

[54] **KILN CHAIN HANGER**

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[51] Int. Cl. **F27b 7/20**

[58] Field of Search 263/33 C; 159/9 A;
34/142

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Primary Examiner—John J. Camby

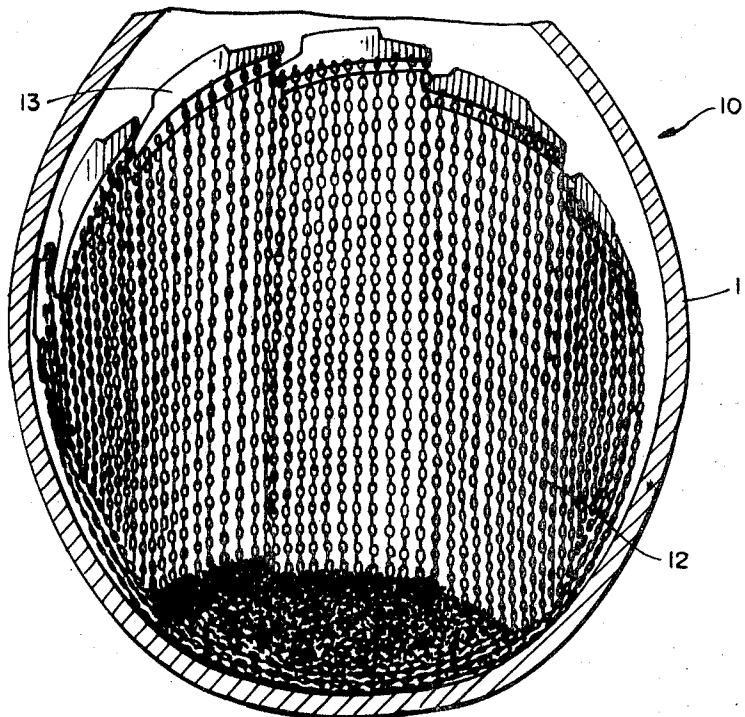
Attorney—Dawson, Tilton, Fallon & Lungmus

[57]

ABSTRACT

A kiln chain hanger for supporting kiln chains along a helical path in a rotary kiln. The hanger includes a generally planar base portion adapted to be secured to the wall of the rotary kiln and a shackle portion adapted to support one or more chain-supporting shackles. The shackle portion includes a generally planar attaching lug for each shackle which extends angularly with respect to the base portion and connecting portions which extend between adjacent lugs. An opening for a shackle pin is provided through each lug, the axis of the opening extending perpendicularly to the plane of the lug. The base is adapted to be secured to the rotary kiln along the helical path, and the angle between the axis of each shackle pin opening and the base is such that the axis extends perpendicularly to the direction of the force exerted by the hanging chain. If the hanger is to be used in a curtain hung system, the axis of each pin opening, and therefore the shackle pin, will extend parallel to the axis of the rotary kiln. If the hanger is to be used in a garland hung system, the axis of each opening will extend angularly with respect to the kiln axis and perpendicular to the direction of the chain pull.

9 Claims, 9 Drawing Figures



SHEET 1 OF 3

FIG. 1

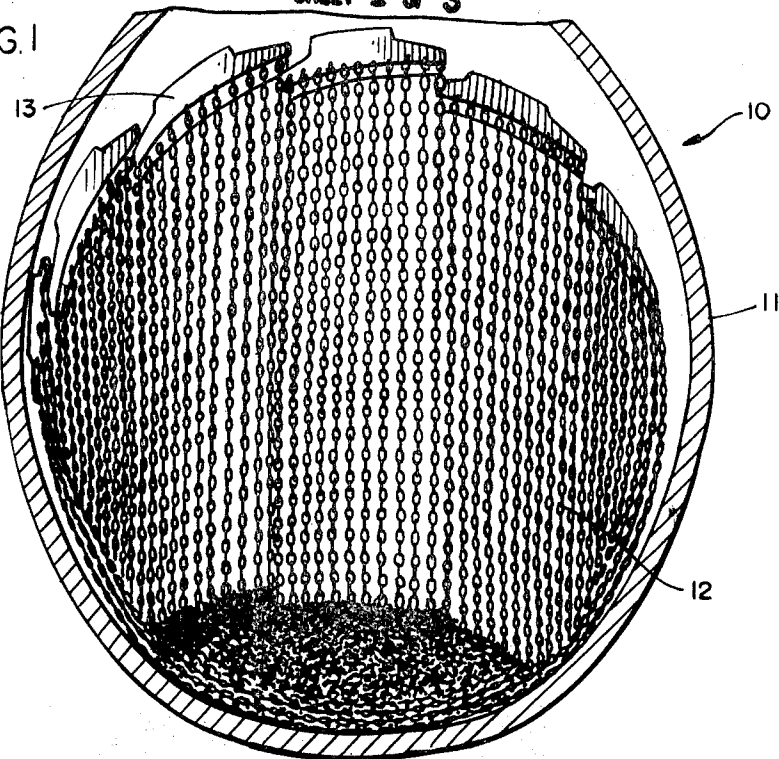


FIG. 2

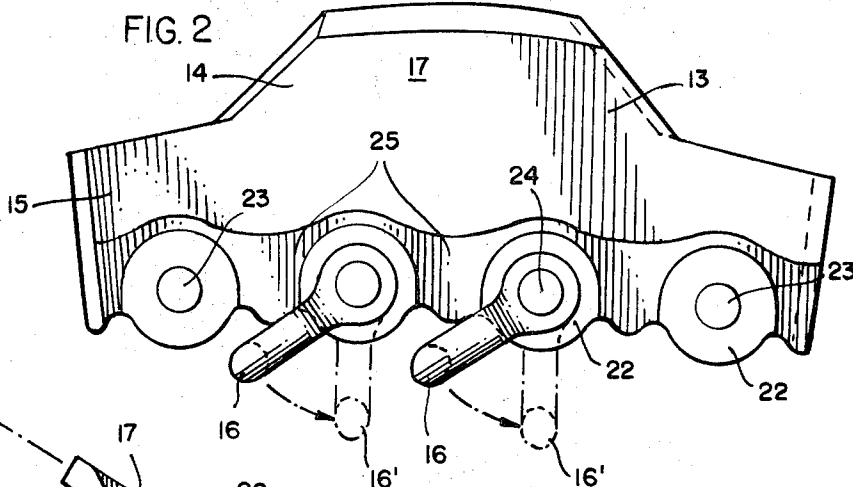


FIG. 3

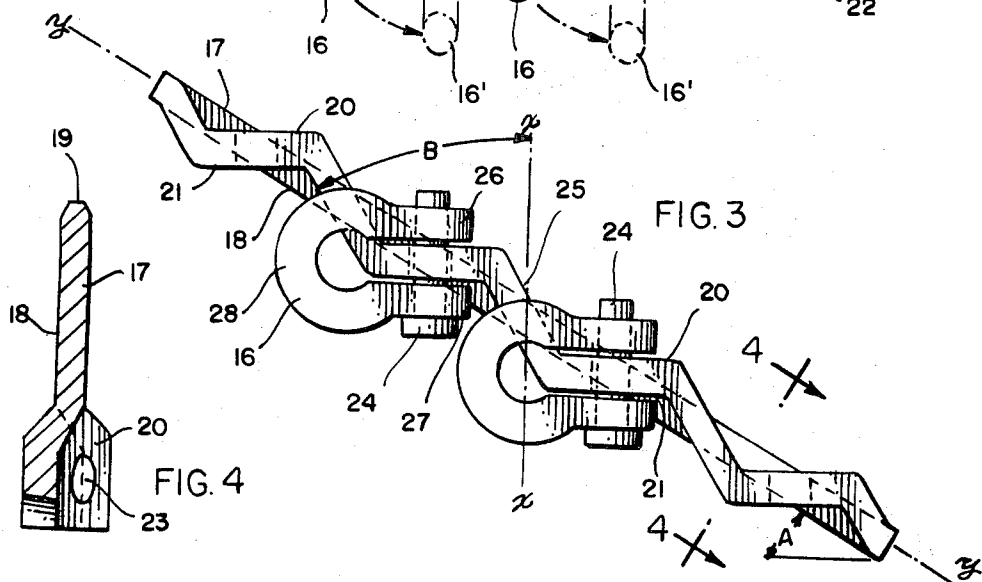
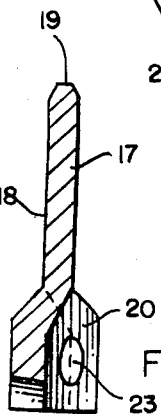


FIG. 4



SHEET 2 OF 3

FIG. 5

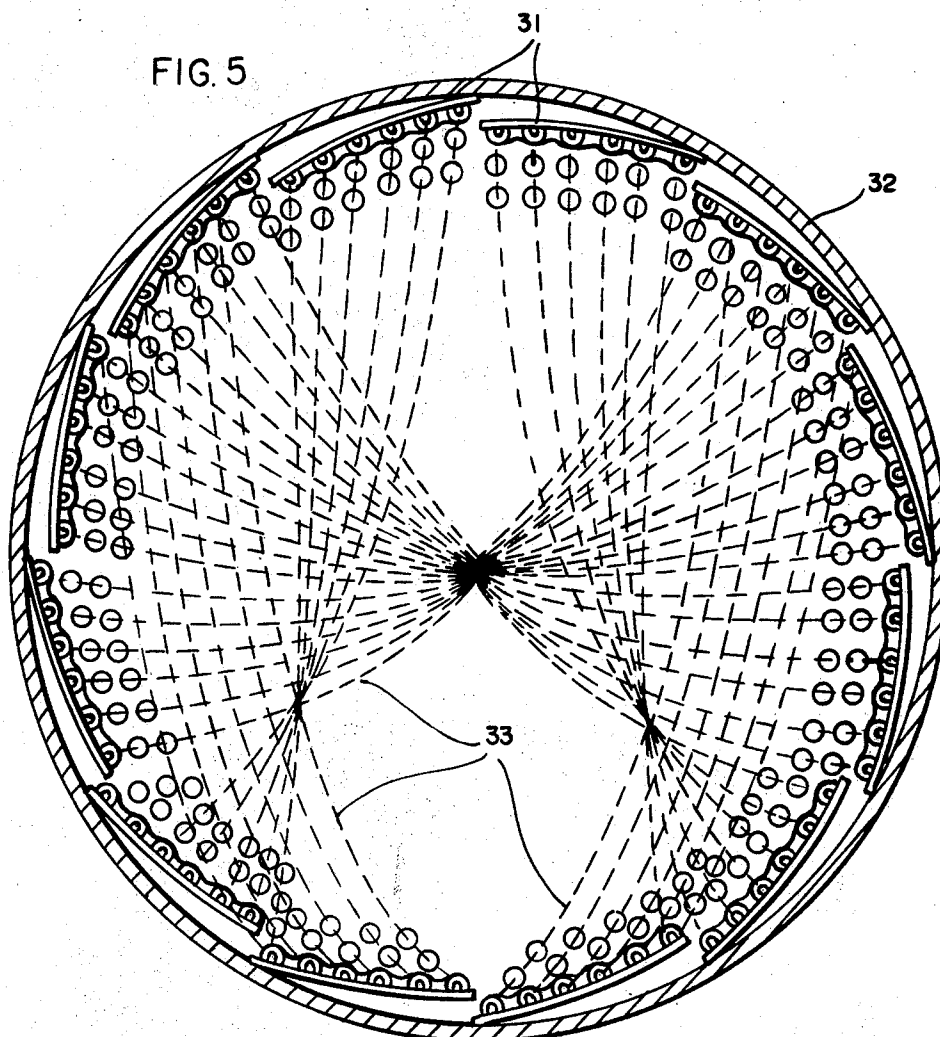


FIG. 6

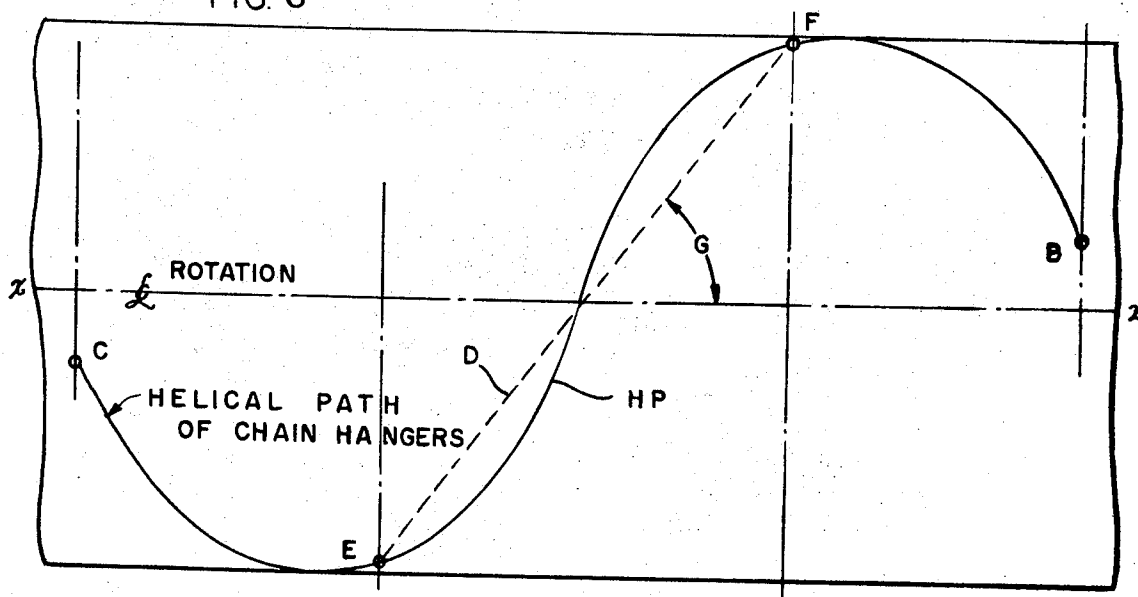


FIG. 7

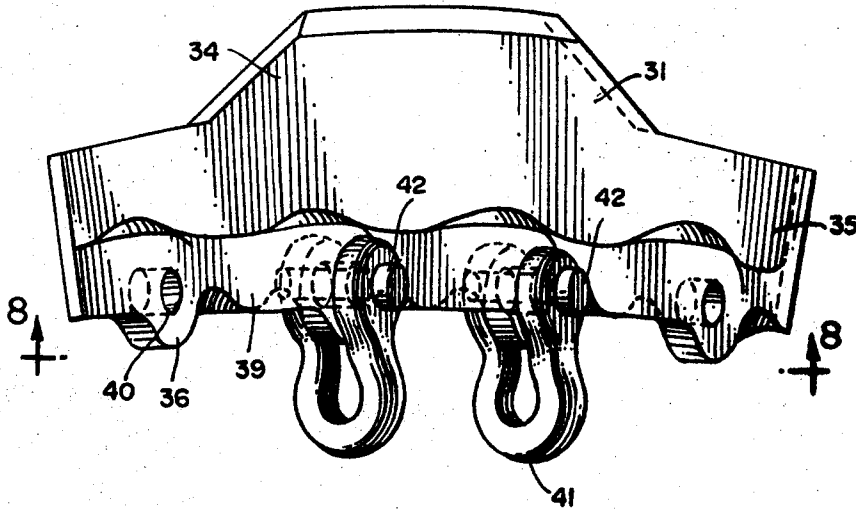


FIG. 8

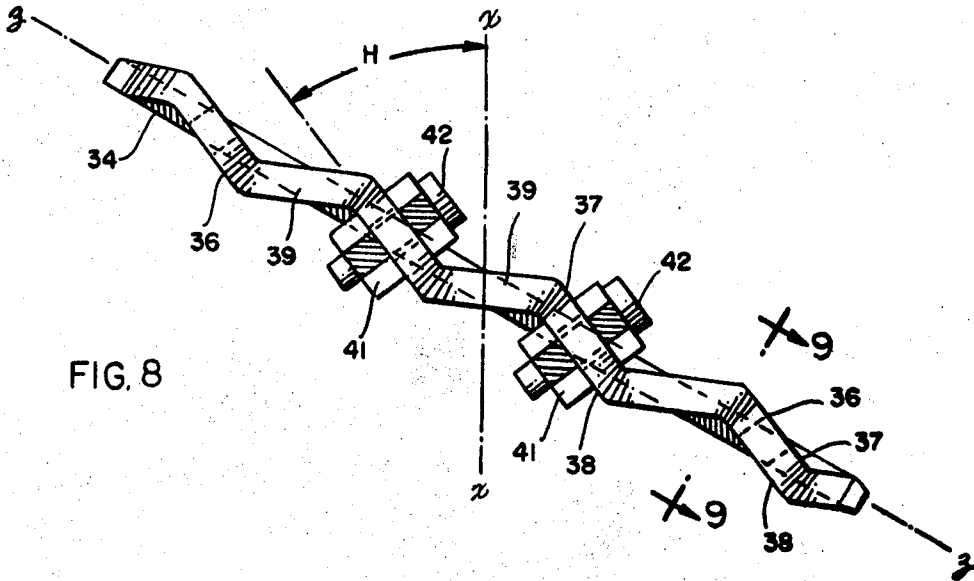
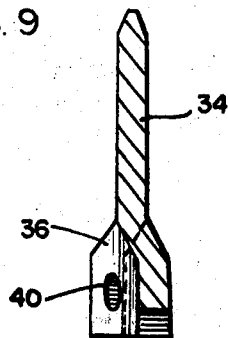


FIG. 9



KILN CHAIN HANGER

BACKGROUND

This invention relates to kiln chain hangers, and, more particularly, to a kiln chain hanger for supporting kiln chains along a helical path in a rotary kiln.

Rotary kilns are commonly used to heat mineral material and the like such as cement raw materials, lime, etc. These materials may be introduced in slurry form into a slightly inclined rotating cylindrical kiln through which hot gases are being passed. Conventionally, kiln chains are used as heat exchange devices between the hot gas and the slurry. The chains are secured to the wall of the kiln, and as the kiln rotates, the chains become heated by the gas and are then submerged within the slurry. The hot chains which lie in the slurry heat the slurry, and as the chains continue to rotate upwardly, slurry which clings to the chain becomes exposed to the hot gas and is further heated.

The attachment points between the chains and the kiln advantageously lie along a helical path, and the chains are conventionally hung in either a curtain hung system or in a garland hung system. In a curtain hung system, only one end of each chain is secured to the kiln so that when a kiln hanger is rotated to the top of the kiln, the chains secured to that hanger hang freely downwardly. In the garland hung system, both ends of each chain are secured to the kiln at spaced points along the helical path, the length of the chain being greater than the distance between the points so that the chain hangs or drapes downwardly.

The kiln chain hangers are secured to the kiln along the helical path, and the chains are conventionally supported by shackles which are rotatably secured to the hanger by shackle pins. However, if the pins extend through the hanger perpendicularly to the helical path, the shackles may bind on the hanger as the kiln rotates because the pins are not perpendicular to the direction of rotation of the kiln or to the direction of the pull exerted by the swinging chains. Reduction in the free movement of a chain shackle by binding increases the likelihood of build up on the chain shackle and on the hanger of the material which is being processed by the kiln, and the chain shackle may eventually become frozen to the hanger by this material build up. This not only reduces the efficiency of the kiln but may cause excessive or uneven wear on the shackle and the chain.

SUMMARY

The invention provides a chain hanger which supports the shackle pins perpendicular to the direction of the tension on the pins provided by the hanging chains. In a curtain hung kiln each pin extends parallel to the axis of the kiln, and in a garland hung kiln, each pin extends perpendicularly to the average tension line provided on the pin by the chain. Since each shackle pin is mounted perpendicularly to the pull exerted by the chain as it articulates during rotation of the kiln, the chain is allowed to swing freely on the hanger, thereby substantially reducing or eliminating the likelihood that the chain will bind. The pins for a multiple chain hanger extend through staggered or offset lug portions on the hanger so that the centers of the pin openings lie along the helical path. The lugs extend from a generally planar base portion which extends through the refractory lining of the kiln and is secured to the kiln wall in the conventional manner.

DESCRIPTION OF THE DRAWING

The invention will be explained in conjunction with illustrative embodiments shown in the accompanying drawing, in which

FIG. 1 is a diagrammatic illustration of a curtain hung rotary kiln equipped with chain hangers formed in accordance with the invention;

FIG. 2 is a front elevational view of one of the chain hangers which is disposed along a helical path;

FIG. 3 is a bottom plan view of the chain hanger of FIG. 2;

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 3;

FIG. 5 is a diagrammatic view of a garland hung system;

FIG. 6 is a diagrammatic illustration of one of the helical paths along which the chain hangers are attached for a garland system;

FIG. 7 is a front elevational view of a chain hanger for use in a garland hung system;

FIG. 8 is a bottom plan view of the chain hanger of FIG. 7; and

FIG. 9 is a sectional view taken along the line 9—9 of FIG. 8.

DESCRIPTION OF SPECIFIC EMBODIMENTS

Referring now to FIG. 1, the numeral 10 designates generally a conventional rotary kiln used for processing cement, lime, etc. The kiln commonly takes the form of an elongated drum or cylinder having an outer wall 11, and a refractory lining (not shown) is usually provided on the inner surface of the cylindrical wall.

The particular kiln illustrated is provided with a plurality of curtain hung kiln chains 12 which are rotatably secured to kiln chain hangers 13 secured to the wall of the kiln at spaced locations along helical paths. A chain which is supported by a chain hanger positioned at the top of the kiln hangs freely downwardly, and as the chain hanger rotates with the kiln toward the slurry which passes along the bottom of the kiln, more and more of the chain becomes supported by the wall of the kiln. Chains which are attached to chain hangers positioned at the bottom of the kiln are clumped at the bottom of the kiln and are completely or substantially completely submerged within the slurry. These chains are drawn out of the slurry as the kiln rotates and become exposed to the hot gas which passes through the kiln.

The inventive kiln chain hanger 13 illustrated in FIGS. 2-4 is designed for supporting kiln chains along a helical path in a curtain hung system. The hanger includes a somewhat trapezoidally shaped base portion 14 which extends through the refractory lining of the kiln and which is secured to the wall of the kiln, as by welding, and a shackle portion 15 to which one or more shackles 16 are rotatably secured. The base portion 14 is substantially flat or planar, having opposed generally parallel surfaces 17 and 18, and is advantageously provided with the same curvature as the helical path so that the longitudinal median line $y-y$ of the base may be aligned with a segment of the helical path along which the chains are to be secured. Because of the diameter of the kiln and the pitch of the helix for conventional installations the curvature of the base is slight, and the base would be substantially planar.

Alternatively, the hanger could be formed with a planar base which, although it would not be perfectly aligned with the helical path, would be substantially so. We have found the helical form of base to be more efficient in uniform feeding of the slurry, in preventing build-up in exposed misalignment, and in ease of alignment on the helix.

The upper edge 19 of the hanger can be beveled as shown in FIG. 4 to facilitate welding the hanger to the wall of the kiln, and is provided with a curvature corresponding to the curvature of the kiln wall along the helical path. The shackle portion 15 is provided with a plurality of pairs of flat surfaces 20 and 21 which provide flat or planar attachment lugs 22 for the shackles. An opening 23 extends through each lug, and the axis of the opening extends perpendicularly to the flat surfaces 20 and 21. A shackle pin 24 is rotatably received by each of the openings 23 and supports a shackle 16.

Referring to FIG. 3, when the chain hanger is used in a curtain hung system, the substantially flat base is aligned with the helical path along which it is desired to secure the chains and will therefore extend angularly with respect to the longitudinal center line or axis $x-x$ of the kiln. The helix angle A is measured with respect to a plane passing perpendicularly through the axis of the kiln, and the angle B between the base and the axis is therefore the complement of the helix angle. Each of the substantially planar surfaces 20 and 21 extend perpendicularly to the axis of the kiln so that the axis of the opening 23 therethrough extends parallel to the axis of the kiln. The shackle lugs 22 are staggered or offset in a direction parallel to the kiln axis so that the midpoint of the axis of each of the openings 23 lies along the mid-plane $y-y$ and the helical path. The lugs are joined and reinforced with flat connecting portions 25 which also extend angularly with respect to the kiln axis to provide the shackle portion 15 of the hanger with a zigzag configuration when viewed in plan.

The hanger may advantageously be made by casting, although it could also be forged or fabricated. The hanger is integrally formed, and the lug and connecting portions which provide the zigzag shaped shackle portion of the hanger merge with the flat base as shown in FIG. 4.

Each shackle 16 includes a pair of bifurcated or spaced-apart ends 26 and 27 and a looped or arcuate chain-supporting end 28. The bifurcated ends of the shackle are spaced apart slightly greater than the thickness of lugs 22, and the shackle is secured by aligning the openings in its ends with an opening 23 and inserting a shackle pin 24. The pin can be secured against withdrawal from the shackle by conventional means.

As the kiln rotates about its axis $x-x$, the shackles tend to rotate in a plane perpendicular to the kiln axis. Since the shackle pins 24 extend parallel to the kiln axis, the shackles and the pins can rotate freely with respect to the hanger as the hanger rotates with the kiln. Referring to FIG. 2, as the kiln and hanger rotate clockwise, the shackles 16 will rotate under the weight of the chains from the position illustrated in solid in FIG. 2 to the positioned illustrated in phantom at 16' when the hanger reaches the uppermost position. The flat surfaces 20 and 21 of the shackle lugs 22 extend parallel to the plane in which the shackles rotate and provide bearing surfaces for the shackles which facilitate free rotation and reduce the likelihood of binding. As the kiln rotates, each shackle pin is maintained perpendic-

ularly with respect to the direction of the pull exerted thereon by the chain, and the chain is free to swing relative to the hanger without binding.

The particular hanger 13 illustrated in FIGS. 2-4 is provided with four pin openings 23 which are arranged along an arc having a radius corresponding substantially to the radius of the refractory lining of the kiln, and this hanger is adapted to support four kiln chains. However, the length of the hanger can be varied to provide more or less shackle lugs, for example, from one to eight or more.

In one specific embodiment of a four-chain hanger for use in a curtain hung system, the length of the hanger from one end of the shackle portion to the other was about 22½ inches, and the pin openings 23 were disposed along an arc having a radius of 7 feet 7½ inches. The overall height of the hanger was 9 inches, and the midpoints of the pin openings 23 were spaced apart 5.84 inches along the helical path.

A garland hung system is diagrammatically illustrated in FIG. 5. A plurality of chain hangers 31 are secured to the cylindrical wall 32 of a rotary kiln along helical paths traced along the inside surface of the wall. Chains 33 are supported by the chain hangers, and each end of each chain is secured to a hanger at spaced locations along a particular helical path. The number of chains and the relative positions of the hangers which support the ends of each chain may vary depending upon the material being processed, all in accordance with conventional practice.

One of the helical paths along which the hangers are secured is shown diagrammatically in FIG. 6. The axial center line of the kiln is indicated by the line $x-x$, the helical path along the kiln wall being indicated by the line HP. The helical path is indicated for one complete 360° revolution about the kiln wall from point B to point C, and the axial distance between these points in one particular embodiment was 28 feet. The radius of the kiln was 7 feet 7½ inches. One of the chains is indicated by the line D, and the two ends of this chain are secured to hangers located on the helical path at points E and F, the axial distance between these two points in the specific embodiment being 11 feet 3 inches. The chain is longer than the distance between E and F and thus drapes between these points when the points are located above the bottom of the kiln. The suspended chain forms an angle G with the center line of the kiln of 52° in the embodiment illustrated.

Although only one helical path is shown in FIG. 6, it will be understood that a number of helical hanger paths are generally provided. For example, a kiln may have 12 helix rows which are spaced at 30° intervals around the circumference of the kiln.

The hanger 31 for use in a garland hung kiln is illustrated in FIGS. 7-9. The hanger 31 is seen to be quite similar to the hanger 13 and includes a generally trapezoidal base portion 34 and a shackle portion 35 which provides a plurality of planar shackle lugs 36. The lugs are provided by spaced-apart parallel flat surfaces 37 and 38, and adjacent lugs are connected by flat connecting portions 39. Shackle openings 40 are provided through each of the shackle lugs, and the midpoints of the axes of the shackle openings are aligned with the midplane of the planar base 34. Bifurcated shackles 41 are rotatably secured to the hanger by shackle pins 42 which extend through the shackle openings. The garland hanger 31 illustrated is also of the four chain type,

but similar hangers can be provided for use with more or less chains.

The hangers are secured to the kiln as previously described with respect to the hangers 13 so that the median line $z-z$ of each base 34 is aligned with the helical path. However, since the chains of a garland hung kiln are supported at both ends, the direction of the tension provided on the hanger by a chain extends at an acute angle with respect to the kiln axis. The planar surfaces of the lugs are designed to extend in the direction of the pull exerted by the chain so that the shackle pins will extend perpendicularly to the direction of pull, thereby allowing the shackles to rotate freely.

In the particular embodiment illustrated in FIG. 6, the ends of each chain D were secured along the helical path to provide a garland angle G of 52° . Accordingly, a hanger 31 intended for use with this kiln would be formed to provide a corresponding angle between the kiln axis and the planar shackle lugs. Referring to FIG. 8, this angle H would also be 52° for the illustrative embodiment.

The garland angles for various garland hung systems may vary, depending upon the length of the chains used, the axial distance between the support points for the ends of the chains, the axial length of the helical path, etc. However, once the garland angle of a particular garland hung system is determined, the hangers can be formed so that the planar shackle lugs extend at the same angle relative to the kiln axis when the base of the hanger is aligned with the helical path.

It will be understood that the kiln is inclined slightly with respect to the horizontal to facilitate the flow of the material through the kiln. For example, the slope of the kiln might approximate three-eighths inch per foot. Accordingly, the chain pull might not always act exactly at 90° to the shackle pin, but the shackle pins are set so that the average chain pull will be at 90° to the pin for both hanging systems.

While in the foregoing specification detailed descriptions of specific embodiments of our invention have been set forth for the purpose of illustration, it is to be understood that many of the details hereingiven may be varied considerably by those skilled in the art without departing from the spirit and scope of the invention.

We claim:

1. A kiln chain hanger for supporting a kiln chain in a rotary kiln, the hanger having a base portion adapted to be secured to the rotary kiln and a shackle portion extending from the base portion and having a pair of spaced-apart generally planar parallel surfaces extending angularly with respect to the base portion, the shackle portion having an opening extending perpendicularly through the planar surfaces whereby when the base portion is secured to the rotary kiln along a helical path a shackle pin extending through the opening will extend generally perpendicularly to the force exerted by the weight of the chain.

2. The structure of claim 1 in which the shackle portion is provided with a second pair of spaced-apart generally planar surfaces which extend parallel to the first-mentioned planar surfaces, the second pair of planar surfaces having an opening extending perpendicularly therethrough, the two pairs of planar surfaces being offset from each other in the direction of the axes of the openings and being joined by a connecting portion extending angularly with respect to the base portion.

3. The structure of claim 2 in which the base portion is generally planar and the openings lie along the median line of the base portion.

4. The structure of claim 1 in which the base portion is generally planar and the angle between the planar surfaces and the base portion is complementary to the angle between the helical path and the axis of the rotary kiln.

5. In a curtain hung rotary kiln assembly having an elongated generally cylindrical rotary kiln rotatable about the central longitudinal axis thereof and a plurality of kiln chains secured to the wall of the kiln along a generally helical path, an improved kiln chain hanger comprising a base portion secured to the wall of the kiln and a shackle portion extending from the base portion and having a plurality of pairs of spaced-apart parallel planar surfaces, the planar surfaces of each pair extending generally perpendicularly to the axis of the rotary kiln, the shackle portion being provided with an opening extending through each pair of planar surfaces, the axis of each opening extending generally parallel to the axis of the rotary kiln, a shackle pin extending through each opening, a bifurcated shackle for each opening having a pair of spaced-apart attaching ends and a looped chain-supporting end, the attaching ends of each shackle straddling one of the pairs of planar surfaces and being rotatably supported by one of the shackle pins, the chain-supporting end of each shackle supporting a kiln chain, the pairs of planar surfaces being offset in a direction parallel to the axis of the kiln so that each opening lies generally along the helical path whereby the kiln chain supported by the hanger hangs freely downwardly when the hanger is positioned at the top of the kiln and may rotate freely with respect to the hanger as the kiln rotates.

6. The structure of claim 5 in which the base portion is generally planar and extends generally along the helical path, the shackle portion including a connecting portion extending between adjacent pairs of planar surfaces.

7. In a garland hung rotary kiln assembly having an elongated generally cylindrical rotary kiln rotatable about the central longitudinal axis thereof and a plurality of kiln chains, each chain having each end thereof secured to the wall of the kiln at spaced points along a generally helical path, an improved kiln chain hanger comprising a base portion secured to the wall of the kiln and a shackle portion extending from the base portion and having a plurality of pairs of spaced-apart parallel planar surfaces, each pair of planar surfaces having an opening extending perpendicularly therethrough, a shackle pin extending through each opening, a bifurcated shackle for each opening having a pair of spaced-apart attaching ends and a looped chain-supporting end, the attaching ends of each shackle straddling one of the pairs of planar surfaces and being rotatably supported by one of the shackle pins, the chain-supporting end of each shackle supporting one end of a kiln chain, the planar surfaces of each pair extending generally parallel to the direction of the force exerted by the chain supported by the associated shackle pin whereby the shackles may rotate freely with respect to the hanger as the kiln rotates.

8. The structure of claim 7 in which the base portion is generally planar and extends generally along the helical path, the shackle portion including a connecting portion extending between adjacent pairs of planar surfaces.

9. The structure of claim 7 in which the base portion is generally planar and the openings lie along the mid-plane of the base portion.

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