United States Patent [19]

Kayatz

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[54] **METHOD AND APPARATUS FOR TREATMENT OF PARTICULATE MATERIAL**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 281,088, Aug. 16, 1972, abandoned.

[52] **U.S. Cl.** **34/20,** 34/62, 432/78, 432/77

[51] **Int. Cl.** **F26b 7/00**

[58] **Field of Search** 34/13, 20, 51, 62, 223, 34/210; 432/78, 77

[56] **References Cited**

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Assistant Examiner—William C. Anderson
Attorney, Agent, or Firm—Frank H. Thomson

[57] **ABSTRACT**

A method and apparatus for heat treating particulate materials such as the cooling of cement clinker discharged from a rotary kiln. The cooler includes a hot material inlet and a cool material outlet with a reciprocating grate conveyor for supporting a bed of material within the cooler and transporting the material from the inlet to the outlet. A plenum chamber is defined below the conveyor and air is supplied to the chamber for passage through the conveyor and bed of material to cool the material. The cooler includes a first, narrow section which establishes a deep bed of material. High pressure air is passed through this deep bed of material so that a lower layer of coarse material and an upper layer of fine material is established. The first section is followed by a transition section through which no air is passed. The transition section is followed by a second, wider section through which low pressure air is passed. In the second section, a shallow bed of material is established.

5 Claims, 5 Drawing Figures

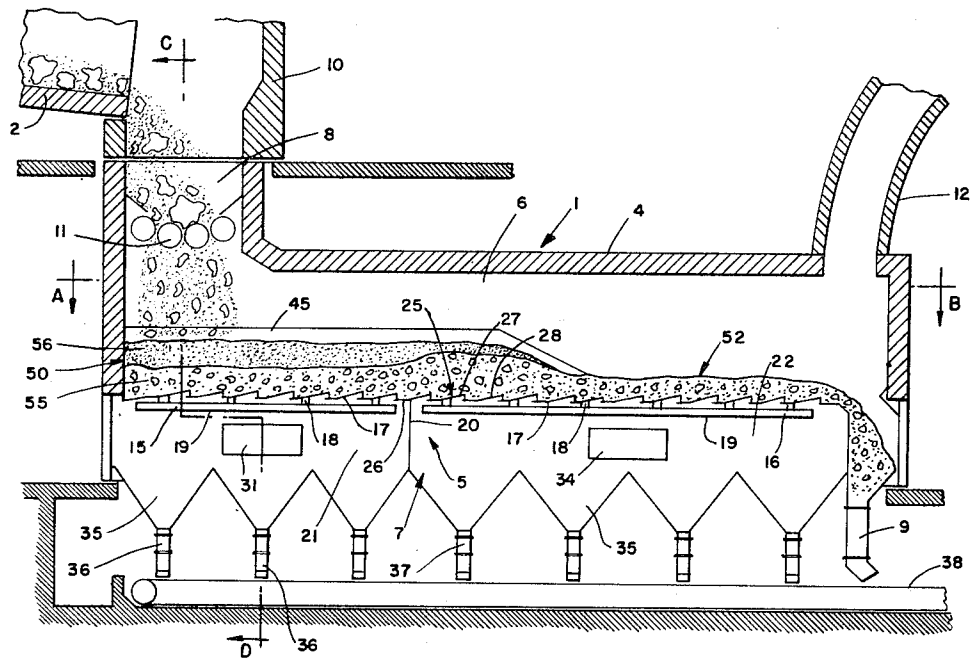

FIG. 1.

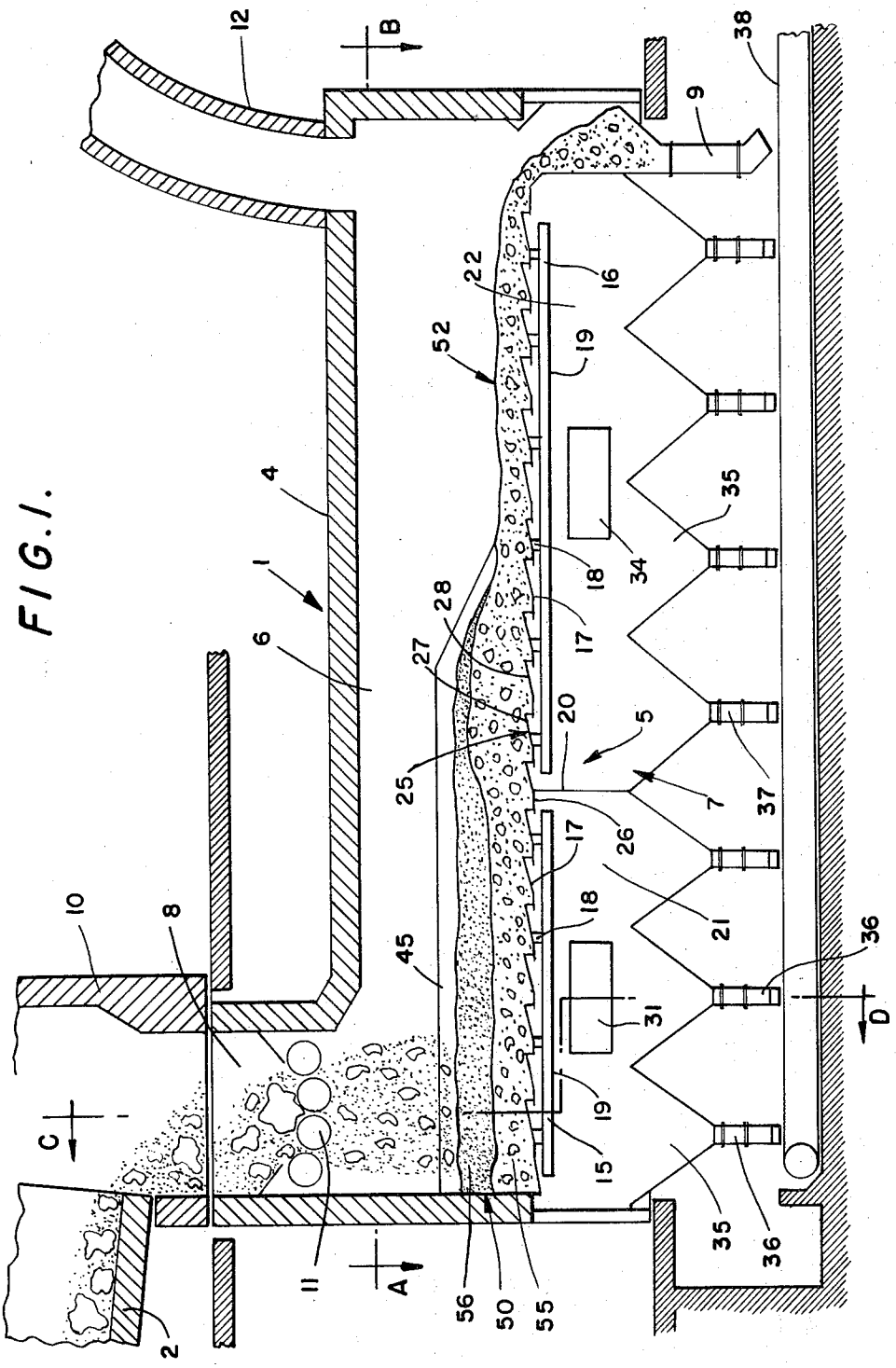
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FIG. 2.

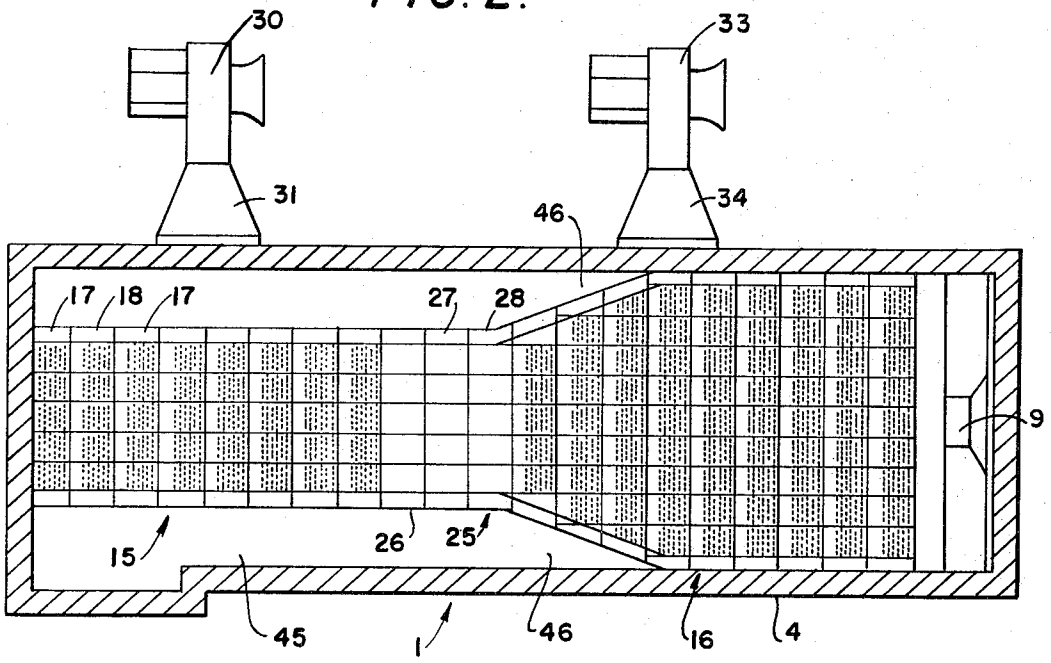
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FIG. 3.

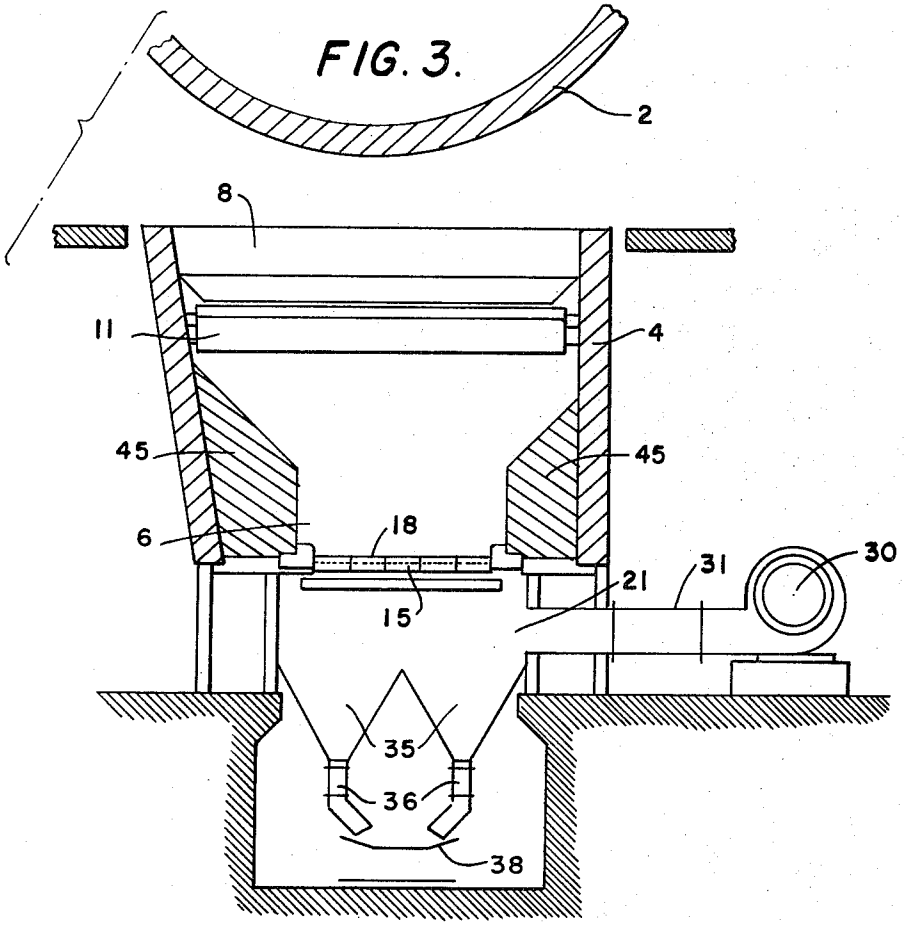
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FIG. 4.

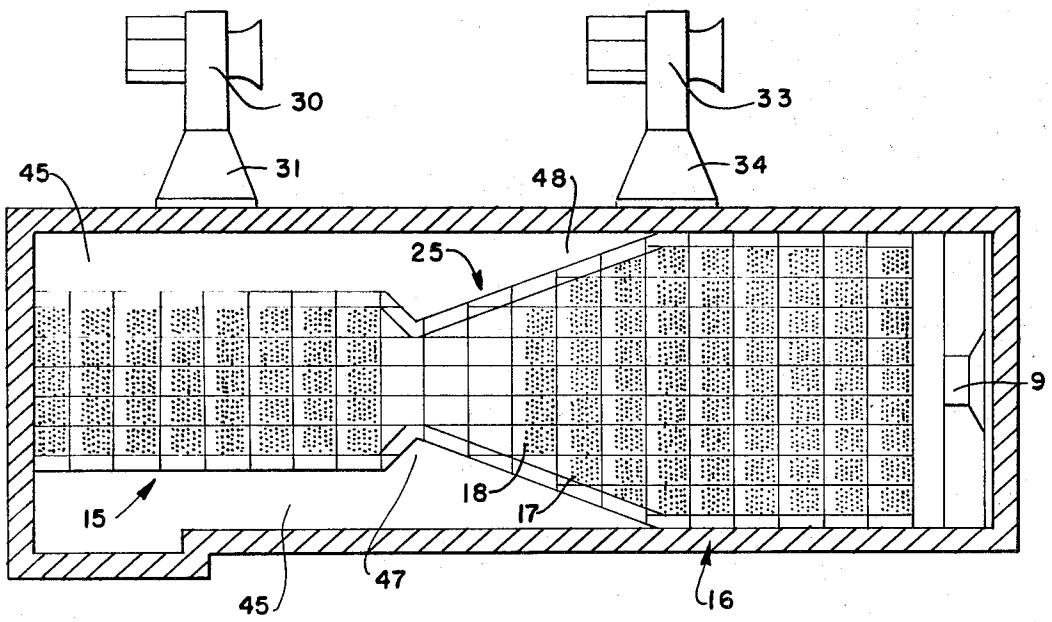
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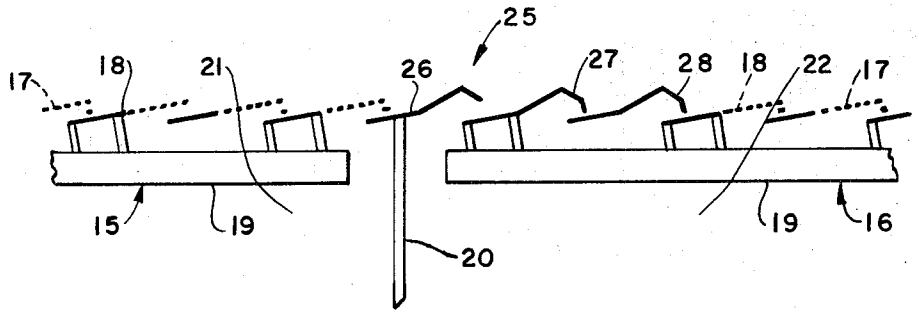
FIG. 5.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METHOD AND APPARATUS FOR TREATMENT OF PARTICULATE MATERIAL

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of my prior application Ser. No. 281,088, filed Aug. 16, 1972, and now abandoned.

This invention relates to a method and apparatus for treating particulate material and in particular to a method and apparatus for cooling hot particulate material such as cement clinker discharged from a furnace, such as a rotary kiln.

Material coolers of the same type to which the present invention relates are generally known prior to the present invention. One such cooler is shown in U.S. Pat. No. 2,846,778 issued to Markle. In such coolers a reciprocating grate conveyor divides a cooler housing into an upper material chamber and a lower plenum chamber. The upper material chamber is provided with an inlet for receiving hot material from a kiln and an outlet for discharging cooled material. The reciprocating grate conveyor includes a plurality of alternate rows of fixed and movable grates with the movable grates adapted to be reciprocated relative to the fixed grates to thereby advance material from the inlet to the outlet. Each of the grate plates which make up the conveyor is provided with a plurality of holes therein to provide communication between the lower plenum chamber and the upper material chamber. Air under pressure is supplied to the plenum chamber for passage through the openings in the grate plates and the bed of material on the conveyor. This air serves to cool the hot material. The cool air is heated as it passes through the hot material and may be returned to the kiln as preheated combustion air.

When the material to be cooled is discharged from the rotary kiln, it is discharged in bands. That is, the material is not continuously discharged from the kiln so that an even bed of material is formed in the cooler, but rather the material tends to be discharged in batches. This pattern of material discharge can result in the formation of channels or "rat holes" in the bed of material in the cooler. Most of the cooling air flows through the open areas because this is the path of least resistance. When these "rat holes" are formed, the cooling deficiency of the apparatus is substantially reduced.

Another problem with prior coolers of this type is that when there are a large number of fine particles on the material, the fine material will "flush" along the sides of the cooler. This can result in heat danger to the sidewalls of the cooler and to the grates of the conveyor. In addition, this flushing will reduce the time the material remains in the cooler. A reduction in material residency time will reduce the cooling efficiency of the apparatus.

One of the main advantages of the cooler of the type to which the present invention relates is that the cool air can be returned to the furnace as preheated combustion air. Therefore, it is important that the best possible heat transfer characteristics be achieved in that area of the cooler in which the material to be cooled is the hottest. This means that the best heat transfer characteristics should be achieved in the area closest to the hot material inlet. It is believed that this can be done by separating the hot particulate material into a coarse

layer and a fine layer and passing high pressure air through this section.

SUMMARY

It is, therefore, the principal object of this invention to provide a novel method and apparatus for treating particulate material which has improved heat transfer characteristics over prior methods and apparatus.

It is another object of this invention to provide a cooler for hot particulate material, such as cement clinker, which will insure adequate cooling of the hot material.

In general, the foregoing and other objects will be carried out by providing a method of cooling hot, particulate material such as cement clinker in a device including a housing having an inlet for hot material and an outlet for cooled material and a conveyor for supporting a bed of material in the housing and moving the material from the inlet to the outlet comprising the steps of establishing a first bed of material on the conveyor; passing a gaseous fluid upwardly through said first bed of material at a pressure sufficient to form a lower layer of coarse material and an upper layer of fine material; establishing a second bed of material on the conveyor downstream of said first bed of material in the direction of material movement from the inlet to the outlet; and passing a gaseous fluid upwardly through said second bed of material at a pressure lower than the pressure of gaseous fluid passed through said first bed of material; said gaseous fluid passing through said first and second beds of material serving to cool said hot material.

The objects of the invention will also be carried out by providing apparatus for heat treating particulate material by passing gaseous fluid through the material comprising a housing having an inlet for material to be treated and an outlet for treated material; conveyor means mounted in and dividing said housing into an upper material chamber and a lower plenum chamber for advancing material from said inlet to said outlet; said conveyor means including first and second gas permeable sections; means for dividing said plenum chamber into first and second sections positioned so that the first section of said plenum chamber underlies the first section of the conveyor means and the second section of the plenum chamber underlies the second section of the conveyor means; means for supplying gaseous fluid at a first pressure to said first section of the plenum chamber for passage through said first section of said conveyor means for heat treating said material; and means for supplying gaseous fluid at a second pressure, lower than said first pressure to said second section of the plenum chamber for passage through said second section of said conveyor means for heat treating said material.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in connection with the annexed drawings wherein:

FIG. 1 is a sectional view of a cooler in accordance with the present invention;

FIG. 2 is a view taken on the line A–B of FIG. 1;

FIG. 3 is a sectional view taken on the line C–D of FIG. 1;

FIG. 4 is a view similar to FIG. 2 showing a modified cooler in accordance with the present invention; and

FIG. 5 is an enlarged fragmentary view of a portion of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, there is shown in FIG. 1 apparatus for heat treating solid particulate material generally indicated at 1. This apparatus will be referred to as a cooler because it is primarily designed for cooling hot particulate material such as cement clinker discharged from a furnace such as a rotary kiln 2. However, it should be understood that the apparatus could also be used for other heat transfer functions such as the heating of particulate material.

The material cooler 1 includes a housing 4 having a reciprocating grate conveyor generally indicated at 5 mounted therein and dividing the cooler into an upper material chamber 6 and a lower plenum chamber 7. The material chamber 6 includes an inlet 8 for material to be treated and an outlet 9 for treated material. A conduit 10 may be provided for flow connecting the kiln 2 and the material inlet 8. A material breaker such as a roll crusher 11 may be provided in the inlet 8 and a breaker (not shown) can be provided at the material outlet 9. The housing 4 also includes an outlet conduit 12 for gases not returned to the kiln 2.

The conveyor 5 includes a first conveyor section 15 and a second conveyor section 16. Each conveyor section 15 and 16 includes alternate rows of fixed grates 17 and movable grates 18 with the movable grates 18 secured to beams 19. Means (not shown) are provided for reciprocating the beams 19 and thus the movable grates 18 relative to the fixed grates 17 and material is advanced through the cooler in a well-known manner. Each of the grates 17 and 18 are provided with a plurality of openings therein providing communication between the plenum 7 and the material chamber 6.

A partition 20 divides the plenum chamber 7 into a first section 21 which underlies the first conveyor section 15 and a section 22 which underlies the second conveyor section 16. The partition 20 serves to substantially completely prevent communication between the first and second sections of the plenum chamber.

A transition section generally indicated at 25 is interposed between the first conveyor section 15 and the second conveyor section 16. The transition section 25 includes a grate 26 fixed to the partition 20 and in line with the grates 17 and 18. The transition section may also include a row of movable grates 27 secured to the beams 19 of second conveyor section 16 followed by a row of fixed grates 28. The grates 26, 27 and 28 of the transition section 25 differ from the grates 17 and 18 in that they are preferably saddle-shaped as clearly shown in FIG. 5 rather than the flat style of grates 17 and 18. In addition, the grates 26, 27 and 28 are not provided with openings. Thus, there is substantially no communication between the material chamber 6 and the plenum chamber 7 at the transition section 25, and the transition section substantially prevents gaseous fluid from flowing upwardly therethrough.

A fan 30 is connected by means of a duct 31 to the first section 21 of the plenum 7 for supplying gaseous fluid, such as air, to the plenum chamber section 21. A second fan 33 is connected through a duct 34 to the plenum chamber section 22. The fan 30 is designed to supply a higher pressure fluid into the first section 21 of the plenum chamber than the fan 33 supplies to the second section 22 of the plenum. The plenum 7 may include a plurality of conical sections 35 each having a conduit 36 connected thereto for discharging material which passes through the conveyor 5. This material may be discharged onto a conveyor 38 which also serves to convey material discharged from the material outlet 9 to a storage point.

In the area above the first conveyor section 15, the material chamber 7 includes sidewalls 45 which narrow the material chamber above the conveyor section 15. In the embodiment of FIG. 2, this narrow section also includes the transition section 25. The walls 45 gradually widen as at 46 in the area above the second conveyor section 16 until they reach the full width of the housing 4. With such a configuration, the bed of material 50 above the first conveyor section 15 will be deeper than the bed of material 52 above the second conveyor section 16. In the embodiment shown in FIG. 4, the walls 45 narrow at the transition section 25 as shown at 47 and then gradually widen as at 48.

In operation, hot material is discharged from the rotary kiln 1 into the inlet 8 of the cooler. The roll crusher 11 may be used for reducing the size of the large clinkers discharged from the kiln 2. As the material drops onto the first conveyor section 15, it forms a deep bed 50 of hot material on the order of 400 to 500 mm. High pressure air, on the order of 700 to 800 kg/m^2 is supplied by fan 30 into the first section 21 of the plenum chamber 7. This high pressure air in the plenum section 21 flows through openings in the grates of the conveyor section 15 and the bed of material. This high pressure air causes the formation of a lower bed 55 of coarse material and an upper bed 56 of fine material. With this particular formation, the formation of "rat holes" in the bed of hot material is substantially eliminated. In addition, the air which passes through the bed of material serves to better cool the hot material and heat to a high temperature the air which is transferred from the cooler 1 to the kiln 2 through the material inlet 8 and duct 10. The fines will not be in contact with the grates 17 and 18 at this point thereby reducing the likelihood of grate damage.

The first conveyor section 15 moves the material from the inlet towards the transition section 25. Because there are no openings in the grates 26, 27 and 28 which make up the transition section 25, the material above the transition section is not aerated. The absence of aeration of the material above the transition section 25 results in the breaking down of the separate beds 55 and 56 of material. This is shown in FIG. 2.

The fan 33 supplies air under pressure to the second plenum section 22 at a pressure lower than that supplied to section 21. This pressure may be on the order of 150 to 200 kg/m^2. The full width of the housing 4 is used above the second conveyor section 16 so that a relatively shallow bed is formed, on the order of 200 mm. Because of the lower pressure air which passes through the grates of the conveyor section 16 and the shallow bed 52, the material which makes up bed 52 is not separated into coarse and fine particles. This shallower, integrated bed is ideal for achieving final cooling of the hot material.

It is believed that with the arrangement of the present invention, optimum cooling can be achieved. The sliding effect which is encountered if an incline conveyor is used is believed to be eliminated. The saddle-shaped grates 26, 27 and 28 of the transition section serve to

hold the deep bed **50** above the first conveyor section **15.** This is further achieved by the configuration shown in FIG. **4** where the transition section of the material chamber includes narrow wall portions **47.**

From the foregoing, the objects of the invention have been carried out. The formation of channels or "rat holes" is eliminated by the use of a deep bed in the initial portion of the heat exchanger to thereby improve cooling efficiency. The material closest to the kiln is in better heat exchange with the cooling air because of the deep bed. This results in better initial cooling and better heating of the air returned to the kiln as combustion air. The large particles of material which require the most air for cooling are subjected to the initial cool air in the layered bed **50.**

It is intended that the foregoing description be merely that of a preferred embodiment and that the invention be limited solely by that which is within the scope of the appended claims.

I claim:

1. A method of cooling hot, particulate material such as cement clinker in a device including a housing having an inlet for hot material and an outlet for cooled material and a conveyor for supporting a bed of material in the housing and moving the material from the inlet to the outlet comprising the steps of:

establishing a first bed of material on the conveyor;

passing a gaseous fluid upwardly through said first bed of material at a pressure sufficient to form a lower layer of coarse material and an upper layer of fine material;

establishing a second bed of material on the conveyor downstream of said first bed of material in the direction of material movement from the inlet to the outlet; and

passing a gaseous fluid upwardly through said second bed of material at a pressure lower than the pressure of gaseous fluid passed through said first bed of material;

said gaseous fluid passing through said first and second beds of material serving to cool said hot material.

2. A method of cooling hot particulate material according to claim **1** further comprising the step of substantially preventing gaseous fluid from passing upwardly through said material in a transition area between said first bed and said second bed.

3. Apparatus for heat treating particulate material by passing gaseous fluid through the material comprising:

a housing having an inlet for material to be treated and an outlet for treated material;

conveyor means mounted in and dividing said housing into an upper material chamber and a lower plenum chamber for advancing material from said inlet to said outlet;

said conveyor means including first and second gas permeable sections;

means for dividing said plenum chamber into first and second sections positioned so that the first section of said plenum chamber underlies the first section of the conveyor means and the second section of the plenum chamber underlies the second section of the conveyor means:

means for supplying gaseous fluid at a first pressure to said first section of the plenum chamber for passage through said first section of said conveyor means for heat treating said material;

means for supplying gaseous fluid at a second pressure, lower than said first pressure to said second section of the plenum chamber for passage through said second section of said conveyor means for heat treating said material; and

a transition section interposed between said first and second sections of the conveyor means;

said transition section adapted to substantially prevent gaseous fluid under pressure from passing upwardly therethrough;

said material chamber above the first section of the conveyor means is narrower than above the second section of the conveyor means so that the bed of material above said first section of the conveyor means is deeper than the bed of material above the second section of the conveyor means.

4. Apparatus for heat treating particulate material according to claim **3** wherein said transition section and the material chamber above said transition section is narrower than said first and second sections of the conveyor means.

5. Apparatus for heat treating particulate material according to claim **3** wherein the transition section of the conveyor means includes means for accumulating material in said first section of the conveyor means.

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