A cooler for cooling hot bulk material, in which cooling gas flows transversely to the conveying direction through a bulk material bed cooling the bulk material. An apparatus carrying the bulk material bed has a ventilation floor comprised of movable planks extending in the conveying direction through which cooling gas flows. At least two adjacent planks are moved simultaneously in the conveying direction and non-simultaneously counter to the conveying direction. The planks have differently configured surfaces, on which the bulk material bed lies, in the conveying direction, and these surfaces, due to different frictional locking with the bulk material bed lying thereon, lead to differing mean transport speeds, and as a result the bulk material bed is stretched in a region of quicker conveying and compressed in a region of slower conveying. The apparatus tumbles the bulk material with vertical mixing, thereby heat is recuperated efficiently.
PROCESS FOR COOLING HOT BULK MATERIAL AND COOLER

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the benefit of the German patent application No. 10 2010 055 825.7 filed on Dec. 23, 2010, the entire disclosures of which are incorporated herein by way of reference.

BACKGROUND OF THE INVENTION

[0002] The invention relates to a cooler for cooling hot bulk material, in which cooling gas flows approximately transversely to the conveying direction through a bulk material bed and in the process takes up the heat of the bulk material, wherein an apparatus which carries the bulk material bed has a ventilation floor through which cooling gas flows, and wherein the conveying principle provides for Plaza which extend in the conveying direction, in which at least two adjacent Plaza are moved simultaneously in the conveying direction and non-simultaneously counter to the conveying direction.

[0003] For the production of cement, raw meal consisting of lime-containing rock and silicate-containing rock is firstly freed of chemically bound carbon dioxide in the form of the carbonate by a first heat treatment, and then the thus calcined raw meal is sintered in a rotary tubular kiln at temperatures of up to 1450°C. In this case, various phases of stoichiometrically different calcium silicates form in a solid-state reaction, and the grain size distribution of the raw meal introduced into the process changes because the grains of the raw meal are joined to one another during the sintering. After they have passed through the rotary tubular kiln, the grains of the clinker which is thus formed generally have the size of coarse meal right up to fist-sized clinker granules. The crystallization in the solid-state reaction during sintering for forming the desired phases requires rapid quenching of the clinker after the sintering process during passage through the rotary tubular kiln. The freshly sintered clinker, which forms a very abrasive and very hot material, is therefore discharged onto a cooler. In the cooler, heat is rapidly taken from the fresh clinker so as to quench the clinker and also to recycle the heat present in the clinker to the very heat-intensive cement production process.

[0004] The cooling of the cement clinker requires considerable procedural expenditure because the clinker is very hot and also because the clinker has a very abrasive action.

[0005] Processes for cooling the cement clinker which have been known for a long time provide for discharging the cement clinker from the rotary tubular kiln onto a stepped grate, where the cement clinker to be cooled forms a bulk material bed. The stepped grate is a static grate on which a static passive layer of cement clinker forms. This passive layer protects the static grate from overheating and abrasion. The clinker emerging from the rotary tubular kiln drops onto this passive layer and slips over the natural slope angle which forms in the conveying direction onto a moving conveying grate. As it is transported over the stepped grate, the cement clinker is cooled by cooling air conducted through the conveying grate from below. The stepped grate is adjoined by a moving conveying grate with grate bars which move alternately in the conveying direction and have grate plates. This conveys the clinker in the direction towards the end of the cooler, the cooling air flowing into the material to be cooled through the movable grate bars and through the stationary grate bars with grate plates or through interstices which are present between the movable grate bars with grate plates. This known type of clinker coolers has proved itself in practice. However, a disadvantage of these clinker coolers is the high wear rate, since the abrasive and also very hot clinker passes into the interstices between the steps. A cooler of this type is therefore high-maintenance compared to more modern clinker coolers.

[0006] Other concepts for improving the cooler, disclosed in DE2831473A1, include pulling the clinker over a stationary, ventilated surface using a traction chain. This type of cooler, too, is sensitive to a high degree of wear, because the traction chain together with the movable links thereof is worn through in the hot cement clinker.

[0007] Yet another concept, which is disclosed in EP1373818B1, pursues the forward movement of a plane which occupies the entire cooler in a first phase, the lowering of a blocking plate in the vicinity of the rotary tubular kiln at the start of the clinker cooler in a second phase, and the withdrawal of the entire plane counter to the blocking action of the blocking plate, such that, when the plane is withdrawn, the cooler is pushed forwards with respect to the latter. This type of cooler has the advantage that no machine parts which move in relation to one another are in direct contact with the hot, abrasive clinker. In the case of this type of cooler, however, very high forces have to be applied to move the plane counter to the action of the blocking plate, and the bulk material bed tends to accumulate on the blocking plate, and therefore it is not always possible to achieve uniform transport with a uniform and reproducible bulk material bed height and therefore reproducible properties of the clinker cooling. This document, mentioned here, also discloses that it would be advantageous to move the plane so slowly that the bulk material bed does not carry out any vertical mixing movement. The abrasion would thereby be reduced.

[0008] The article “Sind Kühltürme Klinkerkühler oder Wärmerekuperatoren?” [“Are cooling grates clinker coolers or heat recuperators?”] from the journal entitled Zement-Kalk-Gips, 37th Volume, No. 5/1984 explains theoretical considerations of clinker cooling. This article focuses on a cross-flow model, which states that the clinker flows in the transport direction and in the process cooling air flows through it perpendicularly to the transport direction. The consideration on which the article is based is that in this case a wedge of a thermal zone which lies in the bulk material bed is formed. The wide part of the wedge is arranged at the start of the cooler and the flat part of the wedge being arranged at the end of the cooler. This thermal wedge forms, according to the established concept, because the cooling air penetrates the hot clinker from the bottom upwards. If the entire layer thickness of the clinker is still hot, the cooling air which enters the clinker from below is heated even after a short distance through the clinker layer, in which case the lower clinker layer is left cooled and the upper, significantly wider part of the layer of the bulk material bed is still hot. Since the clinker continues to move along, this process takes place again in the conveying direction. Here, the cold cooling air penetrates the already cold layer of the bulk material bed and then the still hot lower layer, which is cooled, and therefore the width of the hot layer is reduced. This process takes place until the entire layer thickness of the layer of the bulk material bed of the clinker is cooled. The desired effect of this gradual cool-
ing is for the cooling air to leave the uppermost layer of the bulk material bed at the highest possible temperature. As a result, the clinker is cooled with little cooling air being used, and first and foremost the heat is transported back into the process at a high temperature. According to established concepts, a bulk material bed with little mixing movement, primarily little mixing movement from the bottom upwards, is therefore advantageous. This is because the established cross-flow cooler theory also states that a greatly moving bulk material bed could have the effect that an already cooled grain might pass into the still hot region and be heated again by the still hot layer. As a result, the temperature of the uppermost layer would be reduced, because the thermal energy is distributed over a greater volume of the bulk material to be cooled. As a consequence, the cooling air temperature upon discharge from the clinker cooler layer would be reduced, and the efficiency of the cooling would therefore likewise be reduced.

[0009] This consideration led to the development of a further type of cooler, which is mentioned in the Danish patent application DK 140399. In this type of cooler, the floor of the cooler, which consists of planks extending in the conveying direction, is moved in its entirety in the conveying direction in a first phase, and then in further phases the individual planks are withdrawn individually under the bulk material to be cooled counter to the conveying direction. Since the bulk material bed lies on the other, stationary planks, the bulk material bed is held over the planks which move back. Cooling air is blown through the moving planks such that the desired cooling effect is achieved. First experiences with this type of cooler showed that the bulk material bed is loosened over the borderline between two planks when the planks move in relation to one another. Channels with little flow resistance form as a result, such that cooling air flows with preference through these loosened borderline areas without cooling the bulk material to be cooled. This means that the recuperation efficiency of the cooler is thereby reduced, and the temperature of the air leaving the bulk material bed to be cooled is likewise reduced by the air flowing without a cooling effect through the bulk material bed. DK 140399 therefore proposes fitting flow obstacles on the moving planks, as a result of which the planks are divided into individual portions. The cooler according to DK 140399 is that the bulk material bed rolls over the flow obstacles when the individual planks are withdrawn individually, such that the loosened areas over the borderline between the planks, which are denoted as cold channels, close.

[0010] Furthermore experiences with this type of cooler have shown that, in the teaching according to DK 140399, those portions between the flow obstacles which travel to and fro with the plank fill with a clinker layer. The effect which arises according to this conveying principle appears firstly in a bulk material bed height level with the upper limit of the flow obstacles. A type of autogenous wear protection is thereby formed on the planks of this type of cooler. Although this is advantageous for the use of this type of cooler, because the individual parts of this type of cooler do not come into contact with the closing, hot clinker layer, the formation of cold channels is not desirably reduced as a result.

[0011] A further configuration of this type of cooler is disclosed in EP1509737B1. In said document, it is emphasized that the cooler should be operated in such a way that no vertical mixing is carried out in the bulk material bed, and the height of the clinker bed should be a specific height in relation to the width of the individual planks. It is thereby expected that the transport efficiency and also the efficiency of the heat recovery would be positively influenced as a result.

[0012] In addition to the last-mentioned type of cooler, further types of a clinker cooler have been developed and, as so-called crossbar coolers, have been used in clinker cooling technology. In these types of coolers, individual drivers which protrude from a supporting grate through which cooling air flows are moved forwards and backwards. This type of cooler is described, for example, in EP 2172803B2. This type of cooler typically has wedge-shaped drivers which point in the transport direction with their virtually perpendicular side and point counter to the transport direction with their flat-tened wedge side. The transport mechanism involves applying the above-described principle of common forward movement in the transport direction and of individual backward movement. The wedge form is said to have the effect that the bulk material bed moves over the driver during the backward movement of the individual drivers, which move in relation to the ventilated supporting grate, and by contrast is pushed by the virtually perpendicular side in the conveying direction, and movement in the conveying direction.

[0013] In spite of the mixing of the bulk material bed which is produced by the drivers that move in relation to the supporting grate and plough through the bulk material bed, satisfactory recuperation rates are achieved with these types of cooler. A disadvantage of this type of cooler is the high degree of wear to which the drivers are subjected.

SUMMARY OF THE INVENTION

[0014] It is an object of the invention to provide a cooler which combines the advantages of the known types of cooler and in which the disadvantages of the known types of cooler are avoided.

[0015] The object according to the invention is achieved in that the planks have differently configured surfaces, on which the bulk material bed lies, in the conveying direction, and these surfaces, on account of their different frictional locking with the bulk material bed lying thereon, lead to mean transport speeds which differ from one another, such that as a result the bulk material bed is stretched in the region of quicker conveying and compressed in the region of slower conveying. Further advantageous configurations of the invention are given in the dependent claims. The object is achieved in terms of a process as defined in claims 8 to 9.

[0016] According to the invention, use is made of a conveying principle in which at least two adjacent planks are moved simultaneously in the conveying direction and non-simultaneously counter to the conveying direction. The disadvantage of this conveying principle, specifically the undesirable loosening of the bulk material bed over the borderline extending in the conveying direction between the planks that move in relation to one another in and counter to the conveying direction, is avoided by virtue of the fact that, given alternative stretching and compression of the layer of the bulk material bed, this loosened area is closed during stretching by bulk material which continues to flow from the side, and is closed during compression by compaction of the bulk material. In contrast to the introduction of simple flow obstacles, which leads not to a movement like a transverse wave but to the formation of a layer of the bulk material bed which moves together with the planks, this concurrently moving layer cannot form at all according to the invention, and nevertheless the formation of cold channels is prevented. The invention has
yet another advantage. Like a tumbling movement, the continuous, alternating stretching and compression leads to considerable vertical mixing of the bulk material bed, without the presence of flow obstacles which protrude into the bulk material bed. Although the established concept states that it is specifically the absence of a vertical mixing movement which leads to a particularly good recuperation rate, because the above-described thermal wedge forms as a result, it has surprisingly been found that the temperature of the spent air produced by the cooler according to the invention and the corresponding process is hotter than in the case in the prior art without differently formed surfaces. A further surprising effect is that the clinker grains and granules leaving the cooler, particularly relatively large clinker pieces, still have glowing regions much less often. In the case of conventional coolers, it can be observed specifically that, in a typical concentration, the bulk material leaving the cooler, which is generally comminuted by a crusher, has individual clinker pieces which still glow red. If the conveyer belt which is arranged at the crusher at the end of the cooler and conveys the freshly crushed clinker into a silo is observed, individual clinker pieces which still glow red are apparent depending on the quality of the clinker cooler. These undesirably carry a large amount of heat along into the clinker silo, which is not recuperated and unnecessarily burdens the silo with heat.

[0017] Within the context of the present invention, it is assumed that the established model of cross-flow cooling suitably describes the conditions in the layer of the bulk material bed when the bulk material bed has an ideal form. This means that it behaves like a fluidized bulk material bed which is nevertheless free of mixing movement. This is because the cooling air flowing through the bulk material bed can then cool each particle completely and from all sides. However, the sintered clinker has material properties in terms of thermal conduction like some ceramics, in which a glowing region can be present in the immediate vicinity of a very much colder region. It is therefore possible for a fist-sized clinker piece to still glow on one side and to have a temperature of 60°C to 80°C on the opposite side. It is also possible for hot granite cores, which are exposed only during crushing, to survive within relatively large clinker pieces. It is assumed that these hot spots can form on the clinker granules when the clinker granules partially lie in the slipstream of adjacent clinker grains on account of the fact that no mixing movement occurs. Although the established cross-flow cooling theory assumes that a mixing movement leads to relatively poor heat recuperation, it is suspected that it is precisely the mixing movement which causes better recuperation, because slipstreams resulting from the movement of the bulk material bed are avoided by active mixing upon alternative stretching and compression of the bulk material bed.

[0018] A simple configuration of the invention provides that the planks of the clinker cooler have an apparatus which carries the bulk material bed and has a ventilating floor, the plank having differently configured surfaces in the conveying direction. The surface which differs from the supporting grates as the apparatus carrying the bulk material bed is a simple smooth surface with a very small degree of frictional locking. During the common forward movement, it is not apparent that the different frictional locking of the surfaces comes into effect, but during the return movement the different surface configuration makes its presence felt in the length of the planks in the conveying direction. In an ideal concept, the bulk material bed is held in the region in which a plank moves back individually under the bulk material bed by the adjacent strip of bulk material, which lies on a plank which at that time does not move, such that, despite a return movement of the plank, the strip of the bulk material bed lying thereon remains in its position. During actual operation, however, it becomes apparent that the regions over the borderlines between the planks are loosened, which can be attributed to the fact that the strip of the bulk material bed is withdrawn over the plank moving back with a specific, non-negligible force, as a result of which the loosening is created. In regions of the plank in which the frictional locking is very low, the loosening is therefore less pronounced, and in those regions in which a supporting grate is present as the surface carrying the bulk material bed, the loosening is highly pronounced. As a result, the strip of the bulk material bed is compressed at those points with low frictional locking by the restoring force of the strips of the bulk material bed. A similar situation arises if a plank part having a surface with low frictional locking is adjacent to a plank part with high frictional locking and the adjacent part moves back. On account of the high friction of the strips of the bulk material bed over the individual planks, the strip of the bulk material bed over the plank moving back pulls the strip part of the bulk material bed over the surface with low frictional locking to the rear, where it compacts the bulk material in the rear part and loosens the bulk material in the part directed forwards. Compaction and loosening therefore takes place in each phase of the cooler movement, as a result of which a tumbling movement with vertical mixing and closure of the cold channels arises over the borderlines between the planks which move in relation to one another.

[0019] The first surfaces with particularly low frictional locking are faced by those second surfaces which preferably have overlapping profiles as the supporting grate, between which the cooling gas flows into the bulk material bed.

[0020] In a particular configuration of the invention, it is provided that one configuration of the surfaces has a wedge form, the flat end of which is oriented counter to the conveying direction. In contrast to the crossbar coolers, in which the wedges move in relation to the surface of the supporting grate and therefore represent pushing elements, it is provided here that the wedges are located permanently on the moving supporting grate. As a result of the nature of the forward movement described, the bulk material has to move over the wedge and drops down from the virtually perpendicular side of the wedge at the end of the wedge in the conveying direction. In this case, both the closure of the cold channels and the vertical mixing are further promoted. In contrast to the teaching according to DK 140399, in this case provision is made of wedges with particularly low frictional locking, rather than simple flow obstacles. As a result, an elevated, autogenous wear-resistant layer does not form between the wedges, as is the case in the flow obstacles according to DK 140399, and the wedges bring about the closure of the cold channels in addition to the vertical circulation.

[0021] Yet another variant of the invention, which reinforces the circulation effects, provides that one configuration of the surfaces has a wedge form which is inclined to the side and the flat end of which is oriented counter to the conveying direction. This surface configuration has a structure like a plough, which lies on its back and the ploughshare of which points upwards. In the event of a rearward movement, the wedges inclined to the side slide under the bulk material bed which compresses at this point in this phase, the latter slipping to the sloping side of the cooler. The part of the bulk
material bed which lies to the sloping side is thereby compressed, the borderline is filled in and the bulk material bed undergoes a rotational movement about an axis extending in the conveying direction. The bulk material bed moves like a helix from the rotary tubular kiln to the end of the cooler, one helix being present per planks. This embodiment indicated last here leads to a very intense tumbling movement and vertical mixing, admittedly at the cost of an increased transport resistance, which has to be introduced into the bulk material bed with a higher hydraulic force. The disadvantage of the increased use of hydraulic energy in terms of cost is more than compensated for by the improved heat recuperation.

[0022] In order to also improve the closing action for the plough and the borderlines, it is provided to arrange the different surfaces in regularly repetitive patterns on the bulk material transport surface of the cooler. A pattern which has improved the closing effect for the plough and the borderlines is a pattern of lines arranged obliquely to the conveying direction. In a first case, these can all be aligned, as a result of which it is possible to compensate for a unilateral discharge behaviour of the rotary tubular kiln. Rotary tubular kilns tend to separate clinker grain fractions of different sizes, the fine clinker grains and the coarse clinker grains being discharged alongside one another. Other rotary tubular kilns in turn do not discharge the burnt clinker centrally, but with lateral displacement.

[0023] In order to strengthen the plough action without producing a net transport of the bulk material bed to one or the other side of the clinker cooler, it is provided that the direction of the lines, which are bent with respect to the conveying direction, of the arrangement of the surfaces with low frictional locking alternates, i.e. they point to the left and then to the right.

[0024] In a particular configuration of the invention, it is provided that the arrangement of the surfaces with low frictional locking has an arch form, the arch being oriented symmetrically with respect to the conveying direction. The effect of this arch form is to compact the bed in the direction of the centre of the clinker cooler, depending on the selection of the surface of the form with low frictional locking. If the surface which is planar in the transport plane of the clinker cooler is selected, the tumbling movement continues in arch form. If, by contrast, the wedge form which slopes to the side is used, the conveying action towards the centre is strengthened or weakened, depending on the lateral orientation of the wedge form.

[0025] In a very particular configuration, the surfaces can also be mixed. If, by way of example, the wedge-shaped, smooth surfaces are used on the sides and the planar surfaces with smooth frictional locking are used in the centre line of the conveying direction, the transport efficiency is different between the side wall and the centre line given the same stroke and the same stroke frequency of the individual planks, and the different transport efficiency can be utilized in order to compensate for a non-uniform discharge behaviour of the rotary tubular kiln.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The invention is explained in more detail with reference to the following figures:

[0027] FIG. 1 shows a cooler according to the invention in a first configuration with planar surfaces with low frictional locking.

[0028] FIG. 2 is an enlarged detail showing the planar surface parts,

[0029] FIG. 3 shows different layouts for the different surfaces,

[0030] FIG. 4 shows a further configuration of the cooler with wedge-shaped surface parts with low frictional locking,

[0031] FIG. 5.1 is an enlarged detail showing the wedge-shaped surface parts,

[0032] FIG. 5.2 is a side view showing the wedge-shaped surface parts in the cooler transport plane.

[0033] FIG. 6 shows a third configuration of the cooler with wedge-shaped surface parts which slope to the side.

[0034] FIG. 7 is a view from the front showing the wedge-shaped surface parts which slope to the side in the cooler transport plane.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0035] FIG. 1 shows the parts of a clinker cooler 100 which are essential to the invention in a first configuration. Said clinker cooler consists of four planks 101, 102, 103 and 104, which are arranged alongside one another and extend in the conveying direction 105. The transverse side shown in the foreground is that side onto which the rotary tubular kiln discharges the clinker, and the transverse side shown in the background of the figure forms the end of the cooler. To cool the clinker, the clinker is discharged onto the front side of the clinker cooler 100, and in the process cooling air 107 flows through it, said cooling air flowing from below through the cassette-shaped inserts 110 into the bulk material bed (which is not shown here) lying on the cooler 100. The cassette-shaped inserts have overlapping profiles through which the cooling air 107 flows but through which the clinker cannot drop from above. Smooth surface structures with second inserts 115 alternate with the cassette-shaped inserts 110. These inserts 115 can also be provided with cooling air openings. It is important that the fractional locking of the surfaces of the second inserts 115 having a smooth surface differs considerably from the fractional locking of the cassette-shaped inserts 110, since it is only as a result of the different frictional locking along the transport surface of the cooler 100 that the compacting and re-loosening action described above takes effect, as a result of which a tumbling movement of the bulk material bed is produced, which leads to vertical mixing and which regularly closes the borderlines over the planks arranged alongside one another when said borderlines are torn open when two planks 101, 102, 103 and 104 move in relation to one another.

[0036] The inserts 115 with low frictional locking are shown in the enlarged detail in FIG. 2. These replace the cassette-shaped inserts 110 at regular intervals, such that an alternatively compacting and re-loosening action is established at those points in the strip of the bulk material bed over the planks 101, 102, 103 and 104 where the second inserts 115 are arranged.

[0037] In addition to the form of the surface configuration of the inserts 115, the arrangement thereof in the cooler transport plane is also the cause of the different surface configurations. The simplest type of arrangement, as shown in Subfigure 3a, is a regular alternation of cassette-shaped inserts 110 having overlapping profiles, which are laid slightly deeper in order to form a depression for an autogenous wear-resistant layer in the recess, and second inserts having a virtually planar surface. This arrangement leads to
an almost peristaltic tumbling movement of the bulk material in the strips of the bulk material bed which lie over the individual planks 101, 102, 103 and 104.

[0038] In addition to the regular alternation over the entire width of the cooler, it is also possible to arrange the second surfaces 115 with low frictional locking obliquely with respect to the cooler transport direction 105, as shown in Subfigure 3b. In order to avoid a net conveying effect to the side of the cooler, it is possible to regularly alternate the oblique arrangement, such that the tumbling movement acts to one side and then to the other side of the cooler 100.

[0039] Subfigure 3c, finally, shows an arrangement showing a net conveying effect to the side if the tumbling movement is not distributed symmetrically, as shown in Subfigure 3a, but rather disymmetrically over the cooler transport surface.

[0040] Subfigure 3d, finally, shows an arch-shaped arrangement of the second surfaces 115, the arches being arranged symmetrically about the centre line of the conveying direction 105.

[0041] FIG. 4 shows a configuration of the cooler according to the invention as a cooler 200, which likewise has four planks 201, 202, 203 and 204 which lie alongside one another and extend in the conveying direction 205. In this case, the cooling area penetrating from below not being shown for simplification. In contrast to the cooler shown in FIG. 1, the second surfaces 215 in this cooler have a wedge-shaped configuration, are arranged fixedly on the planks 201, 202, 203 and 204 and do not move as in the case of a cooler type which appears to be extremely similar, in which the wedge-shaped pushing elements move in relation to the plank surface. In the arrangement shown here, the virtually perpendicular surfaces 216 point in the conveying direction 205 and the flat ends of the wedges 217 point counter to the conveying direction. Upon common forward movement, the action of the perpendicular surfaces 216 does not have an effect, because the entire bulk material bed moves forwards on the cooler 200. When individual planks 201, 202, 203 or 204 are withdrawn, the second, wedge-shaped inserts 215 slide under the strip of the bulk material bed located over the plank moving counter to the conveying direction 205, and in the process lift the strip of the bulk material bed over themselves, and the bulk material bed drops over the virtually perpendicular edge 216, the bulk material bed is compacted and in the process also undergoing vertical mixing. In contrast to the flow obstacles according to DK 140399, in this case the bed is gently lifted by a wedge with low frictional locking and circulated, with no depression being formed between the individual wedges which is filled with a layer of the bulk material bed stationary over the planks.

[0042] The arrangement of the wedge-shaped inserts 215 in the cooler 200 which is otherwise equipped with casette-shaped inserts 110 provided with overlapping profiled elements is shown in an enlarged detail in FIG. 5.1, which shows the arrangement of the virtually perpendicular side over which the bulk material emerges when the individual planks 201, 202, 203 and 204 are withdrawn.

[0043] FIG. 5.2, finally, is a sketched side view showing the cooler transport plane of the cooler 200, the wedge-shaped inserts 215 protruding slightly over the cooler transport plane.

[0044] FIG. 6. finally, shows a third configuration of the cooler as a cooler 300, in which the cooling air penetrating from below not being shown for simplification compared with the illustration in FIG. 1. In this configuration, the second inserts 315 of the cooler, which is otherwise identical to coolers 100 and 200, are in the form of wedges which slope to one side. When individual planks 301, 302, 303 or 304 are withdrawn, the second insert 315 with low frictional locking compared to the cassette-shaped inserts 110 slides under the bulk material bed, which is compacted to the sloping side and then drops over the edge of the second insert 315 which points in the conveying direction. When the second insert 315 is pulled through the bulk material bed, this creates a shovel plough-like action, as a result of which the bulk material is moved like a helix in the conveying direction, and in the process undergoes considerable vertical mixing. The mixing always exposes those parts of the surface of the clinker with poor thermal conductivity which still contain surface heat. As a result, this heat can be recuperated and the overall efficiency of the clinker cooler increases.

[0045] It is possible to alternate the rotational movement of the clinker in the strip of the bulk material bed over a respective plank 301, 302, 303 and 304, in order to thereby prevent a net conveying action to the side, and it is also possible to keep the rotational movement uniform by identical orientation of the wedges to the side, in order to thereby obtain desired net conveying to the side.

[0046] The concept of the invention relates to a deliberate disruption of the moving floor conveyor known per se, in order firstly to be able to avoid fluidization of the bulk material bed but also nevertheless to avoid the situation where hot, non-fluidized clinker granules are in the slipstream of others and therefore cannot emit their heat. In order to achieve this, it is possible to select the planar or the wedge-shaped surface parts or the wedge-shaped surface parts with an orientation which slopes to the side as surface parts, and to arrange these in different layout patterns in the cooler transport plane. In this way, the advantages of some types of cooler, such as for example the recuperation efficiency, are retained and other disadvantages, such as moving elements in the hot layer of the bulk material bed, are not present. Loosened areas which are inherent to the transport system over the borderline between the individual strips of the bulk material bed, and which arise in particular in the case of small bulk material bed heights, are closed or the formation thereof is suppressed.

[0047] As is apparent from the foregoing specification, the invention is susceptible of being embodied with various alterations and modifications which may differ particularly from those that have been described in the preceding specification and description. It should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of my contribution to the art.

LIST OF REFERENCE SYMBOLS

| 100 | Clinker cooler |
| 101 | Plank |
| 102 | Plank |
| 103 | Plank |
| 104 | Plank |
| 105 | Conveying direction |
| 107 | Cooling air |
| 110 | Insert |
| 115 | Insert with low frictional locking |
| 200 | Clinker cooler |
| 201 | Plank |
| 202 | Plank |
1. A cooler for cooling hot bulk material, in which cooling gas flows approximately transversely to the conveying direction through a bulk material bed and in the process takes up the heat of the bulk material, wherein an apparatus which carries the bulk material bed has a ventilation floor comprising movable planks which extend in the conveying direction through which cooling gas flows, and wherein the conveying principle provides for at least two adjacent planks being moved simultaneously in the conveying direction and non-simultaneously counter to the conveying direction, comprising:

the planks having differently configured surfaces on which the bulk material bed lies, in the conveying direction, and these surfaces, on account of their different frictional locking with the bulk material bed lying thereon, lead to mean transport speeds which differ from one another, such that as a result the bulk material bed is stretched in a region of quicker conveying and compressed in a region of slower conveying.

2. The cooler according to claim 1, wherein a first configuration of the differently configured surfaces is planar, and a second configuration of the differently configured surfaces is a supporting grate, which has overlapping profiles between which cooling gas flows into the bulk material bed.

3. The cooler according to claim 1, wherein one configuration of the surfaces has a wedge form, the flat end of which is oriented counter to the conveying direction.

4. The cooler according to claim 1, wherein the differently configured surfaces alternate at regular intervals along the conveying direction.

5. The cooler according to claim 1, wherein the differently configured surfaces are arranged in an oblique pattern with respect to the conveying direction.

6. Cooler according to claim 1, wherein the differently configured surfaces form an arch pattern, the arches being arranged symmetrically with respect to the conveying direction.

7. A process for cooling hot bulk material, comprising the steps:

- transporting the bulk material as a bulk material bed via a ventilation floor,
- flowing a cooling gas approximately transversely to a conveying direction through the bulk material bed,
- providing planks which extend in the conveying direction as the ventilation floor, and
- moving at least two adjacent planks simultaneously in the conveying direction and non-simultaneously counter to the conveying direction,

wherein the planks have differently configured surfaces, on which the bulk material bed lies, in the conveying direction, and these surfaces, on account of their different frictional locking with the bulk material bed lying thereon, lead to mean transport speeds which differ from one another, such that as a result the bulk material bed is stretched in a region of quicker conveying and compressed in a region of slower conveying.

8. The process according to claim 7, wherein one configuration of the surfaces has a wedge form which is inclined to the side and a flat end of which is oriented counter to the conveying direction.

9. The process according to claim 7, wherein the differently configured surfaces alternate at regular intervals along the conveying direction.

10. The process according to claim 7, wherein the differently configured surfaces are arranged in an oblique pattern with respect to the conveying direction.

11. The process according to claim 7, wherein the differently configured surfaces form an arch pattern, the arches being arranged symmetrically with respect to the conveying direction.

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