United States Patent [19]

Deussner

[11] **3,837,792**

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[54] **COOLING DEVICE FOR KILN MATERIAL**

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[73] Assignee: **Klockner-Humboldt-Deutz AG**

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[52] **U.S. Cl.** **432/77,** 432/79

[51] **Int. Cl.** **F27b 1/16,** F27b 7/38

[58] **Field of Search** 432/77, 78, 79, 80

[56] **References Cited**

UNITED STATES PATENTS

3,578,297	6/1969	Niems	432/80
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424,065	1/1926	Germany	432/85

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Attorney, Agent, or Firm—Hill, Gross, Simpson, Van Santen, Steadman, Chiara & Simpson

[57] **ABSTRACT**

A structure for cooling particulate hot kiln material by contact with cooling air including a cooling chamber having an upper receiving end with a lower discharge end and a rotary gas fired kiln discharging into the upper end through a feed conduit extending into the upper end of the chamber, an upper downwardly facing air distribution device, a lower downwardly facing air distribution device having radially extending spokes and an outer portion lying adjacent the wall of the cooling chamber, and opening at the lower end discharging into the hopper with an air intake chamber arranged so that air flows over the exposed surface of the material into an intake blower connected to the air distribution devices.

18 Claims, 6 Drawing Figures

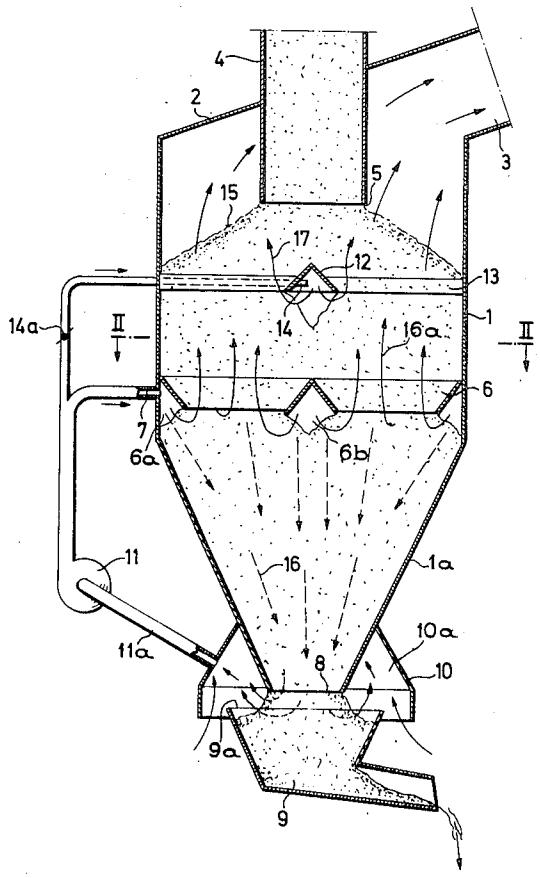
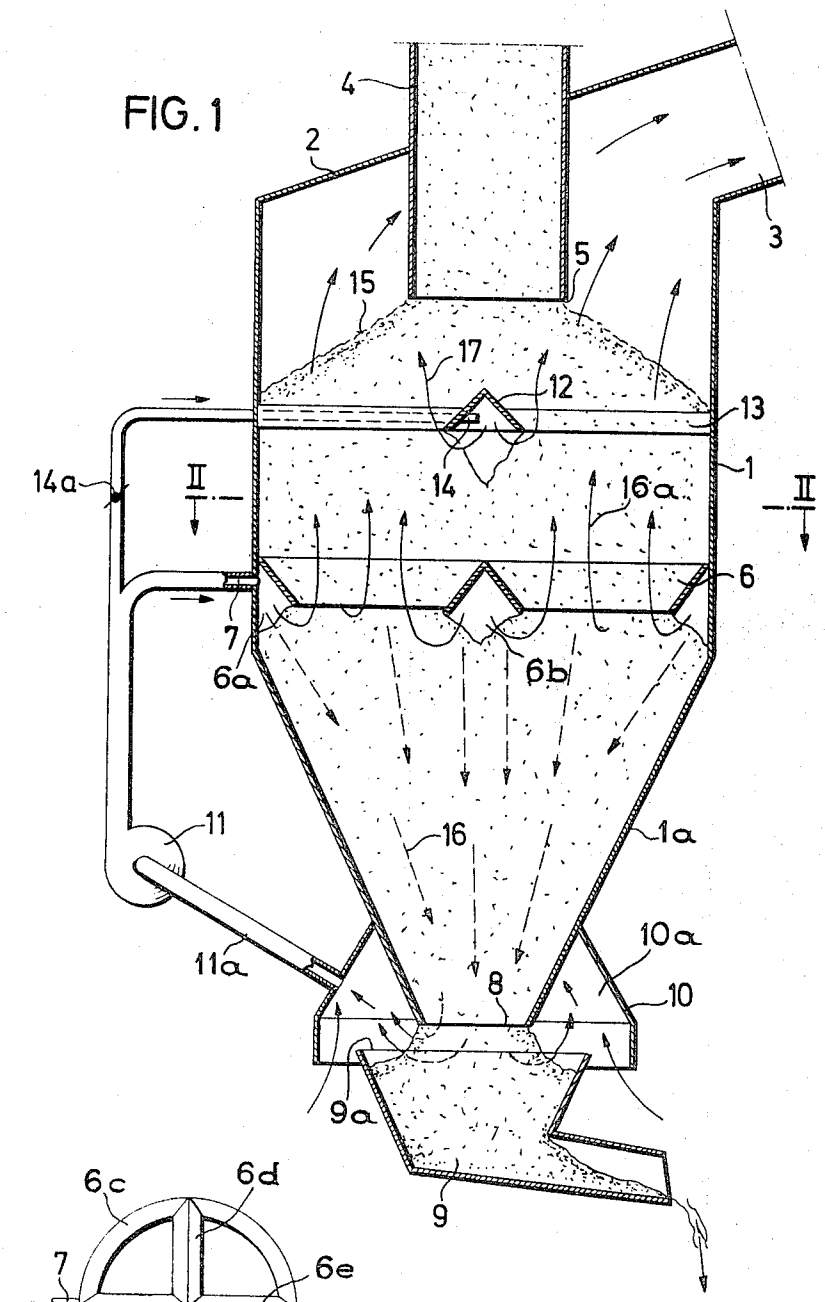


FIG. 1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6c
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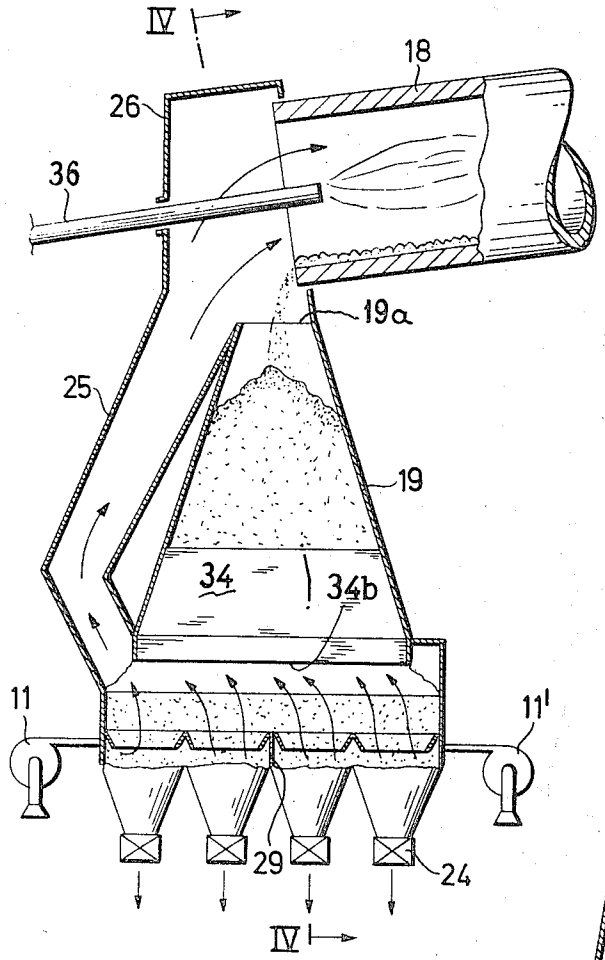
FIG. 2


IV
18
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34b
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11'
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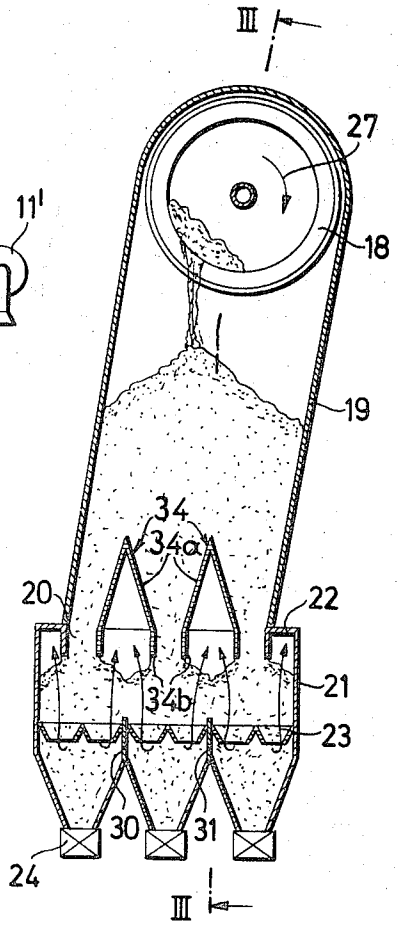
IV

FIG. 3


III
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III

FIG. 4

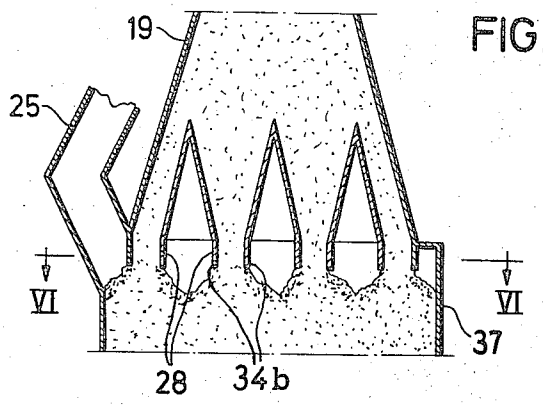

FIG. 5

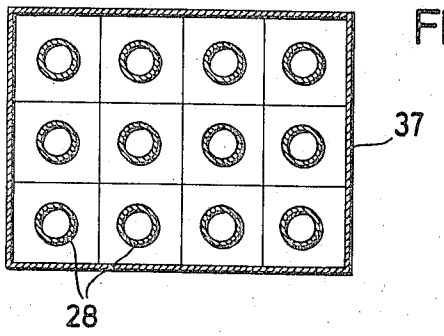

FIG. 6

COOLING DEVICE FOR KILN MATERIAL

BACKGROUND OF THE INVENTION

The invention relates to devices for the cooling of hot kiln particulate material in direct contact with air and more particularly to a device wherein the flow of air is so arranged to obtain optimum cooling of the material and the retention of heat energy in the air for its flow into the kiln.

Devices have been provided heretofore for the cooling of hot kiln material by the flow of air such as disclosed, for example, in French Pat. No. **1,502,170.** In these types of devices, the flow of heated kiln material is distributed within a cooling chamber over roof-like conducting surfaces into several relatively thin layers of particulate material. The roof-like guide surfaces are usually provided with louver-type covered air passages with the cooling air forced transversely through the thin layers of material and the air subsequently conveyed off through discharge channels above the layers of material out of the device.

The uniform guidance of the kiln material through the cooling chamber and the uniform flow of cooling air through the individual layers of material presents appreciable difficulties. Other difficulties exist in that frequently the operation of the device is not uniform requiring that the kiln material stand for a period of time and flow at uneven rates through the cooling chamber. During the standing period, the passage apertures can become clogged because of the kiln material becoming impacted at the openings. This kiln material is still very hot and will tend to compact itself when permitted to stand without flowing. Another difficulty is that the sealing of the discharge opening from the cooling chamber presents difficulties in that the escape of hot air and dust into the surrounding atmosphere presents intolerable and difficult mill operation problems.

It is accordingly an object of the present invention to provide a cooling mechanism which obviates problems of devices heretofore available in the art in which it is capable of cooling the discharge of particulate material from a hot kiln which flows intermittently without clogging or jamming and with continued effective uniform cooling operation.

A further object of the invention is to provide a device for cooling the discharge from a hot kiln wherein uniform improved cooling of the material results and the heat absorbed by the cooling air is utilized by directing the air flow through the kiln.

A feature of the invention in solving the problems of devices heretofore available is obtained in that at least one feed conduit is provided which projects into the cooling chamber with the discharge opening spaced from the chamber walls by the spaced above cooling air distribution devices. The arrangement permits a spreading out of the heated kiln material above the cooling air distribution devices to obtain a uniform layer so that the cooling air issuing from the distribution devices may be conveyed in counter-current flow through the kiln material.

A further feature of the invention resides in that the cooling air distribution device is arranged so that a substantial portion of the cooling air comes into contact with the kiln material already cooled to a certain extent and that with intermittent inoperative or standing periods due to material selection and other reasons, the improvement is attained in still retaining uniform cooling without compacting of the material.

In one form of the invention at least two feed conduits are provided leading into the cooling chamber and the distance between the adjacent feed conduits is twice as great as the distance between either conduit and the wall of the cooling chamber. With this arrangement, the cooling chambers permit high rates of flow through output. Through this spacing and arrangement of feed conduits with respect to each other and with respect to the chamber wall, a relationship between the distribution and the height of the material is attained so that a uniform flow of air and cooling through a uniform layer of material is attained. Also, this arrangement obtains automatic compensation for the differences in height which occur due to adjustments of angles of inclination of the particulate kiln material and the differences in the angle of the inclination of the material as it piles up within the cooling chamber at different rates of flow.

A further feature of the invention is the provision of a material deflecting element within the cooling chamber attached to the cooling air supply so that the material deflecting element is cooled with air. With this arrangement upon encountering longer standing periods, additional cooling air may be introduced into the area directly below the intake opening of the feed conduit. With the arrangement adjustment of the air flow into the initial deflecting mechanism and the proportion of air directed into it as contrasted with the flow of air into additional cooling devices can be controlled to compensate for variations in flow and for inactive periods.

The structure further provides for the possibility of providing a number of supply conduits leading into the cooling chamber with the conduits divided into groups which independently of each other are controllably supplied with cooling air.

Other objects, advantages and features, as well as equivalent structures which are intended to be covered hereby, will become more apparent with the teachings of the principles of the invention connected with the disclosure of the preferred embodiments in the specification, claims and drawings, in which:

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view in somewhat schematic form illustrating a structure constructed and operating in accordance with the principles of the present invention;

FIG. 2 is a detailed fragmentary sectional view taken substantially along line II—II of FIG. 1;

FIG. 3 is a vertical sectional view illustrating another form of the invention, with the section being taken substantially along line III—III of FIG. 4;

FIG. 4 is a vertical sectional view taken substantially along line IV—IV of FIG. 3;

FIG. 5 is a partial vertical sectional view taken through an embodiment constructed in accordance with FIG. 3; and

FIG. 6 is a horizontal sectional view taken substantially along horizontal line VI—VI of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As illustrated in FIG. 1, the mechanism includes a

vertical generally cylindrically shaped cooling chamber **1** with a roof **2** at the upper end having a discharge opening **3** for the flow of heated cooling air from the chamber after it has cooled the material therein. At the upper end of the cooling chamber and extending through the roof **2** is a feed conduit **4** with a conduit opening **5** which is substantially coaxially positioned relative to the cooling chamber **1** and spaced from the wall of the chamber.

Within the cooling chamber **1** is a first or principal cooling air distributor device **6** which has downwardly directed air discharge openings **6***a* and **6***b*. These openings are interconnected and are supplied with air through a cooling air conduit **7** which is supplied with pressurized air from a blower **11.**

The air distribution device **6** extends horizontally across the chamber **1.** The air distribution device provides a downwardly opening V-shaped roof or channel. An outer annular portion **6**c is secured at its upper edge to the wall of the chamber **1** and slopes inwardly so as to deflect the material inwardly. A second portion of the air distribution device includes radial spokes **6***d* and **6***e*, FIG. **2,** which communicate at their ends with the air channel **6***a* and which spokes deflect the hot kiln material as it descends through the chamber. Air flow being discharged from the openings **6***a* and **6***b* will be distributed with a portion passing downwardly as indicated by the broken arrowed lines of FIG. **1** and a portion passing upwardly as indicated by the solid arrowed lines. The position of the cooling air distributing device is substantially intermediate the lower end of the chamber **1** and the upper level **15** of the material so that the resistance to air flow is substantially the same in both directions and so that the flow of air will be divided. The broken arrowed lines indicating a downward flow of air is shown at **16,** and the solid arrowed lines indicating a flow of air upwardly is shown at **16**a.

At the lower end of the chamber **1** is a discharge opening **8** through which the material flows into a hopper **9.** The hopper has an upper end **9**a which is of substantially larger circumference than the lower end **8** of the chamber so that surface of kiln material is exposed to air flowing upwardly into an annular conical shield **10** at the base of the chamber. The lower wall of the chamber is conically tapered downwardly at **1**a. The skirt **10** at the base of the wall **1**a provides an air intake space **10**a for air to flow into an intake line **11***a* leading into a blower **11** which supplies the cooling air. The chamber **10***a* will be at a reduced atmospheric pressure so that atmospheric air will flow upwardly into the space **10***a* and this will effectively provide a dynamic seal at the base of the chamber to prevent the escape of dust and heated air into the surrounding mill.

Instead of the hopper shown at **9,** which operates on the thrust basis to force material from the hopper as it descends, other material receiving and conveying devices may be provided such as a rotating horizontal plate or turntable, a swinging bunker-discharge conveyor or similar belt conveyor or removal device. Discharge may also occur through a screen or a rollergrate and such devices will be positioned so that there will be a uniform exposed surface of material around the apex of the lower end **8.**

The upper surface **15** of the material will have an angle of inclination which is a function of the type of material discharged from the kiln and flowing down into the chamber through the conduit floor. Regardless of the type of material, uniform distribution is accomplished by a coaxially located material deflecting element **12** which is in the shape of an inverted cone having its apex pointed upwardly and having an open lower end. This material deflecting cone **12** is supplied with cooling air through a supply line **14** which is supplied by the blower **11.** A control valve **14**a is positioned in the line **14** so as to control the aportionment of cooling air between the line **7** and the line **14.** Control of this valve may be set prior to operation or may be varied during operation in accordance with the type of material used or in accordance with the rate of flow.

In operation, the hot material coming from the kiln enters through the feed conduit **4** to be discharged into the chamber **1.** The material flows downwardly through the chamber at the rate at which it enters through the line **4** because the upper surface **15** of the material within the chamber will act as an effective regulator of flow. The hopper **9** at the bottom regulates the flow from the chamber **1.**

Cooled air enters the chamber through the distribution cone **12** and through the spider-shaped distribution device **6.** Hot discharge air flows out through the upper opening **3** which preferably connects to the kiln to utilize the heat which has been received by the air.

As the material flows through the chamber **1** relatively slowly, a relatively flat angle of inclination of the surface **15** occurs and a constant flow of upwardly moving air passes through the outlet **3.** The material may be cooled to temperatures below 100°C. and can thus be transported by a regular mechanism from the hopper **9.** At the same time, a high heat recovery occurs which is to the benefit of the overall thermal efficiency of the kiln operation. The seal at the bottom prevents the escape of hot air and dust into the surrounding atmosphere and a seal is achieved which is free from wear. Also a final cooling is obtained of the material being discharged from the cooling chamber in the space **10**a.

Dependent upon the rate of flow through the chamber **1,** the angle of inclination may vary but with a steep or shallow angle of inclination a relatively uniform cooling of the material occurs. The cooling air which emits from the deflecting cone **12** travels in a path which is uniform from a circumferential standpoint, and also substantially constant at any location radially outwardly from the cone and this path remains substantially constant regardless of the angle of inclination of the upper surface **15.** Thus, uniform pre-cooling is achieved as the material starts downwardly and approaches the primary cooling distribution device **6.**

In the arrangement shown in FIGS. **3** and **4,** the embodiment is capable of a relatively high rate of output. In this arrangement, hot kiln material drops directly from the rotating kiln **18** into a cooling chamber **19.** The cooling chamber is tapered with an upper material receiving end **19***a*, and increases in cross section in a downward direction.

The chamber is inclined vertically so that although there may be a shifting in the concentration of the discharge point of the material as it flows out of the kiln, which can occur with a variation in rate of flow, the chamber **19** remains uniformly filled. In addition to the attaining of a uniform distribution of material across the chamber **19,** advantages result in the arrangement with types of material such as chalk or dolomite. When

periods of low rate of flow or inactivity with long standing periods of material in the chamber **19** without cooling, the material can react again so that the chamber arrangement illustrated is advantageous. This results in improvement in the quality of the fired products.

At the lower end of the cooling chamber **19** are a plurality of shaped material distribution dividers **34.** The dividers have tapered sloping roofs **34***a* and the lower orifice edges **34***b*. As will be observed in FIGS. **3** and **4,** the base of the cooling chamber **19** connects to a base chamber **21** which contains an air distributor **23.** The air distributor has a waffle pattern of downwardly directed open inverted V-shaped members which are in air communication so that as air is directed therein by blowers **11,** it will flow downwardly out of the base of the inverted V's and will pass upwardly into the space **22** of the base **21** and into the dividers **34.** A heated gas flow conduit **25** connects to the space **21** and communicates with the interior of the dividers **34** to remove the heated gases which then flow upwardly to a manifold **26** and into the kiln **18.** A fuel pipe **36** extends through the manifold for the pre-heating of the fuel. In some instances, one of the blowers, as shown by the blower **11'** may be connected to the interior of the dividers **34** for conductive cooling of the material as it flows over the roofs **34**a of the dividers.

At the lower end of the base **21** are a plurality of discharge members **24** which are tapered downwardly to connect to gas dynamic seal means, each of which may be similar to those described in connection with FIG. **1.**

In the arrangement of FIGS. **5** and **6,** the dividers, instead of extending fully across the chamber **19,** are each in the shape of inverted pointed cones **28.** The cones are hollow and provide a uniform distribution of material to direct the flow of material into outlets such as **24** of FIG. **3.** The spacing between these distributor cones or dividers **28** is such that the space between each of the adjacent cones is at least twice the distance between the cone and the wall **37** of the base. This insures a uniform flow of material and a uniform flow of particulate material and a uniform flow of cooling air.

If desired, pressure gauges may be provided in the lines leading from the blowers **11** and **11'** or in the lines **7** and **14** of FIG. **1** so that control of the division of air can be readily obtained. This may be accomplished through automatic control devices or manually by the manual operation of the speed of the blowers **11** and **11'** or manual control of the position of the valve **14a** in FIG. **1.**

I claim as my invention:

1. A structure for cooling particulate hot kiln material by contact with cooling air comprising in combination:

a vertical cooling chamber having a receiving upper end for receiving hot kiln material and a discharge lower end for discharging cooled material;

a cooling air distribution device having air discharge opening means communicating with the interior of said chamber;

and a feed conduit of a lesser diameter than the cooling chamber projecting downwardly into said receiving end of the cooling chamber and having a lower end discharging gravitationally into the chamber so that material piles up against the discharge end of said feed conduit, said feed conduit spaced above said air opening means.

2. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **1:**

including a second feed conduit extending into said receiving end and spaced from the walls of the chamber and having a conduit opening spaced above said opening means;

the spacing between said first and second feed conduits being at least twice as great as the spacing between each feed conduit and the wall of said cooling chamber.

3. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **1:**

including a material deflecting element positioned downwardly from said conduit opening.

4. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **3:**

wherein said distribution device opening means is connected to said deflecting element for discharging air out said deflecting element.

5. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **1:**

including a plurality of material discharge devices positioned at the discharge of the cooling chamber for conducting material away from the cooling chamber.

6. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **2:**

including a plurality of material discharge devices positioned at the discharge of the chamber with each discharge device in substantial vertical alignment with a corresponding feed conduit.

7. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **2:**

including at least one additional feed conduit extending into said receiving end and at least one additional cooling air distribution device with each cooling air distribution device positioned in substantial vertical alignment with each feed conduit.

8. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **2:**

wherein the conduit opening is smaller than the walls of the cooling chamber and the chamber widens into a larger chamber.

9. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **1:**

including an air intake chamber exposed to material being discharged from the cooling chamber so that cooling air flows over the discharged material and is directed through the cooling air distribution device.

10. A structure for cooling particulate hot kiln material by contact with cooling air comprising in combination:

a cooling chamber having an outer wall with a receiving upper end for receiving hot kiln material and a

discharge lower end for discharging cooled material;

a feed conduit means of a smaller diameter than the cooling chamber having a lower end within the chamber so that material piles up against the lower end of the feed conduit means and said lower end being positioned for discharging hot kiln material into the receiving end of the chamber;

and a cooling air distribution device including a shield connected at its upper edge to the outer wall of the chamber with its lower edge spaced from the wall to provide a downwardly directed air discharge opening;

and a cooling air delivery means connected to said air opening.

11. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **10**:

including a downwardly facing concave air discharge member positioned above the air distribution device and substantially centrally located with respect to the feed conduit for delivery of material to the chamber.

12. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **10**:

including a downwardly facing concave air discharge member positioned above the air distribution device and substantially centrally located with respect to the feed conduit for delivery of material to the chamber.

13. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **1**:

wherein said chamber discharge includes an opened lower end of the chamber;

a hopper having an open upper end of a larger size than the discharge opening of the chamber positioned below the chamber for material to discharge into the hopper and providing an area of exposed material in the hopper;

and an air intake chamber surrounding the upper end of the hopper for the flow of cooling air over the material in the hopper with the air chamber connected to the cooling air distribution device.

14. A structure for cooling particulate hot kiln material by contact with cooling air comprising in combination:

a cooling chamber having a receiving upper end for receiving hot kiln material and a discharge at the lower end for discharging cooled material;

a kiln positioned for discharging material into the upper end of the chamber;

an air intake chamber positioned within the cooling chamber surrounded by material with an open lower end having an air intake communicating directly with atmospheric air;

cooling air conduit means having an intake connected to said air chamber and a discharge leading to said kiln;

air intake openings at the lower end of the cooling chamber for air to filter up through the material and into the air chamber.

15. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **14**:

wherein said air intake means are connected to a pressure blower means for forcing air into the particulate material.

16. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **14**:

wherein said air chamber includes a plurality of chambers each having upwardly facing inclined roofs for the flow of material thereover and the transfer of heat through said roofs to the air flowing through the chambers.

17. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **1**:

including a secondary air distribution device positioned above the first air distribution device and an air supply connected to said distribution devices with means for controlling the air directed to each of said devices.

18. A structure for cooling particulate hot kiln material by contact with cooling air constructed in accordance with claim **1**:

including a plurality of dividers above the lower end of the cooling chamber, each divider having a tapered sloping upper surface with a hollow open end and with a plurality of openings at the lower end of the cooling chamber with the dividers positioned between said openings.

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