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GAS-SOLIDS HEAT EXCHANGER

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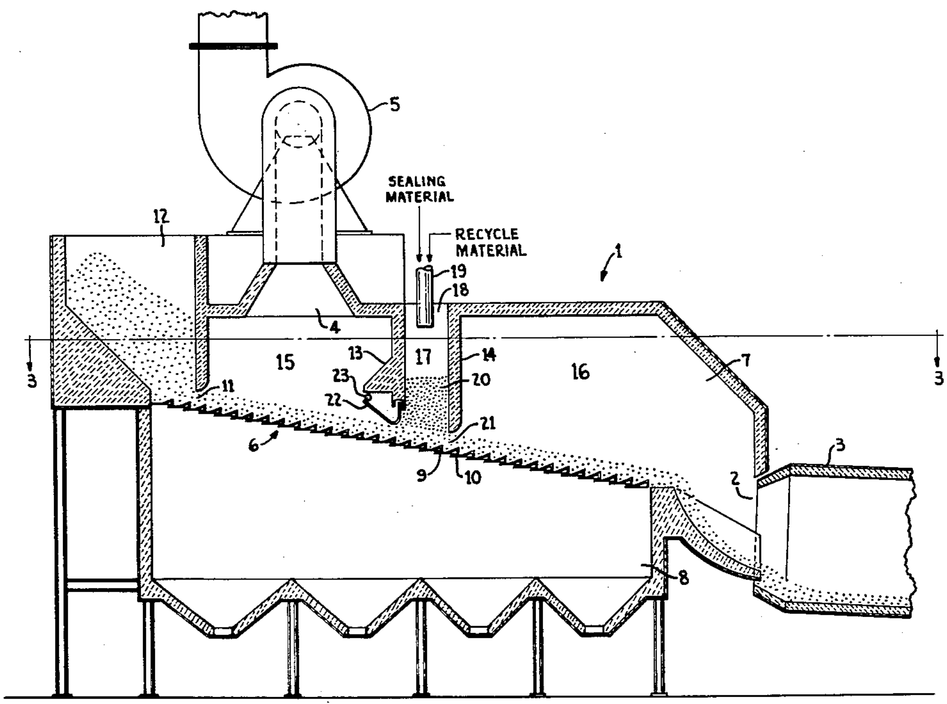

FIG. 1

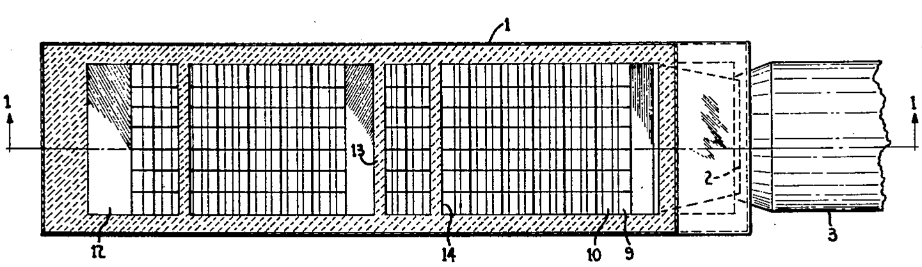

FIG. 3

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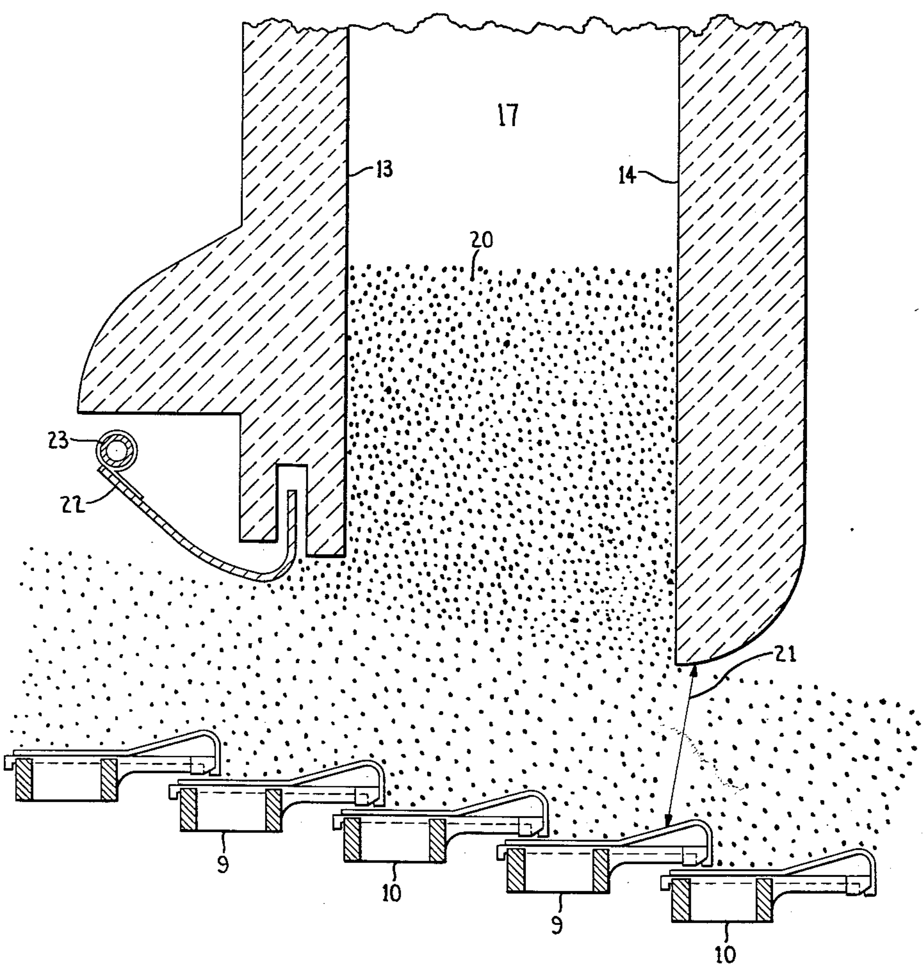

FIG. 2

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GAS-SOLIDS HEAT EXCHANGER
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13 Claims. (Cl. 34—11)

The present invention relates to gas-solids heat exchangers such as for roasting, burning, or sintering operations, and is more particularly concerned with sealing between the chambers of material preheaters having a material-drying and a material-heating chamber, through which a single bed of material is progressively moved, while gases discharged from the furnace are passed successively first through the material in the heating chamber and then through the material in the drying chamber.

It has been proposed to preheat materials by passing them over a traveling grate through a first drying compartment and a subsequent heating compartment before delivering the material into a furnace or kiln. The exit gases of the kiln are, in certain cases, passed downwardly through the material layer in the heating compartment and then upwardly through the material layer in the drying compartment.

However, such prior expedients have not proved entirely satisfactory, and have been particularly prone to short-circuiting of hot gases between the compartments without passing through the materials, and to non-uniform treatment of the material resting without agitation on the traveling grate.

In general, the apparatus of the present invention, as embodied in a preheater for hydraulic cement raw-materials, comprises a chamber having therein an assembly of movable grates alternating with fixed grates, a gas inlet adjacent one end of the grate assembly for receiving hot gases from the cement kiln, and a gas outlet adjacent the opposite end of the grate assembly for exhausting the gases to the atmosphere, or as the case may be, a dust collector.

Intermediate the ends of the grate assembly, a pair of walls extend downwardly from the upper wall of the chamber to divide the chamber into an upstream drying compartment and a downstream heating compartment. The lower ends of the walls are spaced from the grate assembly and the intermediate walls themselves are spaced apart from each other to form a third compartment therebetween of a width at least equal to twice the depth of the slot between the grate assembly and the bottom edge of the wall adjacent the heating compartment.

A feed hopper is positioned adjacent the upstream end of the grate assembly, which is adjacent the gas outlet, and feeds material to the grate assembly through a slot substantially equal in dimensions to the depth of the slot between the grate assembly and the intermediate wall adjacent the heating compartment. Means are provided for transferring heated material from the downstream end of the grate assembly into the kiln.

The space between the paired walls is kept at least partially filled by suitable means and preferably contains relatively stable material such as heated material from the downstream end of the grate assembly.

A fan or other suitable means is provided to cause a flow of gases from the gas inlet downwardly through the material in the heating compartment, adjacent the gas inlet, and then upwardly through the material in the drying compartment and through the drying compartment to the atmosphere.

A better understanding of the invention may be derived from the accompanying drawings and description in which:

FIG. 1 is a sectional side view of a cement preheater embodying the invention;

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FIG. 2 is an enlarged view of a portion of FIG. 1 showing the sealing chamber; and

FIG. 3 is a plan view on line 3—3 of FIG. 1.

As shown in the drawings, the invention, as embodied in a preheater for nodules or pellets of cement raw materials, comprises an elongated chamber **1** having a gas inlet **2** communicating with the gas outlet of a rotary kiln **3** and a gas outlet **4** communicating with the atmosphere through a fan **5**.

A longitudinal conveying-grate assembly **6** divides the chamber **1** into an upper material chamber **7** and a lower gas chamber **8**. The grate assembly comprises a series of perforated grates including fixed grates **9** and movable grates **10** alternating with and overlapping each other stepwise on an incline sloping downwardly toward the end of the chamber having the gas inlet **2**. Where desired, the grate assembly may be arranged on a slope different from that shown, or may be horizontal.

The particular means for driving the movable grates **10** forms no part of the present invention and may be of any suitable form producing positive agitation and mixing of the material as it is conveyed, such as reciprocation or tipping of the movable grates. The grate assembly shown is substantially in accordance with the disclosure of Patent No. 2,431,799 to J. B. Gaffney, in which the movable grates **10** are mounted on a common frame and are thereby reciprocated simultaneously on a plane parallel to the overlapped portions of the fixed grate **9**. Preferable, the driving means employed is to be variable in speed to permit regulation of the conveying capacity of the grate assembly.

The chamber **1** has a material inlet aperture or slot **11** adjacent its end having the gas inlet. The slot **11** is rectangular and extends the full width of the grate assembly **6** to distribute material uniformly thereon from a supply hopper **12**.

The material chamber **7** is divided by a pair of intermediate walls **13** and **14**, respectively, into a drying compartment **15** adjacent the gas outlet, a heating compartment **16** adjacent the hot gas inlet, and a sealing compartment **17** between the walls themselves. The sealing compartment **17** has an aperture **18** at its upper end which opens to the exterior of the chamber **1**. The aperture **18** receives material feeding means such as a conduit **19** which delivers material from any suitable source, as discussed more fully hereinafter. While the intermediate walls **13** and **14** have been shown in vertical arrangement, it is to be understood that they may be arranged on a slope, if desired.

The lower edge of the transverse wall **13** is spaced from the grate assembly and carries a swinging gate **22** which extends the full width of the grate assembly and is rotationally mounted on a shaft **23** to ride on the upper surface of material passing along the grate assembly.

The lower edge of the transverse wall **14** is spaced from the grate assembly and forms therewith and with the side walls of the chamber a metering aperture or slot **21**. The slot **21** preferably is exactly equal in each dimension to the slot **11** at the upstream end of the grate assembly to provide a bed of material in the heating zone equal in dimension to the bed of material in the drying zone.

The walls **13** and **14** preferably are spaced from each other a distance at least equal to twice the depth of the slot **21**, and therefore at least equal in width to the sum of the two material beds in the drying and heating chambers.

In operation, the fan **5** is started and draws air through the kiln **3** and the chamber **1**. The kiln **3** is then fired in a known manner, and the combustion gases therefrom are similarly drawn through the chamber **1**.

When the flow of hot gas has been established the movable grates **10** are set into motion and nodules of cement raw material are delivered to the hopper **12**, and are continuously delivered thereto during operation of the preheater. The nodules pass from the hopper **12** through the slot **11** as a relatively thin, evenly distributed bed onto the upper end of the grate assembly. The action of the movable grates **10** passes the material bed along the upper surface of the grate assembly and toward the lower end thereof. The agitation caused by the grates prevents the material from forming a static layer, and causes a continuous shifting and mixing of the material for more uniform contacting of the gas with the material.

As the advancing material passes under the transverse wall **13**, the swinging gate **22** rides on the upper surface of the material and serves to insure the uniform distribution of material on the grate assembly. When the material bed passes through the restricted intermediate zone between the transverse wall **14** and the gate, the compartment **17** is then filled with material to a depth above the underlying grates at least three times the depths of the slot **21** and is thereafter maintained at or above that depth by any suitable means (not shown) such as a bucket elevator controlled by a material-level indicator. The material delivered into the compartment may comprise heated nodules recycled from the discharge end of the grate assembly, finished clinker or product particles from the discharge end of the kiln, or any material not detrimental to the process conducted within the kiln. If the original material is in a relatively stable physical form, particularly in processes other than cement burning and such as calcining of crushed lime rock, the chamber **17** may be fed with such raw material.

Where material is recycled from the downstream end of the grate assembly or from the kiln, similarly suitable means such as bucket elevators, screw conveyors or belt conveyors may be employed, preferably under the control of a material-level indicator to insure the proper material depth. The choice of the conveyor will be at least partially dependent on the temperatures encountered.

When the compartment **17** has been filled to the required depth, the sealing effect of the material body **20** therein forces the gases being drawn from the kiln first to pass downwardly through the material bed and perforated grates in the heating compartment **16**, then through the gas chamber **8** and ultimately through the perforate grates and the material in the drying chamber **15**. The hottest gases thus meet the nodulized material in the heating chamber **16** and are reduced in temperature before passing through the grates, thereby protecting the grates from extreme temperatures. The continuously agitated material passing over the grate assembly is uniformly permeated by the gases; dried in the drying compartment **15**, and preheated in the heating chamber **16** before being delivered into the kiln.

The pressure drop or differential between the two chambers **15** and **16** is substantial, such as, for example, 120–140 mm. water gauge. However, the maintenance of the proper level of the material body **20** prevents the gases from short-circuiting under the compartment **17** and washing away material at that point. Since the smallest dimension of the body of material **20** is at least twice the combined depths of the equal slots **11** and **21** and the consequently equal depths of the material beds in the chambers **15** and **16**, respectively, its resistance to gas flow therethrough is at least equal to the sum of the resistance of the two portions of the material bed in the drying and heating chambers, respectively. Therefore, with the added resistance to gas flow of the transverse wall **14** and the swing gate **22**, the easiest path for the gases is the desired flow downwardly through the material in the heating zone **16** and upwardly through the material in the drying zone **15**.

Although a small portion of the material in the compartment **17** is gradually and continuously lost through the slot **21**, the constant maintenance of the desired level within the compartment insures continued adequate resistance to short-circuiting of the gas.

Various changes may be made in the details of the disclosed invention without sacrificing the advantages thereof or departing from the scope of the appended claims.

I claim:

1. A heat exchanger comprising a chamber having a gas inlet and a gas outlet, a grate assembly in the chamber having opposite ends thereof in the regions of the gas inlet and the gas outlet, feeding means for delivering material to be treated to the upstream region of the grate assembly, a pair of intermediate walls over the grate assembly and dividing the chamber into a plurality of compartments including a first compartment and a second compartment adjacent opposite ends of the grate assembly, the intermediate walls being spaced from each other to form a sealing compartment therebetween and having their lower edges spaced from the grate assembly to permit material flow therebetween in sealing contact with both the grate assembly and the lower edge of the downstream intermediate wall, means for maintaining a body of material in the sealing compartment, and means for causing a flow of gas through the material and grates underlying the first compartment in one vertical direction, and through the material and grates underlying the second compartment in the opposite vertical direction.

2. A heat exchanger comprising a chamber having a gas inlet and a gas outlet, a grate assembly in the chamber having a downstream end in the region of the gas inlet, said grate assembly comprising a plurality of alternating fixed grates and movable grates, feeding means for delivering material to be treated to the upstream region of the grate assembly, means for actuating the movable grates to deliver material over the grate assembly to the discharge end thereof, a pair of intermediate walls over the grate assembly and dividing the chamber into a plurality of compartments including a first compartment adjacent the gas inlet and a second compartment adjacent the gas outlet, the intermediate walls being spaced from each other to form a third compartment therebetween and having their lower edges spaced from the grate assembly to permit material flow therebetween in sealing contact with both the grate assembly and the lower edge of the downstream intermediate wall, and means for causing a flow of gas through the material and grates underlying the first compartment in one vertical direction, and through the material and grates underlying the second compartment in the opposite vertical direction.

3. Heat exchange apparatus according to claim 2 in which the movable grates are reciprocated longitudinally of the grate assembly.

4. Heat exchange apparatus according to claim 2 including means for maintaining a body of material in the third compartment.

5. Heat exchange apparatus according to claim 2 including means for maintaining a body of material in the third compartment at least equal in depth to twice the distance between the grate assembly and the downstream intermediate wall.

6. Heat exchange apparatus according to claim 2 in which the space between the grate assembly and the downstream intermediate wall defines at least in part a metering aperture equal in dimension to said inlet aperture.

7. Heat exchange apparatus according to claim 5 including means for recycling a portion of material from beyond the downstream side of the downstream intermediate wall to the third compartment.

8. Heat exchange apparatus according to claim 2 in which the intermediate walls are spaced apart a distance at least equal to twice the distance between the grate assembly and the downstream intermediate wall, whereby the resistance to gas flow over a bed of material moving along said grate assembly beneath said third chamber will be at least as great as the combined resistance to

gas flow through the bed of material moving under said first and second chambers.

9. Apparatus according to claim 8 in which said feeding means includes an inlet aperture adjacent the upstream end of the grate assembly and said aperture is substantially equal in dimension to the space between the grate assembly and the downstream intermediate wall.

10. A preheater for cement raw material comprising a chamber having a gas inlet and a gas outlet, a gas-pervious conveyor in the chamber having a downstream end in the region of the gas inlet, feeding means for delivering material to be treated to the upstream region of the conveyor and including a metering aperture adjacent to the upstream end of the conveyor, a pair of transverse intermediate walls over the grate assembly and dividing the chamber into a plurality of compartments including at least a drying compartment adjacent the gas outlet and a heating compartment adjacent the gas inlet, the intermediate walls having their lower edges spaced from the conveyor to permit material flow therebetween in sealing contact with both the conveyor and the lower edge of the downstream intermediate wall, the space between the conveyor and the lower edge of the downstream intermediate wall forming at least in part a metering aperture substantially identical in dimension to the aperture of the feeding means, the intermediate walls being spaced from each other a distance at least equal to twice the depth of the aperture beneath the downstream intermediate wall and forming a third compartment therebetween, means for maintaining a body of material in the third compartment above the material passing therebeneath, and a fan communicating by way of its inlet with the gas outlet of the chamber.

11. A preheater according to claim 10 including means for maintaining the body of material in the third compartment at a depth at least equal to twice the depth of the aperture beneath the downstream intermediate wall.

12. A method of thermally treating loose discrete particles of material which comprises passing a relatively thin bed of the material through a defined zone including upstream, intermediate and downstream portions, passing a gas through the upstream and downstream portion of the zone to effect heat exchange of the material, the gas passing downwardly through one of said upstream and downstream portions, and upwardly through the other, establishing and maintaining a separate body of discrete particles of sealing material on, and extending above, said thin bed immediately above said intermediate portion of the zone, whereby said bed will pick up, when passing through said intermediate portion of the zone, sufficient particles of the sealing material on the upper surface thereof to form a barrier preventing gas flow along the upper surface of the bed at said intermediate portion of the zone and diverting the gas flow downwardly through the bed at one side of the intermediate portion of the zone and for flow upwardly through the bed at the other side of said intermediate portion of the zone.

13. The method of claim 12 in which a portion of the material from the downstream portion of the bed is recycled to maintain said body of discrete particles of sealing material.

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