

March 17, 1942.

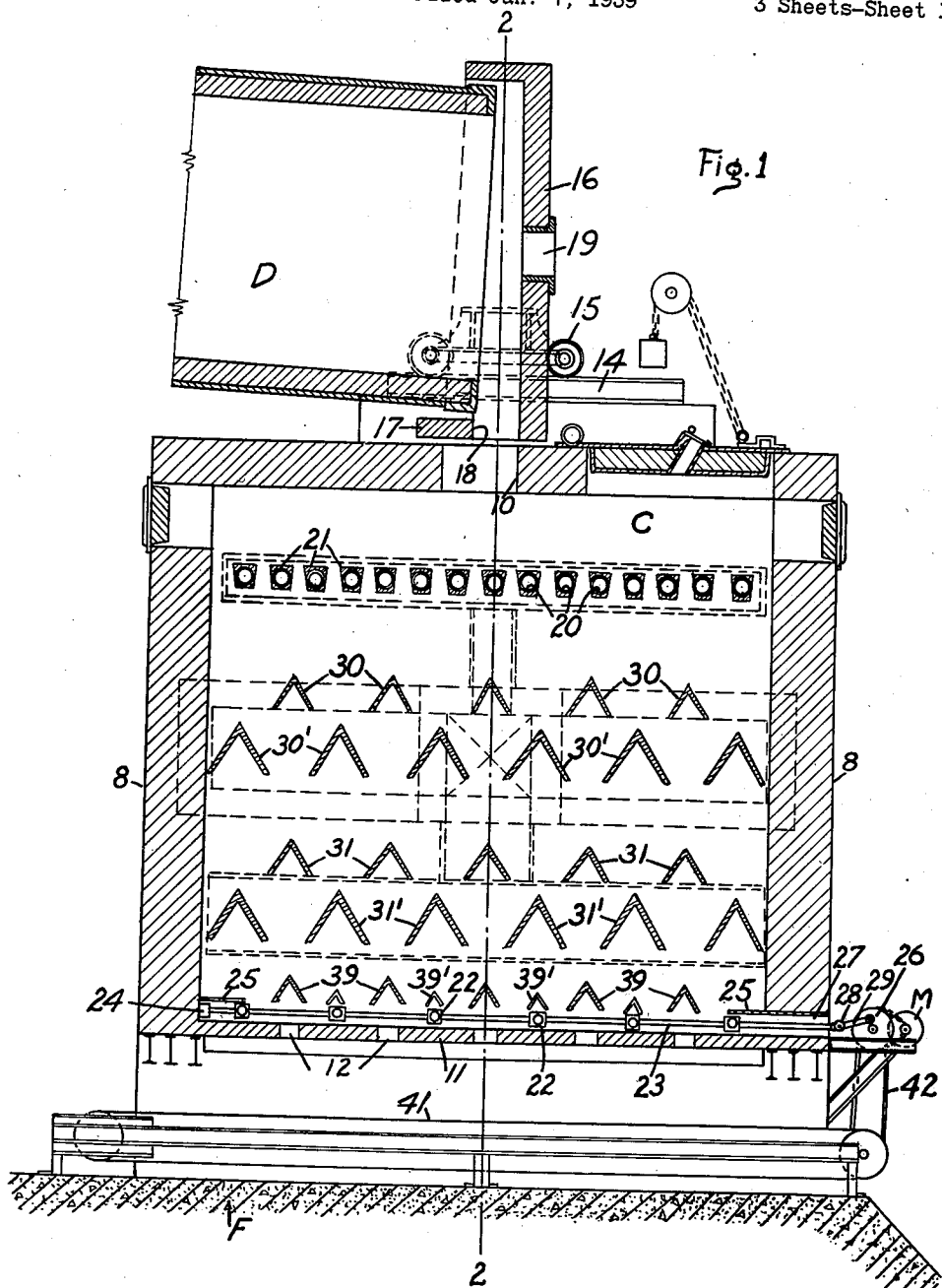
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MEANS FOR COOLING MATERIAL

Filed Jan. 7, 1939

3 Sheets-Sheet 1



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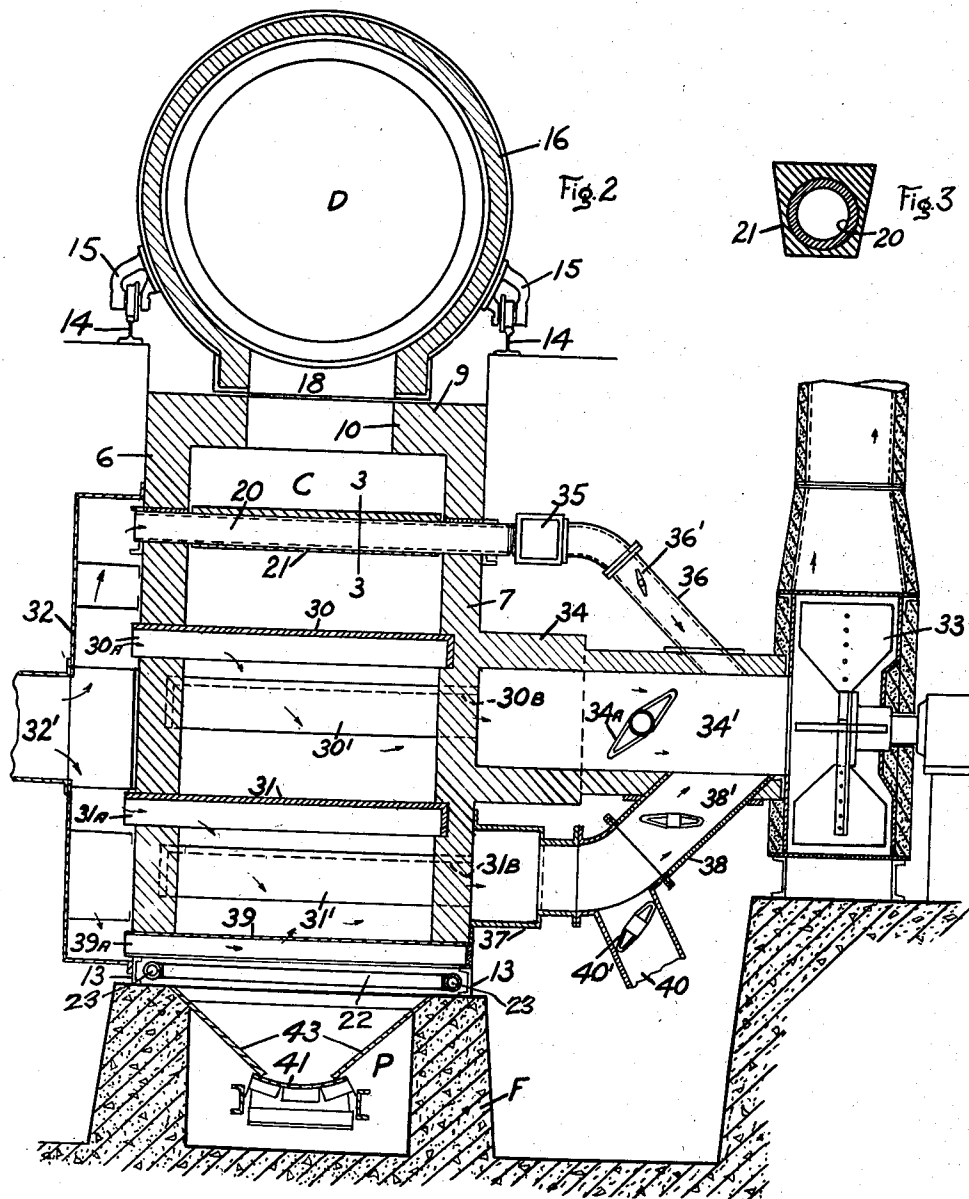
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MEANS FOR COOLING MATERIAL

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3 Sheets-Sheet 2



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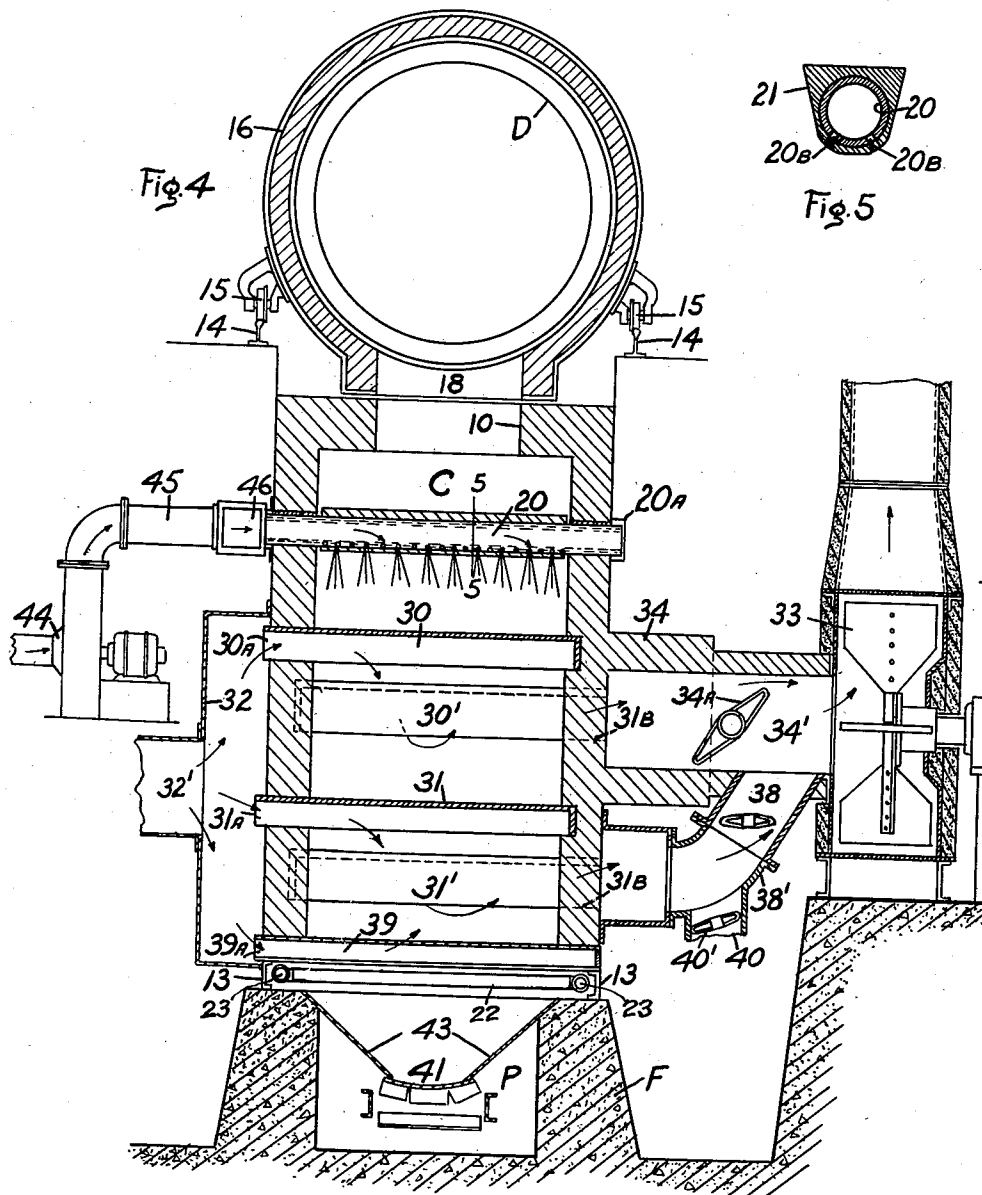
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MEANS FOR COOLING MATERIAL

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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MEANS FOR COOLING MATERIAL

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8 Claims. (Cl. 34—170)

This invention relates to means for heat treating, such as calcining or sintering, material in rotary kilns used in the lime, cement, chemical and allied industries, and relates particularly to means to cool the calcined or sintered material as it is discharged from the kiln.

It is a primary object of the invention to provide improved means for cooling calcined or sintered material adapted to be placed in communication with and receive calcined or sintered material in heated condition from the outlet of the kiln and effect progressive cooling of the material, and to provide means for this purpose that is simple in construction and operation and highly efficient in use.

It has heretofore been contemplated to cool material heat treated in a kiln by means to receive the material in heated condition from the kiln and subject the material in such condition to the direct action of a fluid cooling medium, such as air. Material in a rotary kiln is discharged from the end at which the kiln is fired, and to heat treat the material it is necessary to subject the same to the action of the gases of combustion having a temperature of from 1500 to 2500 degrees Fahrenheit. To subject the material as it is delivered from the kiln heated at such high temperatures to the direct action of a cooling medium, such as air, having a relatively lower temperature may be deleterious to the material.

It is another object of the invention to provide improved means including a casing having an opening in the top for the passage therethrough into the casing of the material to be cooled, and to provide means in the casing adapted for the passage of a fluid cooling medium, such as air, and receive thereon and intercept the passage of the material to be cooled and effect exchange or transference of the heat of the material to the cooling medium passing through said means to effect a primary cooling of the material, and then subject the material to the direct action of the cooling medium and effect progressive cooling of the material to a lower temperature.

It is another object of the invention to provide improved means to receive calcined or sintered material from a kiln and cool the same, including a casing having an opening in the top for the passage therethrough of the material discharged from the kiln and having a grate bottom to support a bed of material therein and permit the material to be delivered from the casing, provide the casing with a horizontal row of laterally spaced tubes opening through opposite side walls of the casing for the passage of a cooling medium,

such as air, to intercept the passage of the material delivered into the casing and effect exchange or transference of the heat of the material to the cooling medium passing through the tubes, the provision of horizontal rows of channel members supported below the tubes in inverted position with alternate rows of the channel members opening through opposite walls of the casing, and means connected to one end of said tubes and alternate rows of said channel members opening through one side wall to induce the flow of the cooling medium through the tubes and into the casing through the voids in the bed of the material in the casing and regulate the volume of the cooling medium flowing through the tubes and into and through the casing, and means reciprocatory transversely of the bottom to eject material from the casing through the grate bottom.

In the calcining of material to produce clinker for use in making cement it has been found that by a quick quenching and cooling of the calcined material or clinker it may be more easily and efficiently reduced or ground and produce a better cement.

It is a further object of the invention to provide means for quickly quenching and cooling calcined material or clinker including a casing having a chamber with an inlet opening in the top through which to deliver the calcined material from a kiln, and the provision of means in the casing to receive and intercept the material delivered therein adapted for the passage and delivery of a cooling medium, such as air, in a spray into the casing to effect exchange or transference of the heat of the calcined material to the cooling medium and then subject the material to the action of the spray delivered from said means to quickly quench the calcined material, and then subject the material to the action of the cooling medium to cool the calcined material progressively to a lower temperature.

Further objects and advantages of the invention will hereinafter appear.

In the drawings accompanying and forming a part of this application,

Figure 1 is a longitudinal sectional view of a cooler embodying the invention and showing the same in relation to the firing and discharge end of a rotary kiln to receive material therefrom.

Figure 2 is a cross sectional view taken substantially on the line 2—2 of Figure 1.

Figure 3 is a cross sectional view of a conductor or tube for the cooling medium taken on the line 3—3 of Figure 2.

Figure 4 is a view similar to Figure 2 but showing a modification of conductors or tubes for the cooling medium and means to cause a cooling medium to flow in and through the casing; and

Figure 5 is a sectional view of a conductor or tube for the cooling medium taken on the line 5-5 of Figure 4.

In carrying out the embodiment of the invention illustrated there is provided a casing or housing C, shown as of rectangular form and constructed of suitable material which may consist of brick or refractory material, and comprising opposite side walls 6, 7, end walls 8, a top 9 having an inlet opening 10 substantially centrally therein, and a bottom 11 having openings in the form of parallel slots 12 extending transversely of the casing and arranging the bottom in the form of a grate adapted to support a bed of material in the casing and permit of delivery of material from the casing through the slots.

The casing is supported upon a suitable foundation, shown as constructed of concrete F, by sills 13 extending longitudinally below the side walls of the casing and of opposite side walls of a pit P in the foundation.

The casing is mounted with the inlet opening 10 disposed below the firing and outlet end of a rotatable cylindrical drum D of a rotary kiln and in relation to means including a track 14 for the engagement of the wheels of a carriage 15 carrying a hood 16 consisting of a disk member of larger diameter than the kiln drum and having an annular flange 17 adapted to engage about the end of the kiln drum when the hood is moved toward the same, the hood flange having an opening 18 adapted to be disposed above the inlet opening 10 of the casing. The kiln is adapted to be fired by a fluent fuel, such as pulverized coal in suspension in an air stream, and for this purpose the hood is provided with a central opening 19 for the passage of a burner, not shown.

The kiln drum is supported to rotate on an axis inclining to the horizontal with the lower end constituting the discharge end for the material therefrom. As the material is discharged from the drum it passes through the opening 18 in the hood flange and the opening 10 into the top of the casing C and adapted to be collected in the casing in a bed by the arrangement of the grate bottom. The material in its passage through the casing is received upon and intercepted by means extending transversely of the casing chamber adapted for the passage of a cooling medium, such as air. Should the material burnt in the kiln consist of lime and as it is delivered into the casing be subjected to the direct action of the cooling medium the cooling medium may have a deleterious action on the material. For this purpose the material is primarily gradually cooled by effecting an exchange or transference of the heat of the calcined or sintered material discharged from the kiln to said cooling medium, and then cause the material to be subjected to the direct action of the cooling material admitted to and passed through the voids in the bed of material in the casing. To exchange or transfer the heat of the material delivered into the casing to the cooling medium without contact with the cooling medium and effect initial cooling of the material an air cooled wall in the form of a grizzly is disposed below the top of the casing and comprising a series of air conducting tubes 20 arranged in a laterally spaced horizontal row extending transversely of

the casing chamber, as clearly shown in Figure 1, the tubes being mounted in and extending through openings in the side walls of the casing and open at the opposite ends to the exterior of the casing. The tubes are adapted to receive thereon material delivered into the casing opening from the kiln and permit the material, which is in the form of nodules or granules, to pass from and through the spaces between the tubes by gravity. The material delivered from the kiln into the casing is at a calcining temperature of from 1500 to 2500 degrees Fahrenheit and as the material is received and accumulates on the tubes it may injure the tubes. The tubes are therefore provided with a jacket of a suitable protecting material 21, such as a refractory material, shown of greater width at the top than at the bottom so that the opposite side walls of the jacket of adjacent tubes form downwardly diverging walls of the spaces or passages between the tubes, as shown in Figures 1, 3 and 5.

The material gravitating over the tubes 20 falls on the casing bottom and is permitted to accumulate thereon to produce a bed of the material in the casing having a level below the tubes 20 after which the material is ejected from the casing through the spaces between the bars of the grate bottom to cause the body of material to move gradually downward in the casing. The material accumulating in the casing bridges the spaces in the bottom and to eject the material through said spaces there is provided means reciprocatory transversely of the grate bars 11 to move the material from the grate bars toward the openings 12 between the grate bars, and comprising, as shown in Figure 1, a series of ejector bars 22 superposed to and of less width than the grate bars, said ejector bars being connected in parallel spaced relation above and extending parallelly of the grate bars midway the sides thereof, as clearly shown in Figure 1. The one end of the bar carrying rods are slidably guided in members, as at 24, and shelves 25 extend transversely of the casing above the end bars to prevent material accumulating on the grate bars at the outer sides of said bars which may interfere with the reciprocatory movement of the ejector bars. The bar carrying rods are operatively connected at the opposite ends to means to reciprocate the same, shown as an electric motor M having a drive connection with a wheel or disc 26 connected to the ends of the bar carrying rods extended through an opening 27 at the juncture of the bottom with an end wall of the casing connected together at the ends by a rod 28 extending parallelly of the bars 22, and said rod pivotally connected intermediate the ends to a link 29 eccentrically and pivotally connected to the wheel or disc 26.

The material after it has been initially cooled by passing over the tubes 20 and accumulated in a bed in the casing is subjected to the direct action of the cooling medium, such as air. For this purpose there is disposed between the tubes 20 and the bottom of the casing superposed laterally spaced horizontal rows of channel members, preferably of V or acute angle shape in cross section supported in inverted position with the channel members open to the casing and extending parallelly of the tubes 20. These members are arranged in pairs of superposed rows, shown as two in number 30, 30' and 31, 31', with the upper members 30, 31 of each pair of members of less cross sectional dimension than and extending parallelly of the spaces between the

members 30', 31' of each pair of members. The members are closed at one end and are supported at the ends in the opposite side walls 6, 7 of the casing with the open end of the members 30, 31 opening to the exterior of the casing through the side wall 6, as at 30A, 31A to constitute inlets for the cooling medium into the casing, and the members 30', 31' opening to the exterior of the casing through the opposite side wall 7, as at 30B, 31B, and constituting outlets for the cooling medium from the casing, and thus permitting the cooling medium or air to be admitted to the casing and pass through the voids in the body of the material at different levels in the casing. To connect the tubes 20 and the open ends 30A, 31A of the channel members 30, 31 with a common source of the cooling air they communicate with a chamber formed by an open end casing 32 secured at the open end to the side wall 6 of the casing C, the casing C having a central inlet adapted for the connection of a conduit thereto, as at 32'.

Means are provided to induce the flow of the cooling medium into and through the pipes 20 and through the open ends of the channel members 30, 31 into and through the voids in the body of the material in the casing and out through the open ends of the channel members 30', 31', as indicated by the arrows, and comprises a fan 33. A manifold 34 in the form of a box like structure, shown as constructed integral with and extending longitudinally and laterally from intermediate the top and bottom of the side wall 7 of the casing, is connected in communication with the open ends of the channel members 30', said manifold having an outlet member 34' connected in communication with the inlet to the fan 33. The ends of the tubes 20 opposite the ends in communication with the casing 32 are connected in communication with a manifold 35 which is connected midway the ends by a conduit 36 to the outlet member 34' adjacent the connection of the latter with the fan inlet. The open ends of the members 31' are in communication with a manifold 37 which is connected midway the ends by a conduit 38 to the outlet member 34' of the manifold 34 adjacent the connection thereof with the fan, as shown in Figures 2 and 4.

A further horizontal row of laterally spaced inverted channel members extending parallelly of the pairs of channel members is interposed between the lower row of channel members 31' and grate bars 11 at the bottom of the casing. The end members and alternating members 39 of said row of channel members extend parallelly of the spaces between the members 31' and are of greater cross sectional dimension than the other members 39' alternating therewith, said members 39, 39' being closed at one end and mounted in the opposite side walls 6, 7 of the casing with the open ends opening through the casing wall 6 in communication, as at 39A, with the inlet casing 32. The members 39 bridge the spaces 12 between the grate bars 11 whereby material gravitating over said members 39 is directed onto the grate bars, and the members 39' are disposed midway the sides of the grate bars 11 and relieve the ejector bars of the weight of the material in the casing which might interfere with the reciprocatory movements of the ejector bars and delivery of material from the grate bars.

It may not be desirable to cool certain material heat treated in and discharged from the kiln, such as lime, to as low a temperature as other material and means are therefore provided to

regulate the flow of the cooling medium through the grizzly tubes 20 and into the casing through the open ends 30A, 31A and 39A of the channel members 30, 31 and 39, 39' and through the voids in the body of the material in the casing, or into and through the voids in the body of the material at different levels in the casing. For this purpose the conduits 34', 36 and 38 are provided with manually operative adjustable closure means, shown in the form of dampers 34A, 36' and 38', respectively, with the closure 34A arranged in the outlet member 34' within the connection of the conduits 36, 38 with said outlet member 34'. It will be obvious that by actuating the closure member 34A to shut off the outlet member 34' from the fan and the closure 38' actuated to open the conduit 38 to the inlet of the fan that air will be drawn into the casing through the open ends 30A, 31A and 39A of the channel members 30, 31 and 39, 39' but that the greater portion of such air will be drawn into the casing through the open ends of the channel members 31 and 39, 39'. Also that by actuating the closure 38' to shut off the conduit 38 from the fan inlet and the closure 34A actuated to open the outlet member 34' to the fan inlet that the greater portion of the air will be drawn into the casing through the open ends 30A, 31A of the channel members 30, 31. The cooling medium or air will be drawn into the casing through the open ends of the channel members 30, 31 and 39, 39' and through a greater or less portion of the body of the material in the casing depending upon whether either one or both of the conduits 34' and 38 are connected to the fan inlet. Should the material heat treated in and discharged from the kiln consist of lime the closure 38' is actuated to open the conduit 38 to the fan and the closure 34A is actuated to shut off the outlet member 34 from the fan and the tubes 20 may be wholly or partly shut off from the fan by the closure 36' with the result that cooling air is drawn into the lower portion of the casing through the channel members 31 and 39, 39' and through the bed of material between said channel members with practically no air drawn into the casing through the channel members 30, the upper portion of the casing in effect constituting a soaking pit in which the lime is subjected to the action of the heat retained in the material and causing unburnt lime to be cured and completely burnt and thus producing a better lime. In heat treating material in the kiln to produce clinker for making cement the tubes 20 and channel members 30' are connected in communication with the fan to effect a quick cooling of the material, and the channel members 31 may be connected in communication with the fan depending to how low a temperature the material is to be cooled.

The air discharged from the fan may be utilized as a heated secondary air supply to a boiler furnace or to the burner for firing the kiln, or it may be utilized as a heated air supply to the reducing chamber of a tube mill in the pulverizing of coal to be mixed with the pulverized coal to serve as the conveying vehicle therefor and a part of the fuel mixture. It may be found that when the fan is connected to the casing through the conduit 38 that the air will be cooled to so low a temperature that it is not desirable to use it as a secondary air supply to burning fuel, but it is desired to cool the material passing through the casing C to a low temperature. In said case the conduit 38 is shut off from the outlet member 34' by the closure means 38', and said conduit is provided with an

auxiliary outlet means in the form of a conduit 40 in communication with the conduit 38 through the wall thereof for the connection of a fan thereto, said conduit 40 also being provided with a closure in the form of a damper 40' to shut off the conduit 40 from the conduit 38.

The material discharged from the casing C through the grate openings in the bottom is delivered to a travelling conveyer 41 arranged to travel longitudinally of the pit P and convey such material to and deliver it from one end of the pit, as shown in Figure 1. The conveyer may be driven from the motor M by a belt 42 passing around a pulley on the shaft of the wheel or disc 26 and a pulley rotatable with a conveyer supporting drum. Guides 43 converge downwardly from the opposite sides of the slots in the casing bottom to the opposite sides of the conveyer, as shown in Figures 2 and 4.

In Figure 4 there is shown a modification of the tubes 20 for effecting cooling of the material by contact of the cooling medium with the material. In this arrangement the air inlet casing 32 is in communication only with the open ends of the channel members 30, 31 and 39 and the fan is not connected to the conducting tubes for the cooling medium or air. Instead of connecting one end of the tubes 20 with the fan and induce the flow of air therethrough said ends of the tubes are closed by caps 20A, and the tubes are provided with two rows of perforations 20B below and diverging in opposite directions from the axes of the tubes and corresponding perforations are arranged in the protecting material for the tubes registering with the perforations in the tubes, as shown in Figure 5. For this purpose the lower corners of such material are rounded. To supply the cooling medium or air under pressure to the tubes and cause the air to be delivered from the tubes in a spray through the perforations 20B a conduit 45 connected to the outlet of a fan 44 is connected to a manifold 46 to which the open ends of the tubes 20 are connected in communication. This form of the cooler is particularly adapted for use in quenching and cooling calcined limestone or clinker for use in making cement, since it effects a quick cooling of the material and produces a clinker that may be more readily reduced or ground and makes a better cement. In this arrangement the calcined limestone or clinker drops through the inlet opening onto the tubes 20 where it is subjected to an initial cooling by exchange or transference of the heat thereof to the cooling medium in the tubes, and as the material gravitates through the spaces between the tubes it is subjected to the direct action of the sprays of the cooling medium delivered from the perforations in the tubes. The material accumulated in a bed in the casing C is further cooled by the air drawn into the casing through the open ends 30A, 31A and 39A of the channel members 30, 31 and 39 and through the voids in the bed of the material as hereinbefore described.

It will be obvious that various modifications may be made in the construction and arrangement of the parts without departing from the invention and that portions thereof may be used without others and come within the scope of the invention.

Having described my invention, I claim:

1. In means for cooling heat treated material, a casing having an inlet opening in the top for delivering the heated material therethrough into the casing delivered from a kiln and having a grate bottom adapted to support a bed of the

material in the casing, a series of tubes spaced from the top and extending in a laterally spaced horizontally row transversely of the casing adapted for the passage of a cooling medium therethrough and over which the material delivered through the inlet opening is adapted to gravitate to effect transference of the heat of said material to the cooling medium passing through the tubes, horizontal rows of inverted laterally spaced channel members of angle form in cross section forming passages extending transversely of the casing, certain of said rows of channel members opening through a side wall of the casing and the channel members of the rows alternating therewith opening through the opposite side wall of the casing, and a fan connected to one end of the tubes and the channel members opening through one wall of the casing to induce the flow of a cooling medium through the tubes and into the casing through the channel members opening through the other wall of the casing and in heat transfer relation to the material through the voids in the bed of material in the casing.

2. In means for cooling heat treated material, a casing having an opening in the top for delivering therethrough material to be cooled into the casing and having a grate bar bottom, a horizontal row of laterally spaced inverted channel members of angle form in cross section extending transversely of the casing in superposed relation to the grate bars and the spaces between said bars, said members forming passages opening at one end through a side wall of the casing for the inlet of a cooling medium into the casing and in co-operation with the grate bars adapted to support a bed of material in the casing, a horizontal row of laterally spaced tubes spaced below said opening and extending parallelly of the grate bars and the opposite ends opening through the opposite side walls of the casing, said tubes being adapted for the passage of a cooling medium therethrough and over which the material delivered through the opening in the top of the casing is adapted to gravitate to transfer the heat of the material to the cooling medium passing through said tubes, pairs of laterally spaced horizontal rows of inverted channel members spaced vertically of the casing below and extending parallelly of the tubes transversely of the casing, the members of one row of each pair of rows of said members being disposed intermediate the members of the other row and opening through one side wall of the casing and the members of the other row of each pair of rows opening through the opposite wall, a fan, and means to independently connect the fan to one end of the tubes and one row of channel members of each pair of rows of channel members opening through one wall of the casing to induce the flow of a cooling medium through the tubes and through the other row of each pair of rows of said channel members and row of channel members spaced above the grate bar bottom into the casing and in heat transfer relation to the material through the voids in the bed of material in the casing.

3. In means for cooling heat treated material, a casing having an opening in the top for delivery of material to be cooled therethrough into the casing and having a grate bar bottom adapted to support a bed of the material in the casing, a horizontal row of laterally spaced tubes spaced below and opening through opposite side walls of the casing adapted for the passage of a cooling medium therethrough and over which the material delivered through the opening in the top

of the casing is adapted to gravitate and transfer of the heat of the material to the cooling medium passing therethrough, pairs of laterally spaced horizontal rows of inverted channel members spaced vertically of the casing below and extending parallelly of the tubes, the members of the upper row of each pair of rows of members opening through one side wall of the casing and the members of the lower rows of members opening through the opposite wall, a fan, a conduit connected to the inlet of the fan and the members of the lower row of the upper pair of rows of channel members, a conduit connecting one end of the tubes to said first conduit, and a conduit connecting the members of the lower row of the lower pair of rows of channel members to said first conduit, means in each conduit to regulate the connection thereof with the fan, and means reciprocatory transversely of the grate bars of the bottom operative to deliver material from the grate bars through the spaces between said grate bars and cause the bed of material in the casing to gravitate over the channel members to the grate bottom.

4. In means for cooling heat treated material as claimed in claim 3, a row of inverted channel members spaced above and extending parallelly of the grate bars, certain of said channel members being disposed above and bridging the spaces between the grate bars and channel members alternating therewith disposed midway the sides of the grate bars and said channel members in co-operation with the grate bars adapted to support a bed of material in the casing, and the means for ejecting the material from the grate bars comprises bars connected in parallel spaced relation disposed below and reciprocatory transversely of the channel members disposed midway the sides of the grate bars, and means to reciprocate said ejector bars.

5. Means for cooling material as claimed in claim 3, wherein the ends of the channel members opposite the ends opening through a side wall of the casing are closed and the channel members of the upper row of each pair of rows of channel members are of less cross sectional dimension and disposed in a plane above and relative to the spaces between the channel members of a lower row.

6. In means for cooling material as claimed in claim 3, means connected in communication with the ends of the tubes and the channel members opening through the side of the casing opposite to which the fan is connected to connect the tubes and casing to a common source of the cooling medium.

7. In means for cooling heat treated material, a casing having a material inlet opening in the top and a grate bar bottom, a horizontal row of laterally spaced members of inverted V shape in

cross section above and extending parallelly of the grate bars with certain of said members bridging the spaces between the grate bars and others disposed midway the sides of the grate bars and adapted in co-operation with the grate bars to support a bed of material in the casing, ejector bars extending parallelly of and reciprocatory transversely below the V shaped members disposed midway the sides of the grate bars, pairs of horizontal rows of inverted channel members closed at one end and open at the opposite end spaced above and extending parallelly of the grate bars with the open ends of one row of each pair of rows of channel members opening through a side wall of the casing and the open ends of the channel members of the other row opening through the opposite side wall of the casing, a fan, a manifold in communication with the open ends of each row of channel members opening through one side wall of the casing, conduits connecting said manifolds to the inlet of the fan housing, and valve means independently operative to regulate the connections of said conduits with the inlet to the fan housing.

8. In means for cooling heat treated material, a casing having a material inlet opening in the top and a grate bottom, a horizontal row of laterally spaced inverted channel members spaced above and extending parallelly of the grate bars, certain of said channel members bridging the spaces between the grate bars and alternate channel members disposed midway the sides of the grate bars and adapted in co-operation with the grate bars to support a bed of material in the casing, said channel members being closed at one end and the open ends opening through a side wall portion of the casing, bars connected in parallel spaced relation reciprocatory transversely above the grate bars below the channel members disposed midway the sides of the grate bars to eject material from the grate bars, a horizontal row of laterally spaced tubes extending transversely of the inlet opening to the casing and opening through opposite side wall portions of the casing, pairs of superposed horizontal rows of laterally spaced inverted channel members below and extending parallelly of the tubes, one end of each of said latter channel members being open with the open ends of the channel members of one row of each pair of rows of channel members opening through a side wall portion of the casing and the open ends of the other rows of channel members opening through the opposite side wall portion of the casing, a fan, and means for independently and regulably connecting one end of the tubes and the open ends of one row of each pair of rows of channel members to the fan.

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