May 6, 1969 R. D. GANTZ 3,442,497

HEAT TRANSFER ELEMENTS FOR ROTARY KILNS

Filed June 5, 1967

FIG. 1

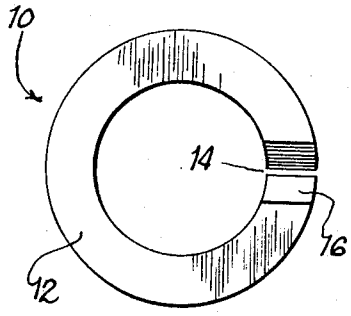


FIG. 2

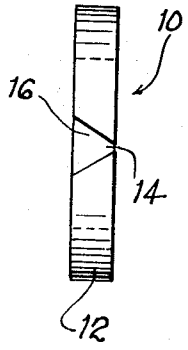


FIG. 3

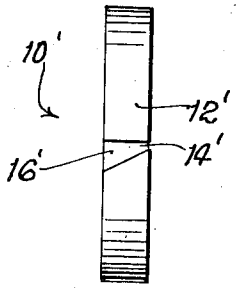


FIG. 4

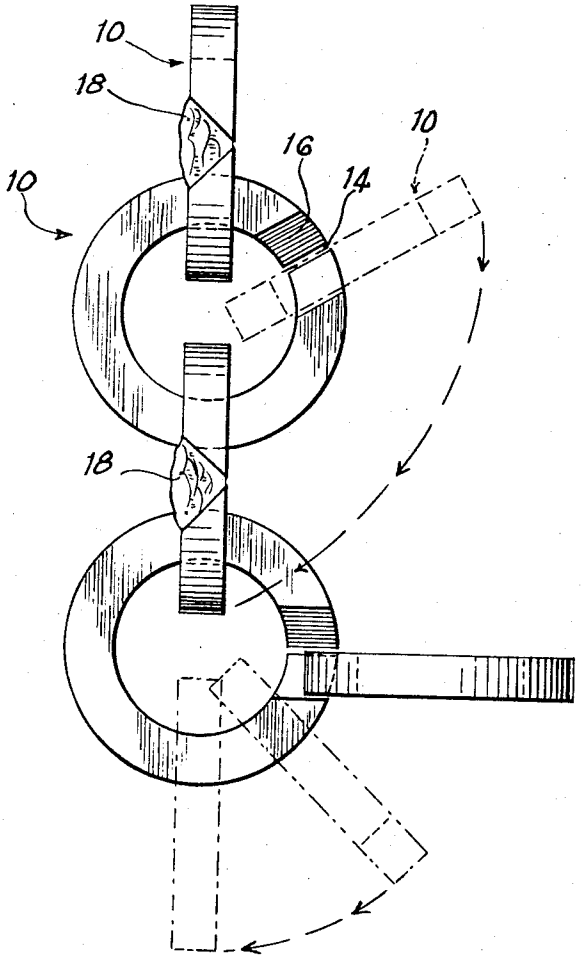
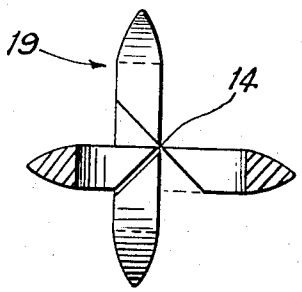


FIG. 5



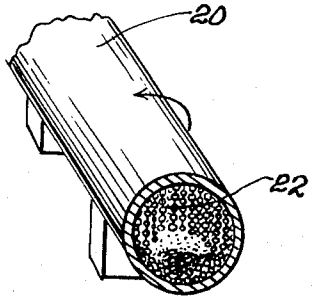


FIG. 6

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HEAT TRANSFER ELEMENTS FOR ROTARY KILNS

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U.S. Cl. 263—33 3 Claims

ABSTRACT OF THE DISCLOSURE

Heat transfer elements consisting of a plurality of interconnected segments whereby the elements can be suspended from the wall of a rotary kiln for contact with material, such as a slurry, as it moves through the kiln. The individual segments comprise annular members defining a narrow point of separation. A V-shaped groove is formed adjacent the point of separation, and this combination permits joining of the segments for purposes of forming one of the elements. Weld material is formed in the V-shaped grooves once the segments have been joined together.

This invention relates to improvements in the efficient operation of rotary kilns. The invention is particularly concerned with rotary kilns of the type used for the handling of materials such as slurries, sludges or dry compounds wherein the materials move progressively through the kilns. The kilns may be referred to as rotary pyro-processing kilns, and the improvements are specifically directed to heat transfer elements used in pre-heater sections of such kilns.

Kilns of the type referred to are employed in the production of portland cement, for re-activating lime sludge, for lime filtration, in pulp and paper operations, and other chemical operations and in various pyro-processing plants. The materials introduced into the kilns may be in the form of wet slurry or sludge having a moisture content between 30 and 50 percent or they may comprise a dry compound having little or no moisture content.

The kilns are usually mounted on foundation piers with a downward slope between 3/8 inch and 5/8 inch per foot length. The kilns may extend for over 500 feet and for an inside diameter between 14 and 16 feet. The materials fed into the kilns move slowly along the length, and the kiln is continuously rotated during this time. The heating means for the kiln are usually located at the extreme lower end, and temperatures in this area may be well in excess of 2000°. The hot gases move toward the entry end of the kiln and become progressively cooler.

It is desirable to provide a pre-heating zone adjacent the entry end. Heat transfer elements are situated in this pre-heating zone. The elements may be suspended from a point 15 to 20 feet downhill from the entry end, and then extend for from 40 to 150 feet. Typically the pre-heating zone extends approximately 1/4 the total length of a kiln. The heat transfer elements comprise a plurality of interconnected segments which hang downwardly when suspended from the top of the kiln and which form a pile when they are moved to the bottom of the kiln if the kiln rotates. The elements are connected all around the inside wall whereby suspended elements as well as a pile of elements at the bottom of the kiln will always be provided in the pre-heating zone.

The elements may be hung in curtain-festoon or garland fashions. The festoon or garland arrangement is employed where it is desirable to influence the material passing through the pre-heating zone. These arrangements may accelerate the movement of the material by acting in the manner of a screw conveyor or they may be arranged to slow down the movement of the material. It will be understood that conventional techniques for suspending of the elements are contemplated.

In the maintenance of rotary kilns of the type described, there are numerous instances where repair of the lengths of heat transfer elements must be undertaken. These elements are subject to relatively severe conditions because of heat, abrasion, and corrosion. It is, therefore, desirable to provide heat transfer elements which can be economically produced and maintained. In addition, the design of the elements must be such that efficient heat transfer can be accomplished.

It is a general object of this invention to provide improved heat transfer elements for use in rotary kilns.

It is a more specific object of this invention to provide segments for use in assembling the heat transfer elements whereby initial production and maintenance of the elements can be economically accomplished.

These and other objects of this invention will appear hereinafter and for purposes of illustration, but not of limitation, specific embodiments of the invention are shown in the accompanying drawings in which:

FIGURE 1 is a plan view of a heat transfer segment characterized by the features of this invention;

FIGURE 2 is a side elevation of the heat transfer segment of FIGURE 1;

FIGURE 3 is a side elevation illustrating an alternative design for a heat transfer segment;

FIGURE 4 is an elevational view of a portion of a heat transfer element formed of segments of the type contemplated by this invention;

FIGURE 5 is an elevational view illustrating a modified form of the segments; and

FIGURE 6 is a schematic illustration of a rotary kiln employing heat transfer elements.

This invention is generally concerned with rotary kilns of the type used for the handling of materials, such as slurries, lime sludge, dry compounds and other compounds. In such kilns, the materials are moved progressively from the feed end into contact with heat transfer elements located in a pre-heater section.

The heat transfer elements are formed of a plurality of segments whereby the elements, in one position, will hang downwardly from the top of the kiln. As the kiln rotates, the elements will gradually form a pile at the bottom of the kiln. The elements are connected all around the inside wall of the kiln whereby suspended elements and a pile of elements will be provided throughout the pre-heating section at the feed end of the kiln. After pre-heating, the work load enters the calcining and burning zones.

The specific improvement of this invention relates to the design of the segments employed in providing the heat transfer elements. The segments comprise annular members which define a narrow point of separation. A V-shaped groove is formed at the point of separation, and this combination permits joining of the segments. Specifically, the separation in adjajcent segments can be aligned and then moved toward each other while the segments are held at an angle of about 90° with respect to each other. The provision of the V-shaped grooves permits joining of the segments even though the separations in the walls of the segments are extremely small.

In referring to a "V-shaped" groove, it will be understood that many groove configurations are contemplated. As will appear from the following discussions, symmetrical or non-symmetrical designs will provide the desired results.

The accompanying drawings illustrate various segments characterized by the features of this invention. The segments **10** of FIGURES 1 and 2 comprise an annular wall **12** with a separation **14** being defined at one point in

this wall. A V-shaped groove **16** is formed by cuts which extend angularly outwardly from the point of separation.

FIGURE 3 illustrates a segment **10'** including a wall **12'** and separation **14'**. The groove **16'** is of a non-symmetrical V-shape. This provides a smaller gap and reduces the amount of weld material required when forming a heat exchange element.

FIGURE 4 illustrates the manner in which the segments can be joined together. The separations **14** of adjacent segments are placed in alignment while the segments are held at an angle with respect to each other. When the segments are moved toward each other, the angles defined by the respective grooves permit the desired linking action.

In FIGURE 4, the two upper segments **10** are shown linked together. A third segment **10** shown in dotted lines is added to the heat exchange element by aligning the groove of the third segment with the groove of the second segment. The third segment is then moved to the solid line position shown at which time a fourth segment can be added.

Weld material **18** preferably fills the grooves after the segments are joined together.

In FIGURE 5 the segment **19** defines a triangular cross section. This represents a preferred form of the invention since the triangular cross section provides maximum exposed surface area for a given weight of material. The efficiency of the pre-heating operation can be definitely improved with this arrangement.

FIGURE 6 illustrates a section of the pre-heating zone of a rotary kiln **20** which is provided with a plurality of heat transfer elements **22**. It will be noted that the elements at the top of the kiln are suspended vertically while the elements at the bottom of the kiln rest in a pile. The elements will alternate between these positions as the kiln rotates.

The elements which hang downwardly are directly in the path of gases moving from the heating zone from the entry end of the kiln. These elements present a large surface area which will withdraw heat from the gases. As the kiln rotates, the heated elements move to the bottom of the kiln whereby intimate contact is achieved with the material moving through the kiln. This pre-heating function is achieved in a uniform and continuous fashion since there are always suspended elements for picking up heat from the gases as well as elements in the lower part of the kiln for transferring heat to the material being treated. In a wet process, this pre-heating serves to accelerate the evaporation of moisture from the work load, and to elevate the temperature of the work load. In a dry process, the increase in temperature represents the pre-heating function.

The segments of this invention may be used for forming the initial elements included within the rotary kiln. These segments are also extremely useful for purposes of repairing elements. For example, if a few segments on a particular element have deteriorated or are broken, a corresponding number of segments of the type described can be provided to quickly form a section of an element corresponding to the section to be replaced.

FIGURES 1 and 2 illustrate an element having a groove **16** which defines a 60° angle. The segments shown in FIGURE 5 on the other hand have grooves defining an angle of 90°. It will be appreciated that other angles can be employed to achieve the desired function, and where a more or less symmetrical configuration is provided, the angles may vary between about 45° and 120°.

Where a non-symmetrical arrangement is provided, as shown in FIGURE 3, the angle defined by the groove **16'** preferably varies between about 30° and 60°.

It will also be appreciated that the rectangular cross section illustrated is not a requirement and the V-shaped grooves and corresponding separation could be located in other positions on the annular wall. Two opposed V-shaped grooves extending from a common point of separation toward opposite faces of the wall could also be utilized. It will be appreciated, however, that the configuration of the grooves preferably depends upon a desired configuration for achieving suitable welded characteristics.

The segments may be cast or cold formed in different cross sections from various metals suitable for heat transfer purposes. Carbon, alloy and stainless steels are most commonly used in systems of the type described.

The segments have been found to be of a simple, inexpensive and rugged design which can be interconnected into varying lengths by unskilled labor without the need for expensive special tools. In one form of the invention, the segments were produced with a three-inch inside diameter whereby four segments were required for forming a one-foot length.

It will be understood that various changes and modifications may be made in the constructions described which provide the characteristics of this invention without departing from the spirit thereof.

That which is claimed is:

1. In a rotary kiln wherein a slurry is moved progressively through the kiln and is acted upon by a plurality of heat transfer elements attached at spaced intervals around the inside wall of the kiln, said elements consisting of a plurality of interconnected segments, said elements alternately hanging downwardly when located at the top of the kiln while being disposed in a pile at the bottom of the kiln as the kiln rotates, the improvement wherein said segments comprise annular members defining a rectangular cross section, a narrow point of separation defined in the wall of each segment, a V-shaped groove in said wall at said point of separation, said separation being defined in one flat surface of the segment, said groove being defined by opposed walls extending outwardly away from the separation toward the opposite surface, said separation and groove cooperating to permit the connection of like segments by aligning the separations of said segments and sliding one segment through the other while holding the segments at an angle with respect to each other, and wherein the separations and grooves of the segments are filled with weld materials when the segments are connected in an assembly.

2. A construction in accordance with claim **1** wherein said V-shaped groove defines an angle between about 30° and 120°.

3. In a rotary kiln wherein a slurry is moved progressively through the kiln and is acted upon by a plurality of heat transfer elements attached at spaced intervals around the inside wall of the kiln, said elements consisting of a plurality of interconnected segments, said elements alternately hanging downwardly when located at the top of the kiln while being disposed in a pile at the bottom of the kiln as the kiln rotates, the improvement wherein said segments comprise annular members defining a triangular cross section, a narrow point of separation defined in the wall of each segment, a V-shaped groove in said wall at said point of separation, said separation and groove cooperating to permit the connection of like segments by aligning the separations of said segments and sliding one segment through the other while holding the segments are filled with weld material when the segments are connected in an assembly.

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