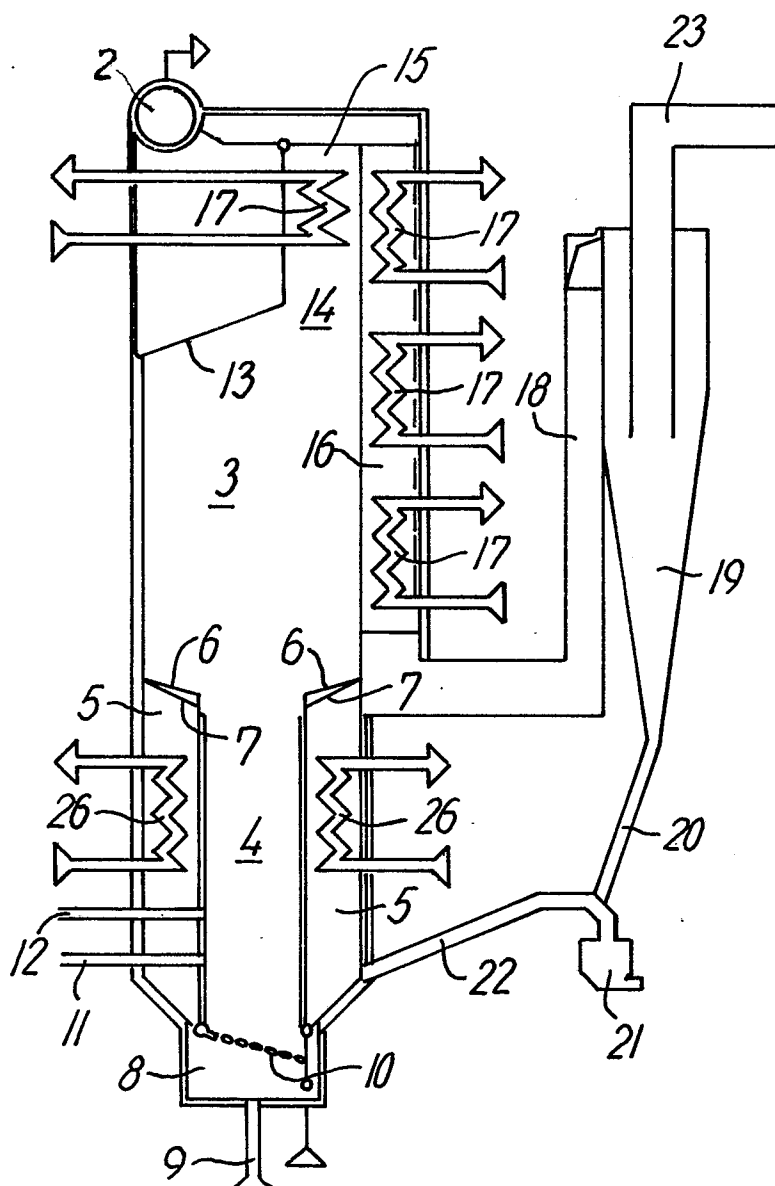


FIG. 3



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	DE-A-3 322 971 (LENTJES) * Page 1, claims 1,2; page 2, claims 5,6,7; page 6, last paragraph - page 9, paragraph 2; page 12, line 10 - page 13, line 13; figures 1-3 *	1-5,7	F 23 C 11/02 F 22 B 31/00
A	DE-A-2 753 173 (CHAMBERT) * Page 10, lines 8-24; figure 1 *	1,7	
P,X	EP-A-0 204 176 (KRAFTWERK UNION) * Column 12, lines 13-44; figure 11 *	1,3,5,7	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			F 23 C F 22 B B 01 J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 31-07-1987	Examiner PHOA Y.E.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	