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G. BOJNER

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ROTARY DRIER, KILN AND THE LIKE

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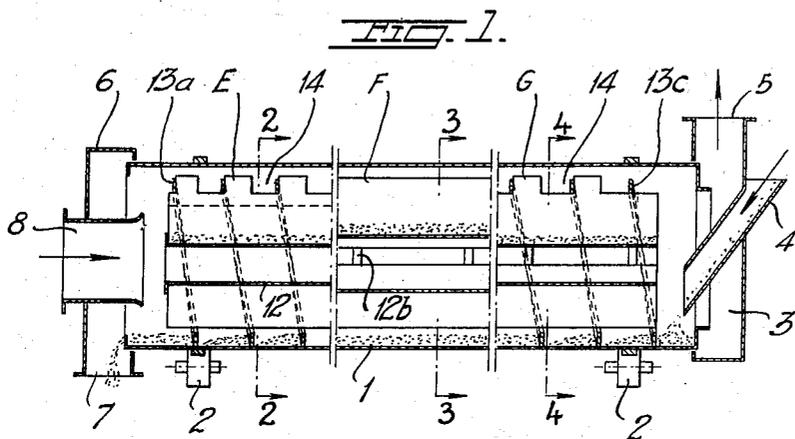
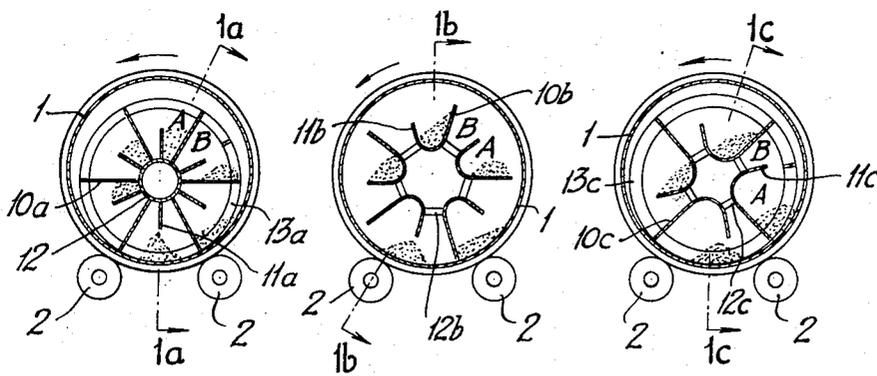


FIG. 2.

FIG. 3.

FIG. 4.



Inventor
Gustav Bojner
by Sommers & Young
Attorneys

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ROTARY DRIER, KILN, AND THE LIKE

Gustav Bojner, Stockholm, Sweden

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12 Claims. (Cl. 34-137)

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This invention relates to rotary driers or kilns for drying or other heat treatment of granular or pulverulent or similar materials.

In my copending application Serial No. 131,217 filed December 5, 1949, I have described an improvement of such rotary driers or kilns, in which a rotary drum contains an inset or cage formed of substantially radial partitions dividing the interior of the drum into longitudinal channels through which the goods to be dried and a drying gas pass in direct contact with each other, the material being advanced through the channels while performing a revolving movement therein. According to the invention as illustrated in said copending application, alternate partitions have different radial length, the long partitions serving chiefly to catch the goods when moving upwards, whereas the short partitions allow a communication between adjacent channels; and the inner ends of each long partition and the next short partition in front of said long partition are interconnected by means of closed wall elements. Essentially on account of the fact that the channels formed between said two partitions are closed towards the centre of the drum, at least one side of the partitions will remain substantially free from material and thus an improved supply of heat from the drying gas to the partitions as well as to the material adhering to the opposite side will be obtained.

An object of the present invention is to create a still further improvement of apparatus of the type set forth above, especially in connection with the treatment of material of sticky nature, by the provision of a strip extending helically around the cage at the outer edges of the long partitions. Such a feed screw does cause not only a positive advance of the material through the drum but also an increase of the effective heat transfer area as the front side of the feed screw contacts the material to be dried while being cooled, whereas the screw on the free path above the level of the material is heated by the drying gas. Moreover, the screw will prevent the sticky material from remaining on the mantle surface of the drum and will also impart a turbulent movement to the gas, thus reducing the lamina flow of the gas.

Another object of the invention is to create an improvement of apparatus of the type set forth above by the provision of recesses in the outer edges of the longer partitions, said strip extending through said recesses. By a proper selection of the longitudinal extent of said recesses the amount of material fed by the screw can be adjusted in relation to the amount of material caught by the longer partitions.

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A further object of the invention is to create an improvement of apparatus of the type set forth above by avoiding central tubes or similar elements and providing gutters spaced apart so as to leave free spaces between themselves both at the center and in the peripheral direction, said gutters being mounted so as to present their rounded closed bottom portions towards the center of the drum and their open sides towards the circumference of the drum. Such freely spaced gutters allow a free flowing of the gas around the feed screw and the channel system, thus an improved drying effect. Moreover, the costs of manufacturing the cage are reduced and corners are avoided in which the material to be dried could stick.

According to another feature of this invention a strip is provided, extending helically around the cage through recesses made in the edges of the partitions.

Some embodiments of the invention are by way of example illustrated in the accompanying drawing, in which:

Fig. 1 is a longitudinal central section of a rotary drier or kiln, in which three different embodiments of cages according to the invention are shown, the left portion of Fig. 1 being a section on the line 1a-1a of Fig. 2, the intermediate portion of Fig. 1 being a section on the line 1b-1b of Fig. 3, and the right portion of Fig. 1 being a section on the line 1c-1c of Fig. 4;

Fig. 2 is a cross-section on the line 2-2 of Fig. 1;

Fig. 3 is a cross-section on the line 3-3 of Fig. 1;

Fig. 4 is a cross-section on the line 4-4 of Fig. 1.

Referring now to the drawing, the drum 1 which is rotatably journalled on rollers 2, is provided at one end with a stationary chamber 3 having an inlet chute 4 for the moist goods to be treated and an outlet 5 for the drying gas, and at the other end with a stationary chamber 6 having an outlet 7 for the dried material and an inlet 8 for hot drying gas. In the drum 1 three somewhat different inset bodies or cages E, F, G are shown, all of said cages being loosely mounted in the drum so that they can rotate or roll within the drum when the latter rotates, while suitable guiding means (not shown) in the drum prevent them from moving axially.

The cage E, shown in cross-section in Fig. 2 is composed of a central core 12 preferably made as a tube and the radial partitions 10a and 11a, extending from said core. The partitions 10a have a radial length greater than the radial

length of the partitions 11a but less than the difference between the radii of the drum and the core. Thus, the cage will obtain a somewhat eccentric position in the drum when resting against the lower portion of the mantle, for instance with two of its partitions 10a as shown in Fig. 2. The partitions 10a and 11a divide the interior of the drum into longitudinal substantially sector-shaped channels A and B, and the partitions 11a should be of such a short length that they do not catch the material to be dried when the drum is charged to a normal height. Around the cage a strip 13a of sheet material or the like extends helically at a suitable pitch, said strip forming a feed screw for accelerating the advancing movement of the material through the drum in such cases in which the inclination or rotational speed of the drum is not sufficient or the properties of the material to be dried are such that an additional advancing force is required. The intermediate cage F, shown in cross-section in Fig. 3, comprises longitudinally extending gutters 10b, 11b of curved sheet material or the like, the two walls 10b and 11b of each gutter terminating at different distances from the mantle of the drum and, thus, corresponding to the partitions 10a and 11a, respectively, of Fig. 2. The gutters are joined together by means of strut-like members 12b so as to constitute a structural unit, no central core being provided. The third cage G, shown in cross-section in Fig. 4, is similar to the cage F, thus comprising gutters 10c, 11c joined together by the members 12c, but combined with a feed screw 13c of the same type as in Fig. 2.

In operation the three cages E, F, G will act substantially in the same manner. When the drum is rotating the material supplied is caught by the partitions 10a, 10b, 10c, respectively, and is advanced chiefly through the channels A while performing a rolling movement, thereby being dried by the drying gases flowing through the drum. As according to my said prior application substantially only one side of the partitions will be covered by the material, viz. the side of the long partitions facing forwards in the direction of rotation, and the side of the short partitions facing rearwards in the direction of rotation, whereas the opposite side will remain substantially free from the material and will be able to receive heat from the drying gases flowing in direct contact with said last-mentioned side, so that the partitions are effectively heated and a rapid drying of the boundary layer of any material adhering to the partitions is produced, thus causing the latter to loosen.

When the cage is combined with a feed screw, as are the cages E and G, each longer partition 10a or 10c, respectively, should be provided with recesses 14 for each convolution of the strip 13a or 13c forming the feed screw, each such recess extending forwards in the direction of advance through the drum and having its axial extension selected according to the kind of material to be dried. Thus, according to the size of said recesses a different amount of material to be dried is fed by the feed screw, while the remaining part of the material is caught by the longer partitions. Irrespective of the proportions of the amounts fed by the screw and caught by the partitions, respectively, mixing of the materials is apparently effected when the materials fall from the partitions onto the lower portion of the mantle of the drum, whereby a uniform drying action is obtained.

The cages E, F, G are caused to rotate together with the drum by their friction against the inner surface of the mantle or by means of suitable tappets (not shown) and perform a slow stepwise rotation in the drum, whereby the loosening of any material adhering to the partitions of the cage is accelerated. The longer partitions impact against the inner surface of the mantle and strike said surface along axial lines of contact, whereby also any material adhering to the mantle is loosened. As the cages have a diameter of rolling smaller than the diameter of the mantle, the cages will evidently rotate or roll somewhat more than one revolution while the drum performs one revolution.

The provision of several different cages in the drum as shown in the drawing, is not essential to the invention inasmuch as the drum may be provided with two or more cages of the same structure or with one single cage extending substantially along the whole length of the drum. Moreover, the constructional details in carrying out the invention may be varied without departing from the scope of the invention.

The cages according to the invention may be mounted in already existing driers or rotary kilns and may be applied also to rotary kilns for burning cement or lime, a cage according to the invention then being provided in the inlet end of the kiln tube, and the sector system preferably being made of fire-proof sheet metal or other refractory material.

What I claim is:

1. An apparatus for the treatment of pulverulent materials to be dried, comprising, in combination, a drum rotatable in a predetermined direction, a cage mounted in said drum and including substantially radial partitions of alternately different lengths in the radial direction, dividing the interior of the drum into longitudinal channels for the passage of material to be dried and of a drying gas in direct contact with each other, the space between each long partition and the next short partition in the direction of rotation being closed towards the center, and a single strip extending helically around the cage at the outer edges of the long partitions for rotation together with the cage.

2. An apparatus for the treatment of pulverulent materials to be dried, comprising, in combination, a drum rotatable in a predetermined direction, a cage loosely mounted in said drum in an eccentric position and including substantially radial partitions of alternately different lengths in the radial direction, dividing the interior of the drum into longitudinal channels for the passage of the material to be dried and of a drying gas in direct contact with each other, the space between each long partition and the next short partition in the direction of rotation being closed towards the center, and a single strip extending helically around the cage at the outer edges of the long partitions for rotation together with the cage.

3. An apparatus for the treatment of pulverulent materials to be dried, comprising, in combination, a cylindrical drum rotatable in a predetermined direction, a cage mounted in said drum and consisting of substantially radial partitions of alternately different lengths in the radial directions, dividing the interior of the drum into longitudinal channels for the passage of material to be dried and of a drying gas in direct contact with each other, the space between each long partition and the next short partition in

the direction of rotation being closed towards the center, recesses being provided in the outer edges of said long partitions, and single strip extending helically around the cage through said recesses for rotation together with the cage, and passing a quantity of the pulverulent material through said recesses.

4. An apparatus for the treatment of pulverulent materials to be dried, comprising, in combination, a cylindrical drum rotatable in a predetermined direction, a cage loosely mounted in said drum in an eccentric position and consisting of substantially radial partitions of alternately different lengths in the radial direction, dividing the interior of the drum in longitudinal channels for the passage of material to be dried and of a drying gas in direct contact with each other, the space between each long partition and the next short partition in the direction of rotation being closed towards the center, recesses being provided in the outer edges of said long partitions, and a single strip extending helically around the cage through said recesses for rotation together with the cage and passing a quantity of the pulverulent material through said recesses.

5. An apparatus for the treatment of pulverulent materials to be dried, comprising, in combination, a cylindrical drum rotatable in a predetermined direction, a cage mounted in said drum, including a plurality of longitudinally extending gutters having closed bottom portions and mounted so as to present their closed bottom portions towards the center of the drum and their open sides towards the circumference of the drum, said gutters being spaced apart so as to leave free spaces between themselves extending from the center to the circumference of the drum and dividing the interior of the drum in longitudinal channels for the passage of material to be dried and of a drying gas in direct contact with each other, each gutter having its rear wall in the direction of rotation extending over a greater radial length than its front wall, and a strip extending helically around the cage for rotation together with the same.

6. An apparatus for the treatment of pulverulent materials to be dried, comprising, in combination, a cylindrical drum rotatable in a predetermined direction, a cage loosely mounted in said drum in an eccentric position and including a plurality of longitudinally extending gutters having closed bottom portions and mounted so as to present their closed bottom portions towards the center of the drum and their open sides towards the circumference of the drum, said gutters being spaced apart so as to leave free spaces between themselves extending from the center to the circumference of the drum and dividing the interior of the drum in longitudinal channels for the passage of material to be dried and of a drying gas in direct contact with each other, each gutter having its rear wall in the direction of rotation extending over a greater radial length than its front wall, and a strip extending helically around the cage for rotation together with the same.

7. An apparatus for the treatment of pulverulent materials to be dried, comprising, in combination, a drum rotatable in a predetermined direction, a cage mounted in said drum and including a plurality of longitudinally extending gutters having closed bottom portions and mounted so as to present their closed bottom portions towards the center of the drum and their open sides towards the circumference of the drum, said gutters

being spaced apart so as to leave free spaces between themselves extending from the center to the circumference of the drum and dividing the interior of the drum in longitudinal channels for the passage of material to be dried and of a drying gas in direct contact with each other, each gutter having its rear wall in the direction of rotation extending over a greater radial length than its front wall, recesses being provided in the outer edges of said rear walls, and a strip extending helically around the cage for rotation together with the same, and passing a quantity of the pulverulent material through said recesses.

8. An apparatus for the treatment of pulverulent materials, comprising, in combination, a cylindrical drum rotatable in a predetermined direction, a cage loosely mounted in said drum in an eccentric position and including a plurality of longitudinally extending gutters having rounded closed bottom portions and mounted so as to present their closed bottom portions towards the center of the drum and their sides towards the circumference of the drum, said gutters being spaced apart so as to leave free spaces between themselves extending from the center to the circumference of the drum and dividing the interior of the drum in longitudinal channels for the passage of material to be dried and of a drying gas in direct contact with each other, each gutter having its rear wall in the direction of rotation extending over a greater radial length than its front wall, recesses being provided in the outer edges of said rear walls, and a strip extending helically around the cage for rotation together with the same, and passing a quantity of the pulverulent material through said recesses.

9. An apparatus for the treatment of pulverulent materials to be dried, comprising, in combination, a cylindrical drum rotatable in a predetermined direction, a cage mounted in said drum and including a plurality of longitudinally extending gutters having rounded closed bottom portions and mounted so as to present their closed bottom portions towards the center of the drum and their open sides towards the circumferences of the drum, said gutters being spaced apart so as to leave free spaces between themselves extending from the center to the circumference of the drum and dividing the interior of the drum in longitudinal channels for the passage of material to be dried and of a drying gas in direct contact with each other, each gutter having its rear wall in the direction of rotation extending over a greater radial length than its front wall.

10. An apparatus for the treatment of pulverulent materials to be dried, comprising, in combination, a cylindrical drum rotatable in a predetermined direction, a cage loosely mounted in said drum in an eccentric position and including a plurality of longitudinally extending gutters having rounded closed bottom portions and mounted so as to present their closed bottom portions towards the center of the drum and their open sides towards the circumference of the drum, said gutters being spaced apart so as to leave free spaces between themselves extending from the center to the circumference of the drum and dividing the interior of the drum in longitudinal channels for the passage of the material to be dried and of a drying gas in direct contact with each other, each gutter having its rear wall in the direction of rotation extending over a greater radial length than its front wall.

11. An apparatus for drying sticky materials

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with hot gases, comprising, a substantially cylindrical drum rotatable in a predetermined direction, and a freely rotatable unit loosely mounted in the drum and having an eccentric position therein for rolling within the drum and performing a scraping and cleaning action on the inside of the drum, said unit consisting of a plurality of longitudinally extending gutters spaced substantially uniformly in circular relation to each other, presenting their concave surfaces towards the circumference of the drum, each gutter having its rear wall in the direction of rotation extending over a greater radial length than does its front wall, thereby permitting the sticky materials to get in contact only with the concave surfaces of the gutters and the hot gas to flow around both sides of the gutters, each long wall of the gutters having recesses in the outer edges, and a single strip secured to said unit and extending helically around said unit through said recesses for rotation together with said unit and moving a quantity of sticky material forward in proportion to the size of said recesses.

12. An apparatus for drying sticky materials by hot gases, comprising, in combination, a substantially horizontal rotatable drum for feeding

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the sticky material and the hot gases in one longitudinal direction through the same, and a loosely rolling unit in said drum, comprising a helically wound metal strip, only the feeding surface of the strip being in contact with the sticky material when passing through the lower portion of the revolution, and the entire strip surface being in contact with the gas when passing through the upper portion of the revolution.

GUSTAV BOJNER.

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