ABSTRACT OF THE DISCLOSURE

A kiln or furnace containing a plurality of platforms for both supporting a granular feed and moving the feed from the inlet to the outlet of the kiln. The platforms are mounted in the kiln in a manner such that the spaces between is minimal and the upstream end thereof is free of support. The kiln has, about an axis of rotation through the downstream end of the platform, with adjacent platforms simultaneously moving in opposite directions.

This invention relates to furnaces or kilns and more particularly to a new and improved furnace or kiln which provides for movement of a granular feed therethrough.

The kiln generally employed for treating granular materials at high temperatures is either a travelling grate or rotary kiln, and both types have particular disadvantages. The travelling grate kiln is expensive and provides poor heat transfer rates to the granular feed since there is no provision for renewal of the feed surface. Thus, only the topmost layer receives intense heating by radiation or convection and heating of the remainder of the feed is provided by generally ineffective particle to particle conduction. As a result of the heat transfer limitations, only shallow layers of feed may be employed, and this results in the use of large and expensive installations. Furthermore, even in such installations there is a low heat transfer rate in terms of B.t.u./hr. ft.

The rotary kiln permits a very high heat transfer rates but this type of kiln control of temperature and heat flux patterns is difficult. Thus, in large kilns, firing is possible only at one end of the kiln and attempts to compensate for this limitation by using auxiliary air jets inside the kiln to provide distributed combustion is not satisfactory for the following reasons:

1. Only gaseous fuels or light oils may be employed.
2. The heat released at the multiple air injection points is only a small portion of the total heat released by the burner.
3. The maintenance of a strong reducing atmosphere is virtually impossible.

Furthermore, there are certain size limitations associated with a rotary kiln because of the difficulty of building a self supporting rotatable structure having a diameter greater than about 20 feet. In addition, tight sealing of the ends of a rotary kiln are difficult, particularly if leakage of air into the kiln is to be avoided or if the kiln is to be operated at a pressure slightly greater or less than atmospheric pressure. Moreover, the combination of constant rotation and the large thickness of the burden or charge results in considerable size degradation thereof.

Accordingly, an object of this invention is to provide a new and improved furnace or kiln.

Another object of this invention is to provide a kiln wherein the surface of the feed may be renewed.

A further object of this invention is to provide a kiln wherein heat and temperature profiles may be controlled.

Yet another object of this invention is to provide a kiln that is less costly and easier to maintain.

These and other objects of this invention should be apparent from the following detailed description of the invention when read with reference to the accompanying drawings wherein like numerals designate like parts throughout and wherein:

FIG. 1 is a schematic elevational view of a kiln or furnace incorporating the invention;
FIG. 2 is an elevational view of a drive mechanism for the kiln or furnace of FIG. 1;
FIG. 3 is an elevational view of another drive mechanism for the kiln or furnace of FIG. 1;
FIG. 4 is a side view of the drive mechanism of FIG. 3; and
FIG. 5 is an elevational view of another drive mechanism for the kiln or furnace of FIG. 1.

The objects of this invention are broadly accomplished by providing a furnace or kiln with a plurality of platforms wherein each platform is oscillated in a circular arc with adjacent platforms moving in opposite directions over the path of the arc during the oscillating cycle. The feed for the kiln is introduced onto a platform at one end of the kiln and as a result of the oscillation of the platforms is moved from platform to platform to the discharge end of the kiln. The accurate path of the platform is limited to provide for gentle intermittent rolling of the material across the platform. The invention will now be described in further detail with reference to the specific embodiments thereof illustrated in the drawings. It is to be understood, however, that these embodiments are only illustrative of the invention and are not intended to limit the scope thereof.

Referring now to the drawings, there is shown a kiln or furnace 10, provided with a plurality of burners 11 for effecting heating of a granular material, a feed inlet 12, a product outlet 13, a combustion gas outlet 14 and a product outlet 15 for fines. The kiln is shown as having a rectangular cross-section and as being inclined at a slight angle with respect to the horizontal. The kiln, burners, outlets, etc., have only been schematically indicated and the particular shape, positioning, etc., of such parts form no part of the invention and such details are deemed to be within the scope of those skilled in the art. Thus, for example, the kiln may operate with external firing or as a recuperator, i.e., hot gas being introduced through a suitable duct. As previously noted, the present invention is particularly directed to the combination of a kiln or furnace with a particular type of platform for both supporting the feed to the furnace or kiln and effecting passage thereof from the inlet to the outlet.

The interior of the kiln is provided with platforms or grates 21 of a width such that they encompass the entire cross-sectional area of the kiln. The platforms 21 are comprised of a metal base portion 22 and a refractory upper portion 23, the upstream ends of the platforms 21 having a greater thickness than the downstream ends thereof. The platforms 21 are mounted, as hereinbefore described, so that the upstream ends thereof are free to oscillate about an axis 24 passing through the upper edge of the downstream portion of the platforms. The platforms 21 are provided with thickened upstream ends so that during rotation thereof to a raised position, as hereinbefore described, the upstream (moving) end remains close to the next adjacent platform, thereby preventing spillage.

The platforms 21 are positioned in the kiln 10 in a manner such that the spacing between adjacent platforms 21 is minimal; i.e., the platforms almost touch each other, and the axis 24 of the platforms 21 lie in a single plane, the plane generally having a downwardly sloping angle between about 5° and about 10° in the downstream direction. The platforms 21 are mounted in the kiln by the means of trunnions 25 mounted on the axis 24 of the platforms 21 and protruding through circular
slots in the outer wall of the kiln 10, as hereinafter more fully described with respect to the embodiment of FIG. 4.

The platforms 21 are linked together in pairs so that as one platform is moving upwards in the oscillating path, the other platform is moving in the opposite direction. As shown in FIG. 2, an upwardly extending rocking arm 31 has one end thereof rigidly connected to the trunnion 25 of the upstream platform indicated as A, and a downwardly extending rocking arm 32 has one end thereof rigidly mounted to the trunnion 25 of the downstream platform indicated as B. A link arm 33 is connected to the other ends of rocking arms 31 and 32 by pins 34 and 35, respectively. The link arm 36 is connected to the link arms 33 and rocking arm 32 through the pin 35 and to a reciprocating drive rod 37 by a pin 38. The drive rod 37 is reciprocated by a suitable drive means, schematically indicated by 39. It should be apparent that the particular arrangement of the driving mechanism facilitates movement of the platforms, since the platforms in each pair counterbalance each other. The driving mechanism for the platforms, illustrated in FIG. 2 is exterior to the wall of the kiln.

In operation, movement of the drive rod 37 in the direction of the arrow D will cause platform A to rotate in a downward path about its axis 24 and platform B to rotate in an upward path about its axis 24. Movement of the drive rod 37 in the direction of the arrow C will cause platform A to rotate in an upward path about its axis 24 and platform B to rotate in a downward path about its axis 24. Thus, as the drive rod 37 moves in the direction of the arrow C, the platform A moves into a raised position and the material thereon passes over the downstream edge onto the upstream edge of the platform B which is in a lowered position. As the drive rod 37 moves in the direction of the arrow D, the platform B is moved to a raised position and the material thereon passes over the downstream edge onto the upstream edge of the platform A of the next pair of platforms, the platform A now being in a lowered position. In this manner, the feed material is moved from the inlet end of the furnace or kiln to the outlet end, with frequent renewal of the feed surface.

The extent of the arc of rotation of the platforms 21 may be varied depending upon the sphericity and uniformity of the granules, the slope of the kiln, the angle at which the kiln and the platform and the desired average depth of the granules on each platform. In general, for a well-rounded charge of granules, the angle of oscillation is between about 10° and about 20°. Further control over the high temperature kiln may be exercised by controlling the relationship between the speed at which the platforms are oscillated and the rate at which feed is introduced. The correlation of these operating conditions is deemed to be well within the scope of those skilled in the art from the teachings contained herein.

The platforms of the kiln may be formed entirely of a suitable metal; e.g., iron or a suitable high temperature alloy, or may be covered with insulation and/or refractory material for high temperature service, as shown with respect to the embodiment of FIG. 1. The platforms may also be provided with side walls; e.g., formed from a refractory material. In the event of operation at severely high temperatures, cooling of the metal parts of platforms may be necessary and such cooling may be effected by mounting the kiln above ground level on an open frame so that heat may freely radiate from the bottom of the platforms. Alternatively, a suitable heat transfer medium, e.g., air or other cooling gas, may be passed below the platforms to effect cooling thereof. These and other methods of effecting cooling of the platforms are deemed to be within the scope of those skilled in the art.

It is to be understood that the hereinabove described kiln or furnace may be varied within the spirit and scope of the invention. Thus, for example, a drive mechanism other than the type particularly described may be employed for providing oscillation of the platforms.
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5 the invention, unlike a rotary kiln, indirect firing or multiple burners to achieve a desired heat input profile may be employed. In addition, the operation is simpler than a rotary kiln, in that the majority of the heavy parts and refractory are stationary, resulting in reduced maintenance requirements and more facile sealing. In addition, the size restrictions associated with a rotary kiln are eliminated.

Many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In combination with a furnace, having an inlet means at one end and an outlet means at the other, a plurality of platforms mounted in the furnace between the inlet and outlet means for transporting a material to be treated in the furnace from the inlet to the outlet means, said platforms being positioned adjacent each other so that the space therebetween is minimal, drive means to oscillate said platforms in a limited arcuate path about an axis through the upper portion of the end of the platform nearest the outlet means, said drive means simultaneously moving adjacent platforms in opposite directions on the arcuate path and limiting the movement thereof to provide gentle rolling of a material from platform to platform.

2. The combination as defined in claim 1 wherein the drive means includes an upwardly extending arm connected to one of a pair of platforms, a downwardly extending arm connected to the other of the pair of platforms, a reciprocating rod, and connection means linking the upwardly extending arm and downwardly extending arm to each other and to the reciprocating rod.

3. The combination as defined in claim 2 wherein the upwardly and downwardly extending arms are mounted at the axes about which the platforms oscillate.

4. The combination as defined in claim 1 wherein the platforms are mounted in the furnace by trunnions, said trunnions being located at the axes on which the platforms oscillate, and the axes of the platforms lie in a single plane.

5. The combination as defined in claim 1 wherein the drive means includes a pair of reciprocating rods, means to move the rods in opposite directions, connection means linking the platforms to the pair of reciprocating rods, adjacent platforms being linked to different rods whereby the adjacent platforms are oscillated in opposite directions.

6. The combination as defined in claim 5 wherein the connection means are linked to the platforms at the lower portion of the end of the platform nearest the inlet means.

7. The combination as defined in claim 1 wherein the drive means includes, a rocker plate, a first rocker arm connected to one of a pair of platforms and to one end of the rocker plate, a second rocker arm connected to the other end of the rocker plate and the other of the pair of platforms, means pivotally mounting the rocker plate, a reciprocating rod, and connection means connecting the reciprocating rod to the rocker plate whereby movement of the reciprocating rod simultaneously moves the pair of platforms in opposite directions.

8. The combination as defined in claim 7 wherein the first and second rocker arms are connected to the platforms at the lower portion of the end of the platform nearest the inlet means.

9. The combination as defined in claim 1 wherein the platforms are thicker at the end nearest the inlet means.

10. The combination as defined in claim 1 wherein the platforms contain side walls.

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