

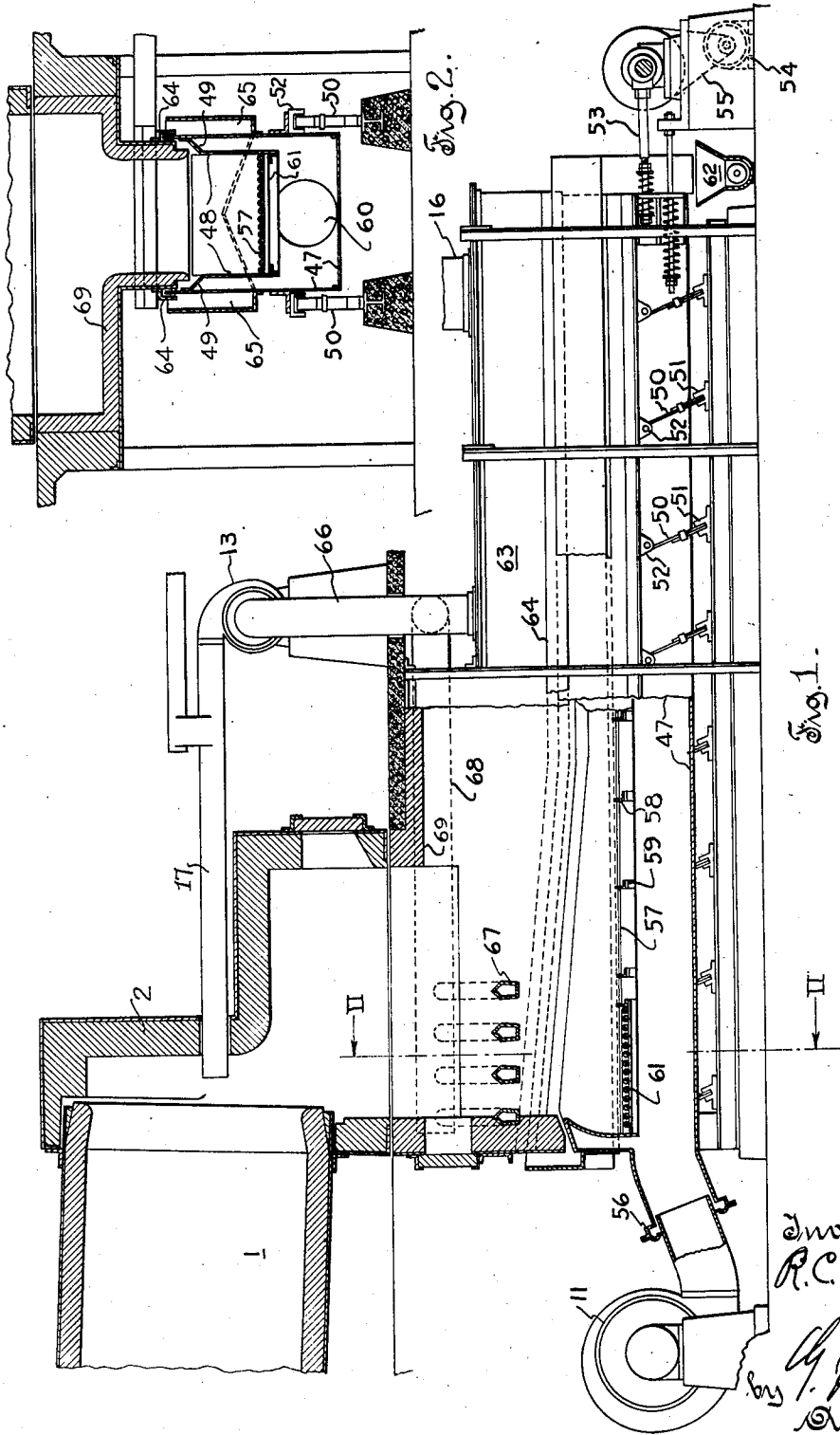
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CLINKER COOLER

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CLINKER COOLER

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The invention relates to coolers, and it is concerned more specifically with a cooler for Portland cement clinker.

Portland cement clinker which is burned in a rotary kiln is discharged from the kiln at a temperature ordinarily within the limits of 2000° F. and 2400° F.; the mass of clinker leaving the kiln consists for the most part of small size nodules mingled with larger size nodules, grit and dust, but at times large lumps of clinker are also contained in the mass which is discharged from the kiln; the rate of discharge from the kiln varies, and at times very little clinker is discharged while at other times great quantities of clinker are discharged. Under these conditions satisfactory and efficient cooling of the clinker becomes a difficult problem.

It is an object of the invention to handle the mass of clinker which is discharged from the kiln, in an improved manner so that the clinker can be cooled so rapidly as to be chilled or quenched; so that most of the heat which is carried out of the kiln with the discharged clinker may be returned into the kiln with the "secondary combustion air" at a high temperature and with the "primary combustion air" at a somewhat lower temperature; so that the irregularities in the size of the clinker and the varying rate of delivery from the kiln do not affect proper cooling of the mass; and so that the large lumps, the grit and the dust contained in the mass of clinker may be properly disposed of. The term "primary combustion air" is here understood to mean all air used to transfer and introduce fuel into the kiln from a fuel container, such as a coal bin, and the term "secondary combustion air" is here understood to mean all air used for combustion in the kiln, exclusive of the primary air.

Another object of the invention is to produce a nozzle effect upon the cooling medium, preferably air, which is used to cool the clinker, the mass of clinker discharged from the kiln being formed into a moving bed and the cooling medium being forced through the bed from below. The nozzle effect is to produce an even distribution of the cooling medium under the bed and to oppose the dropping of fine particles contained in the bed.

Another object of the invention is to make Portland cement clinker easier to grind and to improve the quality of the cement obtained from such clinker.

Still another object of the invention is to provide a cooling equipment which is simple in design, efficient in operation, and which may be manufactured at low costs.

These and other objects and advantages of the invention will be apparent from the following description. A clear conception of an embodiment of the invention and of the operation of a device constructed in accordance therewith, may be had by referring to the drawing accompanying and forming a part of this specification in which like reference characters designate the same or similar parts in the various views.

Fig. 1 is a side view, partly in section, of a clinker cooler installation embodying the invention.

Fig. 2 is a section on line II—II of Fig. 1.

The reference numeral 1 in Fig. 1 indicates the discharge end of a conventional rotary kiln for burning cement clinker. 2 indicates a firing hood which is placed over the discharge end of the kiln 1 and which has a large bottom opening through which clinker discharged from the kiln may pass and through which secondary combustion air may enter the kiln. A fuel pipe through which primary combustion air enters the kiln is shown at 17 and extends through the hood 2. The hot clinker discharged from the kiln 1 and falling through the bottom opening of the hood 2 is received by a shaking conveyor arranged on a level below the level of the bottom opening of hood 2. The shaking conveyor has a shaking trough which comprises an outer box-shaped sheet metal shell indicated at 47, Fig. 2, and an inner carrying tray indicated at 48. The carrying tray extends longitudinally within the sheet metal shell substantially from one end thereof to the other and is secured to upper portions of the side walls of the shell, as indicated at 49. The side walls of the outer shell have horizontal upper edges which at the charge end of the trough slope upwardly, as best shown in Fig. 1, so as to increase the height of the side walls at the charge end of the trough. The trough is swingably supported on a plurality of leaf springs 50 standing on end. Each leaf spring is clamped in a bracket 51, secured to the foundation, and extends upwardly therefrom in a somewhat inclined position. The upper ends of the leaf springs are pivotally connected to depending brackets 52 secured to the side walls of the outer shell 47, the springs acting as reeds or supporting legs. A vibrating mechanism including a reciprocating rod 53 secured to the trough is provided to impart shaking movement to the trough, the vibrating mechanism being driven by an electric motor 54 through a suitable power transmitting mechanism indicated at 55. In operation the trough has a short backward and forward motion, with a slight rise on the forward

stroke which conveys the material in a smooth, floating stream, the direction of advancement of the stream being away from the kiln. The trough may have a travel of approximately one inch in each direction at a rate of from 300 to 400 strokes per minute.

Cooling air is forced by a fan 11 into the outer shell 47 through an opening 60 in the transverse end wall thereof at the end adjacent to the kiln, a flexible connection 56 between the shell 47 and the fan 11 being provided to permit shaking movement of the trough. The bottom of the carrying tray 48 is constructed to permit cooling air, supplied by the fan 11, to pass therethrough from below. For this purpose the bottom of the carrying tray is formed by a number of longitudinally extending round bars 57 supported in juxtaposition and slightly spaced apart on cross members 58 which in turn are supported by angle iron clips 59 secured to the side walls of the carrying tray. At the end of the carrying tray, adjacent to the kiln, additional round bars 61 are placed underneath the round bars 57 transversely thereto for reinforcing purposes. It will be seen that in the construction of the shaking trough as described hereinabove the carrying tray may be termed a false bottom of the trough and that the gaps between the bars 57 provide perforations of the false bottom through which the cooling air may pass upwardly and fine material may fall downwardly upon the closed bottom of the shell 47. The hot mass of clinker discharged from the kiln will be delivered upon the carrying tray and owing to the shaking movement thereof it will be advanced in a direction away from the kiln and finally be discharged into a cross conveyor generally indicated at 62. While the clinker is thrown up by the tray and falls down again it will assume a state of even distribution on the carrying tray, and at the same time some of the fine material mixed with the coarse material coming from the kiln will fall through the gaps between the bars 57 and accumulate on the bottom of the outer shell 47. As the carrying tray and the outer shell are rigidly connected one to the other and, as they will, therefore, swing as a unit the fine material collecting on the bottom of the outer shell will be advanced simultaneously with the coarse material on the bed, and the cross conveyor 62 receiving the coarse material will also receive the fine material discharged from the bottom of the outer shell 47 at the end adjacent to said conveyor. It should be noted that the hot material, while being continually thrown up from the carrying tray and falling back thereupon, is exposed to a large volume of cooling air and that the latter will therefore cool the clinker most efficiently.

The gaps between the round bars 57 in the bottom of the carrying tray are narrow, as stated, and the spacings of adjacent bars are so proportioned relative to the diameters of the bars that the gaps produce a nozzle effect upon the air passing therethrough. That is, the cooling air passes through the gaps at a greater velocity than it has below and above the bottom of the tray, and it is given a tendency to spread evenly under the layer of material on the tray. The velocity of the cooling air below the tray, and particularly above the tray, is preferably kept low enough so that the cooling air does not pick up a substantial quantity of the fine material which is carried on the bottom of the outer shell 47 or of the fine material which is contained in the layer of material on the carrying tray 48. If the cooling air above the layer of material on the tray were laden

with a great quantity of dust and permitted to enter the kiln it would create a hazy condition which would make it difficult to observe the conditions in the kiln. In the cooler described herein the necessary large volume of cooling air for rapidly cooling the material on the tray may conveniently be supplied at such low velocities below and above the bottom of the carrying tray as to afford substantial freedom of the cooling air from dust. On the other hand, the momentary increase of the air velocity in the gaps between the bars 57 opposes the falling of fine particles through said gaps. The longitudinal side walls of the carrying tray 48 are transversely spaced from the longitudinal side walls of the outer shell 47, as shown in Fig. 2, and the side walls of the carrying tray are, therefore, exposed to the cooling air which is forced into the outer shell 47.

A stationary air chamber, generally indicated by 63, is arranged above the shaking trough to collect the air passing through the carrying tray and through the layer of clinker thereon. The air chamber extends over the shaking trough throughout the length of the latter and is formed of brickwork 69 for a suitable length at the hot end of the cooler, the remaining portion of the air chamber being formed of sheet metal suitably supported on a frame structure.

The upper portions of the side walls of the outer shell 47 project into channels formed by straps 64 at portions of the air chamber adjacent to the upper edges of said side walls. An air seal obstructing escape of air from the air chamber is thus provided but inasmuch as some air and dust are likely to leak through this seal, dust pockets 65 are formed adjacent to the seals at the shaking trough as best shown in Fig. 2. If dust works through the seals it will be collected in the pockets 65 and as the latter partake in the shaking movement of the trough the dust will be advanced in the pockets towards the discharge end of the trough. At the discharge end of the trough the pockets 65 have openings arranged in such relation to the cross conveyor 62 that the dust will fall from the pockets through said openings and into the cross conveyor.

It should be noted that the cooler using a conveyor of the shaking trough type as described hereinbefore is free from rotating or articulated parts which are subject to the abrasive action of a blast of air carrying highly abrasive clinker particles. It should also be noted that the rate of material travel may be changed considerably by a slight variation of the speed of vibration.

The cooling air passing through the bottom of the carrying tray 48 and collecting in the air chamber 63 is disposed of in the following manner: Part of the air is drawn from the air chamber by a fan 13 through an intake pipe line 66 and is injected by the fan through the fuel pipe 17 into the kiln; another part of the air enters the kiln as secondary air through the bottom openings of hood 2; and the rest of the air escapes through a stack 16 connected with the air chamber at the end thereof adjacent the discharge end of the shaking conveyor.

At the end of the cooler, adjacent to the discharge end 1 of the kiln, a plurality of hollow grate bars 67 are arranged above the shaking trough, the bars being open at one end and connected through a pipe line 68 with the intake pipe line 66 of the fan 13. The fan 13, therefore, draws air not only from the air chamber 63 but also through the grate bars 67, and the air drawn through the grate bars 67 is injected

into the kiln together with the air drawn from the chamber 63. The air thus injected into the kiln through the fuel pipe 17 is the "primary air" referred to hereinbefore. The grate bars are intended to protect the charge end of the conveyor from excessive impact which may be caused by large lumps of clinker discharged from the kiln. It will be seen that such large lumps when falling upon the grate bars, which preferably have pointed top edges as shown, will be broken up, and that only small pieces will fall upon the conveyor underneath. The grate bars are efficiently cooled by the air which is drawn there-through by fan 13. In the operation of the cooler the hottest air collecting in the air chamber 63 passes into the kiln as secondary air; the next hottest air is taken in by the fan 13 and is used as part of the primary air; and the air escaping through the stack 16 is the coolest air collecting in the air chamber 63.

It should be noted that the entire bottom of the carrying tray 48 will be covered with a layer of clinker and that the entire mass of the layer is exposed to the action of the cooling air. In this manner the clinker may be cooled very rapidly, which has been found to produce certain beneficial results not heretofore known in the manufacture of Portland cement. Comparative tests with slowly cooled clinker and rapidly cooled, or chilled, clinker have shown that the latter is easier to grind than the former, and that the cement obtained from rapidly cooled clinker is stronger than cement obtained from slowly cooled clinker. It has further been found that, in order to obtain these results, it is essential to effect rapid cooling of the clinker from the temperature at which it leaves the kiln, which is ordinarily within the limits of 2000° F. and 2400° F., to a temperature of about 1200° F., the temperature to which it is desirable to cool Portland cement clinker being not higher than 150° F. The cooler described hereinbefore is adapted to effect rapid cooling of the clinker from the temperature at which it leaves the kiln to a temperature of 150° F., or lower.

It should further be noted that in the cooler described hereinbefore the extremely high heat of the clinker leaving the kiln is prevented from causing damage to the carrying tray of the conveyor. This result is accomplished by directing the fresh cooling air to the carrying tray from below and by forcing it upwardly therethrough, so that the air first carries off the heat from the carrying tray. Instead of using a pressure fan, as shown in Fig. 1 the same result may be obtained by causing a vacuum above the layer of clinker and drawing fresh air through the perforations of the carrying tray of the conveyor. Forcing fresh air through the carrying tray by a pressure fan, as shown in Fig. 1, is considered to be more desirable, however, because the size of the fan required in this case will be smaller than in the other case, and because the hot air is not handled by the fan as would be necessary if the air were drawn through the perforations of the carrying tray.

It should be understood that it is not intended to limit the invention to the exact details of construction shown and described hereinbefore, for various modifications within the scope of the claims may occur to persons skilled in the art.

I claim:

1. In combination, a shaking conveyor including a trough having a perforate bottom, a stationary housing arranged to form a hood over

said trough, means for causing a flow of air into said housing through said perforate bottom of said trough and through a layer of material to be conveyed thereby, and means for sealing said housing and said trough along the sides of the latter and permitting said trough to oscillate relative to said housing.

2. In combination, a shaking conveyor including a trough having a perforate bottom, a stationary housing arranged to form a hood over said trough, means for causing a flow of air into said housing through said perforate bottom of said trough and through a layer of material to be conveyed thereby, means for sealing said housing and said trough along the sides of the latter and permitting said trough to oscillate relative to said housing, and a pocket at each side of the conveyor below said sealing means and partaking in said oscillations of said trough, said pockets being arranged to collect dust working out of said housing through said sealing means.

3. In combination, a shaking conveyor including a trough having a solid bottom and a perforated false bottom, a stationary housing arranged to form a hood over said trough, means for sealing said housing and said trough along the sides of the latter and permitting said trough to oscillate relative to said housing, air blast means connected with said trough for forcing air into the space between said solid and said false bottom of said trough, and air draft means connected with said housing for withdrawing air therefrom.

4. In combination with a kiln having a discharge opening for discharging clinker, a shaking conveyor arranged to receive clinker from said kiln and including a trough having a solid and a perforated false bottom, a stationary housing arranged to form a hood over said trough and having an opening in communication with said discharge opening of said kiln, means for sealing said housing and said trough along the sides of the latter and permitting said trough to oscillate relative to said housing, air blast means connected with said trough for forcing air into the space between said solid and said false bottom of said trough, and fuel injecting means for said kiln, including air blast means connected with said housing for withdrawing air from said housing.

5. In combination with a kiln having a discharge opening for discharging clinker, a shaking conveyor arranged to receive clinker from said kiln and including a trough having a solid and a perforated false bottom, a stationary housing arranged to form a hood over said trough and having an opening in communication with said discharge opening of said kiln, means for sealing said housing and said trough along the sides of the latter and permitting said trough to oscillate relative to said housing, air blast means connected with said trough for forcing air into the space between said solid and said false bottom of said trough, an air outlet associated with said housing near the discharge end of said shaking conveyor, and fuel injecting means for said kiln, including air blast means connected with said housing for withdrawing air from a portion of said housing intermediate said opening and said air outlet.

6. In a cooler, a trough, a perforated bottom in said trough, means for reciprocally mounting said trough, means for reciprocating said trough to convey material carried thereby, and means for forcing air upwardly through said bottom and

material thereon to cool same, said perforated bottom being constructed to permit dust, contained in the material to be conveyed, to fall through the perforations thereof while said trough is being reciprocated, and said perforations being shaped to form air ducts of varying cross section producing a nozzle effect upon the air passing therethrough and causing said air to spread evenly under material carried by said bottom.

7. In a cooler, a trough having a bottom comprising a plurality of parallel round bars slightly separated from each other, means for reciprocably mounting said trough, means for reciprocating said trough to convey material carried thereby, and means for forcing air upwardly through the spacing between said bars and material carried by said bottom to cool said material, the spacing between said bars being such as to produce a nozzle effect upon the air passing therethrough, and to cause said air to spread evenly under material carried by said bottom.

8. In a cooler, a trough having a bottom comprising a plurality of parallel round bars slightly separated from each other and extending in the longitudinal direction of said trough, means supporting said trough for longitudinal reciprocating movement, means for reciprocating said trough to convey material carried thereby, and means for forcing air upwardly through the spacing between said bars and material carried by said bottom to cool said material, the spacing between said bars being such as to produce a nozzle effect

upon the air passing therethrough, and to cause said air to spread evenly under material carried by said bottom.

9. In a cooler, a trough having a closed bottom, a perforated false bottom in said trough, inclined means for mounting said trough, means for reciprocating said trough to convey material carried thereby, and means for forcing air through said false bottom and material thereon to cool same, said perforated false bottom being constructed to permit dust, contained in the material to be conveyed, to fall through the perforations thereof while said trough is being reciprocated, the dust accumulating on said closed bottom being separately conveyed and discharged by the latter.

10. In a cooler, a shaking conveyor comprising a reciprocably mounted perforated carrying tray adapted to convey a layer of material thereon and constructed to permit minor particles of said material to pass through the perforations thereof while said layer advances on said carrying tray, an element reciprocable with said carrying tray and adapted to receive and convey said minor particles, said carrying tray and element being arranged to discharge the material conveyed thereby at one end of said shaking conveyor, and means associated with said shaking conveyor for forcing a cooling medium from below through said perforated carrying tray and the layer of material thereon.

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