July 16, 1963 G. P. HURST 3,097,834

WIRE ROPE CONNECTOR AND KILN STRUCTURE

Filed Jan. 18, 1962 2 Sheets-Sheet 1

FIG _ 1

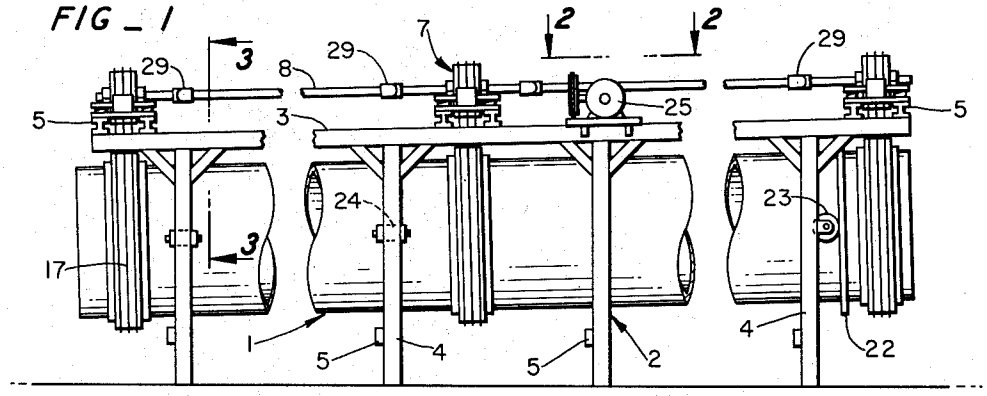


FIG _ 3

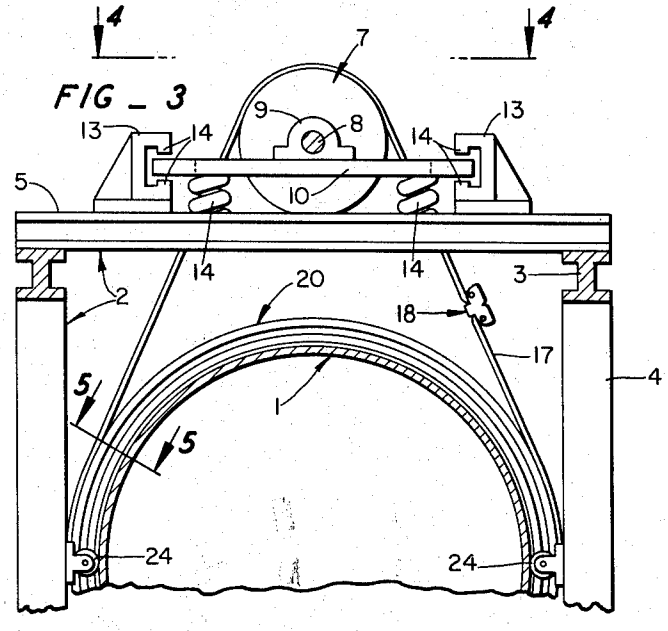


FIG _ 2

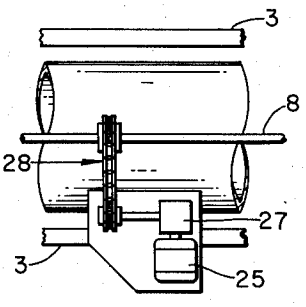


FIG _ 5

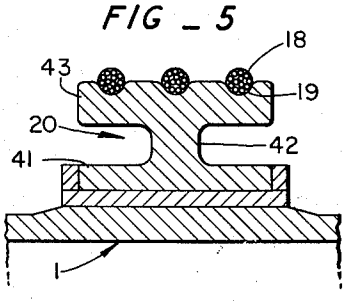
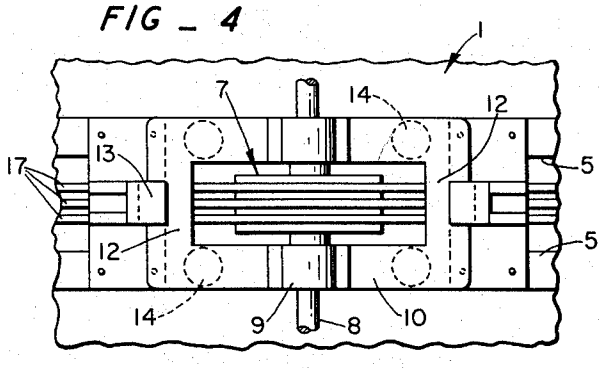


FIG _ 4



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FIG _ 6

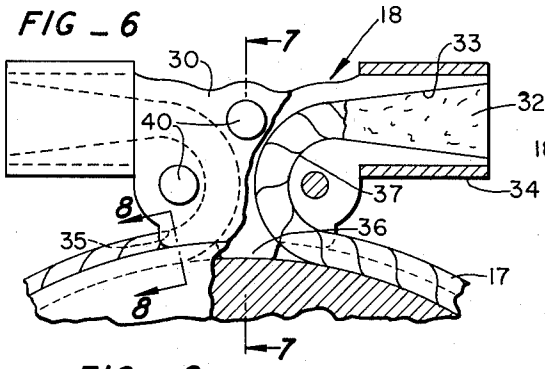


FIG _ 7

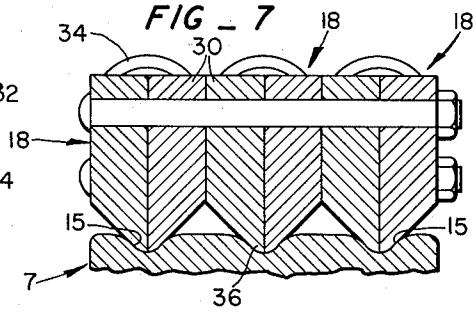


FIG _ 8

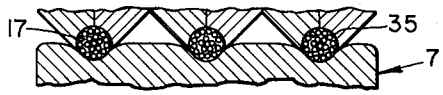


FIG _ 10

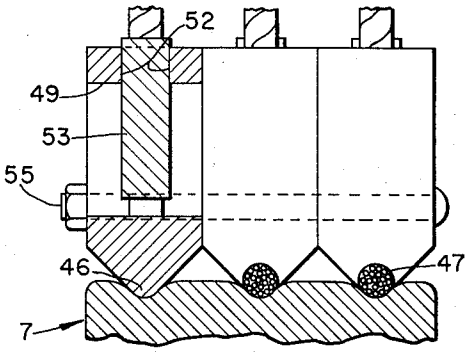


FIG _ 9

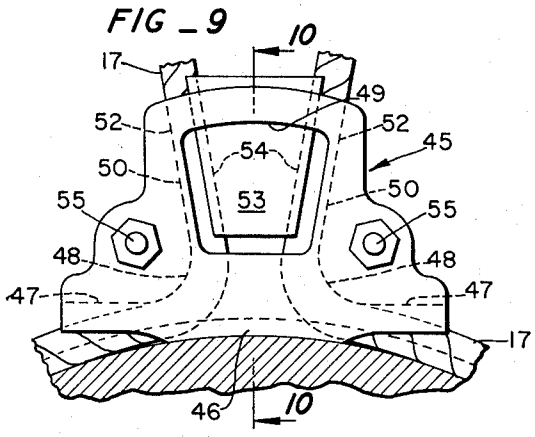


FIG _ 12

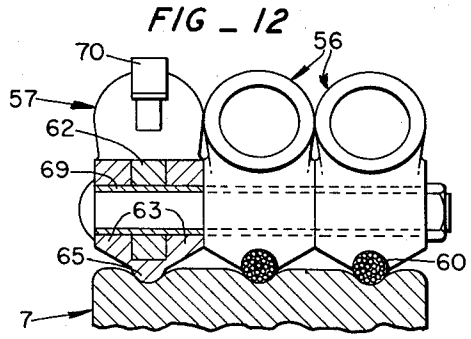
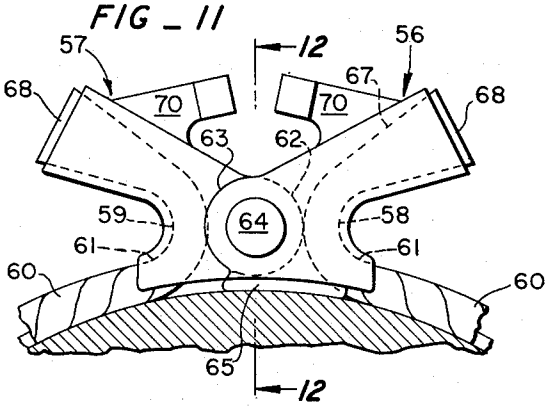


FIG _ 11



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WIRE ROPE CONNECTOR AND KILN STRUCTURE

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12 Claims. (Cl. 263—33)

This invention relates generally to kiln structure including wire rope connecting means employed in such structure.

The kilns with which this invention is concerned are kilns of the type used in the cement industry, each being a generally horizontally extending, slightly inclined cylinder supported on rollers for rotation about the longitudinally extending axis of the cylinder. The raw material is fed into the cylinder at the upper end thereof and as the cylinder is rotated the material moves toward and out of the lower end. A burner at the lower end, directed into the cylinder, provides heat for progressively drying the raw material, which may be in the form of dry dust or a slurry, as it moves from the upper to the lower end, said material being converted to clinker at said lower end.

Such cylinders are from approximately 400 to 600 feet in length and approximately from 10 to 20 feet in diameter. To partially counteract the tendency of each such cylinder to move axially downwardly in a direction from its upper to its lower end, the supporting rollers usually are supported for rotation about axes that are at a slight angle to the axis of rotation of the cylinder to tend to move the cylinder axially upwardly, instead of downwardly, thereby preventing the normal downward movement of the cylinder axially thereof.

The above arrangement of the supporting rollers results in a grinding effect thereon and on the tire or bearing ring on the cylinder that requires their relatively early replacement. There are usually many sets of such rollers for each cylinder, say five to seven sets per kiln, the number varying with the length of the latter.

When it is considered that each tire or ring on the kiln that engages each set of supporting rollers may weigh up to seventy-five tons, and that each pair of supporting rollers, including their support bearings may weigh an additional seventy-five tons, it is apparent that the initial cost of these rollers and tires is considerable, and that the cost of replacing them, apart from labor costs, is substantial. Even in those installations where the axes of the supporting rollers are parallel with the axis of rotation of the cylinder, the wear on them is rapid, necessitating their frequent replacement, and replacement of the tires or bearing rings.

Approximately one-half of the power applied for rotating conventional, roller supported kilns is utilized to overcome the friction inherent in the roller structure, and conventional kiln rotating means comprises a ring gear encircling and secured to the cylinder, which gear is driven by a pinion. As the cylinder expands and contracts or distorts due to temperature changes, there will be changes in the relationship between the teeth on the ring gear and the teeth of the pinion that results in undesirable wear on the teeth and loss in efficiency.

A further difficulty encountered in the roller supported cylinders is the fact that the cylinder may, at times, be distorted upwardly, so that the weight becomes quite unevenly distributed on the supporting rollers. This upward bowing or distortion is due to the zones of unequal temperature along the cylinder. When the upward distortion occurs at one of the ring bearings that engages a set of supporting rollers, the weight of the cylinder and its contents at and adjacent to the ring bearing is transferred to the other ring bearings, resulting in excessive wear and strain on such other bearings and rollers.

Still other problems associated with the use of roller supports is the excessive wear on rollers that are at one side of a central vertical plane bisecting the cylinder longitudinally thereof. The material within the cylinder will climb on the upwardly moving side of the cylinder as it rotates, thus placing more strain on the rollers at said one side. While other rollers may be provided at the side of the cylinder to resist the tendency of the cylinder to roll to the heavier weighted side, nevertheless the supporting rollers under said side will carry a heavier load than the rollers at the other side, with consequent greater wear on the rollers carrying the heavier load.

One of the objects of the present invention is the provision of means for overcoming the above objections, and which means are more economical to make and to maintain than heretofore.

In the solution disclosed hereinafter, wire ropes are employed to support the cylinder and which ropes extend over overhead sheaves. The provision of rope couplings that will readily pass over the sheaves without materially weakening the ropes or couplings, and which couplings will hold the coupled ends of the ropes against slippage relative to each other while carrying the load of the kiln and moving around the sheaves and cylinder, is an important object of the invention.

An additional object of the invention is the provision of a structure for supporting the cylinder of the kiln for rotation and for insuring a better distribution of the weight, than heretofore, in the event of a deformation of the cylinder.

Other objects and advantages will appear in the drawings and in the description.

In the drawings,

FIG. 1 is a side elevational view of a kiln, broken in length, illustrative of a general arrangement thereof including features of the present invention.

FIG. 2 is a fragmentary top plan view of a portion of FIG. 1 as seen from line 2—2 of FIG. 1.

FIG. 3 is an enlarged cross sectional view taken at line 3—3 of FIG. 1.

FIG. 4 is a fragmentary top plan view of the upper sheave and its support, as seen from line 4—4 of FIG. 3.

FIG. 5 is an enlarged fragmentary cross sectional view along line 5—5 of FIG. 3.

FIG. 6 is a part elevational and part sectional view of a rope connector for the wire rope support, and part of the sheave is shown in cross section.

FIG. 7 is a cross sectional view along line 7—7 of FIG. 6.

FIG. 8 is a cross sectional view along line 8—8 of FIG. 6.

FIG. 9 is a side elevational view of a wire rope connector that is a modification of the form shown in FIGS. 6, 7, a portion of the sheave over which the rope passes being in cross section.

FIG. 10 is a part cross sectional and part elevational view of the connector shown in FIG. 9, the portion in cross section being along line 10—10 of FIG. 9.

FIG. 11 is a side elevational view of a still further modification of the connector shown in FIG. 6, the portion of the sheave over which the rope extends being indicated in cross section.

FIG. 12 is a part cross sectional and part elevational view of the connector of FIG. 11, the portion in cross section being taken along line 12—12 of FIG. 11.

In detail, referring to FIG. 1 the cylinder of the kiln is generally designated 1, and the kiln supporting frame is generally designated 2.

The frame comprises parallel upper side frame members 3 supported on posts 4 that are spaced at opposite sides of the cylinder, and cross frame members 5 wherever

desired or found necessary may connect the posts 4 both above and below the cylinder 1 (FIGS. 1, 3).

The side frame members 3 are supported on the posts 4 inclined relative to horizontal, the right hand ends of the members 3, as seen in FIG. 1, being higher than the left hand end.

The said cross frame members 5 are in pairs, spaced longitudinally of the frame members 3, and extending at right angles to the latter.

Between each pair of the cross frame members 5 and directly over cylinder 1 is a sheave generally designated 7, and a shaft 8 extending longitudinally of the cylinder 1, having its axis parallel with the axis of the cylinder, has each sheave 7 keyed or otherwise suitably secured thereto.

Shaft 8 rotatably extends through aligned bearings 9 (FIG. 3), one being on each side of each sheave (FIG. 4) and each pair of bearings 9 at opposite sides of each sheave is secured on a bearing supporting plate 10 that is centrally open to rotatably clear the sheave, and which plate has end members 12 (FIG. 4) at the ends of the central openings for the sheave.

Extending vertically across each of the end members 12 are a pair of opposedly opening guide channel elements 13 (FIG. 3), secured to a plate that is in turn secured on cross frame members 5, and the end members 12 extend between the upper and lower sides of each channel member. These elements 13 may be provided with stops 14 for limiting vertical movement of the plate 10.

Pairs of heavy coil springs 14 are disposed between the plate 10 at opposite sides of each sheave 7 and the cross frame members 5 for floatingly supporting the sheaves 7.

Said sheaves 7 are formed with a plurality of radially outwardly opening grooves 15 (FIG. 7) in the outer periphery thereof that are substantially complementary in cross sectional contour with wire ropes 17, there being three grooves and three ropes in the form of the invention herein illustrated, but any desired number may be used for each sheave.

These ropes are each separate from the others and are made endless by reason of connectors 18 (FIG. 3) that connect their ends. These will be described more in detail later on.

The sets of wire ropes, one set at each sheave position, extend around the cylinder 1 in complementarily formed grooves 19 (FIG. 5) in the outer periphery of rings 20 that surround the cylinder 1 or the grooves may be formed directly in the thickened sections of the cylinder. Where the rings are used, they may each have a base 41 (FIG. 5) that is floatingly supported around the cylinder in the same manner as the conventional tires, although the rings are not of the same ponderous structure as the conventional bearing rings employed where supporting rollers are used since the wear is negligible compared to that on the tires on the ordinary roller supported kilns. Each ring 20 may have a base 41 and a heat dissipating web 42, while head 43 has the grooves for the ropes.

The cylinder 1 carries a thrust ring 22 (FIG. 1) at preferably its upper end, which ring has an axially facing surface that is on the side thereof facing toward the other end of the cylinder, and rollers 23 respectively carried by frame 2, or posts 4, at the upper end of the cylinder at each of the two opposite sides of the latter, engage said ring 22 to hold the cylinder against swinging on the wire ropes to a position in which said ropes are vertical. At all times, each of the ropes is in a plane that is at right angles to the axis of the cylinder transversely of the latter and it is the thrust ring 22 and rollers 23 that insure this.

Also rollers 24 (FIG. 3) carried on posts 4 at opposite sides of the cylinder will stabilize the cylinder against lateral movement during rotation of the cylinder.

A motor 25 supported on upper cross frame members 5 (FIG. 2) is connected through a speed reducer or transmission 27 with shaft 8 by any suitable means, such as a chain and sprocket connector 28 for driving the shaft 8 in the desired direction, and for thereby rotating the cylinder. Flexible or universal couplings 29 may be in the shaft 8 to permit slight relative angularity between the portions of the shaft at opposite sides of the intermediate sheaves, so that any axial misalignment of the rings 20 due to possible distortion of the cylinder 1 will not place undesirable strain on any particular portion of the shaft 8 or the bearings supporting the sheaves. In some instances it is not necessary that all of the sheaves be driven. In some cases two or three adjacent sheaves on shaft 8 may be driven, and the remainder supported on separate shafts and bearings and merely supporting the cylinder for rotation.

The wire ropes in an actual installation may each be approximately one and a quarter inches in diameter, and the ends of each rope length must be coupled together in a manner that will enable the ropes to pass over the sheaves and around the rings 20 without placing a detrimental strain or shock on either the connectors or the ropes, and they must hold the ends of each rope rigid so there is no slippage.

FIGS. 6–12 are illustrative of several forms of connectors that may be used.

In FIGS. 6–8 the connector or clamp comprises a pair of plates 30 that are formed on their adjacent sides with corresponding recesses corresponding to the cross sectional contours of the end portions of the wire rope that are adapted to be connected, when said plates are secured together with said end portions in the recesses.

The ropes for supporting the cylinder are first accurately cut to the desired lengths, and the strands of wire at the ends are separated and molten metal, such as zinc or any metal alloy adapted to bond with the steel strands connects the separated strands to form a generally frusto-conical body 32 of the metal integral at each end of the wire rope (FIG. 6).

This zincing of the ends may be accomplished in any suitable mold that corresponds in contour to the recesses 33 in the halves or plates 30 of the connector for each length of wire. The enlarged diameter end of each body 32 is at the outer ends of the separated wire strands, while the lesser diameter ends are of substantially the diameter of the rope at the junctures between the separated strands and the rope. The forming of the bodies 32 on the ends of the rope lengths may be accomplished in the shop and the ropes may be very accurately formed to exact lengths. Their lengths may be predetermined according to their positions around the kiln. In certain large kilns, for example, there may be substantial variations in diameter that are unavoidable. These differences are known and the rope lengths may readily be made to compensate for the variations.

As seen in FIG. 6, plates 30 are elongated and the recesses 33 are equally spaced at opposite sides of a medial line between the ends of the plates with the said recesses symmetrically positioned so that their central axes are substantially in longitudinal alignment and parallel with the longitudinal axis of the plates 30.

The edge of the pair of plates 30 of each connector that is adapted to face the sheave 7 and the cylinder is recessed as at 35 (FIG. 8) to conform to the cross sectional curvature of each rope 17, but this recessed portion of said edges terminates short of the medial line between the ends of the plates so that a bridge portion 36 (FIGS. 6, 7) is at the adjacent ends of recesses.

Between the terminating adjacent ends of the recesses 35 and the smaller diameter ends of the recesses 33 that are for bodies 32 are correspondingly curved recesses 37 that are complementary in cross sectional contour to the rope 17. These recesses 37 are linearly curved to substantially U-shape so that the convex sides of the curves are adjacent to a medial line intermediate the ends of the plates 30.

When the bodies 32 are in recesses 33 and the pair of plates are secured together, the lengths of the rope 17 adjacent to bodies 32 will extend around curved recesses

37 and then away from each other in the edge recesses 35 and around the sheave 7. The bridge 36 will project outwardly in the plane of the plates so that the outer edge will be substantially even with the outer surfaces of the rope lengths in recesses 35. The cross sectional outer contour of this bridge 36 will project outwardly in the plane of the plates so that the outer edge will be substantially even with the outer surfaces of the rope lengths in recesses 35. The cross sectional outer contour of this bridge 36 generally corresponds to the outer contour of the wire rope 17 (FIG. 7), hence when the connector 18 passes over the sheave, the bridge will practically form a continuation of the wire rope and will engage the sheave in the same manner as the rope.

Bolts 40 will bolt any desired number of pairs of plates 30 together. In the present instance, where there are three rope lengths, there will be three pairs of plates or three connectors for single rope lengths. Obviously there may be more or less, according to the circumstances.

It will be noted that recesses 33 are in tubular, oppositely outwardly projecting extensions on each connector (FIG. 6) and secured around each such extension is a tubualr sleeve 34. This sleeve not only cooperates with the bolts 40 for securing the halves of plates 30 together but it reinforces the extensions within said sleeves against the possibility of bursting under the strains imposed on the walls of the recesses 33.

The spacing between the rope lengths in any set of connectors may be accomplished by positioning spacers on the bolts 40 between the adjacent pairs of plates 30 or by any structure of the plates that will increase or decrease the spacing between the adjacent ropes in a set of connectors.

This form may be used for all the rings, or it may be used only at the lower end of the cylinder where the heat is greatest. As previously pointed out, the grooves, in certain installations, may be formed in thickened sections of the cylinder.

FIGS. 9, 10 illustrate a form of the invention that is a modification of the form shown in FIGS. 6–8. In this form each connector for each wire rope comprises a body, generally designated 45 which is flattened, as seen in FIG. 10 and which is formed along one edge thereof with a central solid bridge portion 46 (FIG. 9) that is complementary in cross sectional contour to the groove in the sheave.

The edge along which this bridge portion is positioned is formed with aligned outwardly opening channels 47 (FIGS. 9, 10) of cross sectional contour that is approximately the same as the cross sectional contour of the wire rope. These channels are generally semi-circular in cross sectional contour and their outer ends open outwardly of the two opposite sides of the body 45, while their inner or adjacent ends open into a pair of linearly curved passageways 48 (FIG. 9) that curve away from the bridge portion 46, the latter being disposed between said passageways.

The central portion of said body 45 is formed with an opening 49 and the ends of the passageways 48 that are remote from the channels 47 open into this opening at two of the opposite edges of the latter, and said two opposite edges are straight and extend divergently away from the bridge portion 46. The two edges are recessed to provide channels 50 opening toward each other across opening 49, and the edge of the body 45 opposite to the bridge piece is formed with an opening 52 (FIG. 10).

The channels 50 continue across the ends of opening 52 and open outwardly of the body 45 at their ends that are opposite to the curved passageways 48.

The end portions of a wire rope for supporting the cylinder 1 extend through the passageways 48 from the adjacent ends of the channels 47 and along and against the divergently extending channels 50, and a wedge 53 extending through the opening 52 and against the adjacent sides of the rope ends tightly wedges said ends against the surfaces of channels 50.

The edges 54 of the wedge 53 that engages said rope ends may be contoured to substantially correspond to the cross sectional contour of the rope.

The depths of the channels 50 and 54 are such that the wire rope 17 will project sufficiently from channel 50 to be wedgedly held by the wedge (FIG. 9) and the end of the wedge at the convergent ends of the channels 54 terminate at a point spaced from the bridge portion 46 when the wedge is in wedging relation to the rope 17. This space enables any suitable instrument to engage the end of the wedge that is adjacent to the bridge 46 for moving the wedge out of the body 45 and out of wedging relation to the rope to facilitate changing ropes when required.

At opposite sides of the central opening 49 and generally in the reentrant angles formed by the channels 47, 50, bolt openings are provided for bolts 55 that bolt any desired number of bodies 45 together so that a plurality of the ropes may be used at spaced points along the cylinder 1.

FIGS. 11, 12 provide a still further modification of the connector of FIGS. 6–8. In this form of connector there are two body portions 56, 57 respectively formed with generally U-shaped passageways 58, 59, in linear directions, for the end portions of wire rope 60. The portions 56, 57 themselves are each generally U-shaped in form to follow the linear contour of passageways 58, 59.

At the bends in said portions 56, 57 and projecting from the convex sides of said bends are projections 62, 63. The projection 63 actually is a pair of spaced ears between which projection 62 extends, and said projections 62, 63 are formed with coaxial openings for a pivot pin 64.

In this form of connector, there is a solid bridge piece or portion 65 between the bends of passageways 58, 59 and below pivot pin 64 in the connector for each rope, as seen in FIG. 11, that has a cross sectional contour to fit in a groove in the sheave and in the ring on the cylinder, the same as in the two forms shown in FIGS. 6 and 9, except that the bridge piece 65 is on the body 56 of the connector.

The wire rope 60 fits in outwardly opening aligned recesses 61 where they enter the passageways 58, 59 that are substantially the same as channels 47 on FIG. 9 or 35 in FIG. 6, and the bends in passageways 58, 59 are greater than right angle bends.

The outwardly opening ends of the passageways 58, 59 are progressively enlarged as at 67 to receive the bodies 68 of metal, such as zinc or a zinc alloy for example, which the separated strands at the ends of the rope 60 are bonded and embedded, and in this form of the invention, these bodies are zinced directly in the enlargements 67, hence may be bonded to the walls thereof.

The divergently extending ends of bodies 56, 57 in which enlargements 67 of the passageways 58, 59 are positioned are formed with projections 70 that extend toward each other and into meeting relation when the end portions of the ropes that are in the recesses 61 are in alignment, the rope taut along the straight lengths thereof when in use.

It should be noted that in this form of the invention the pivot pin itself may be a bolt having a bushing 69 that extends through the aligned openings in the projections on bodies 56, 57 on which said bodies are rotatable, or the pin 64 may be keyed to the portion 56 and portion 57 is rotatable on the pin. In whatever structure is used the bodies 56, 57 are rotatable relative to each other about the pin 64.

This latter structure, such as shown in FIGS. 11, 12 may be preferable where the sheaves are of relatively small diameter so as to reduce the amount of bending at the commencement of the bends of the wire ropes in the connectors although this is negligible in most installations.

The connectors in each of the forms disclosed are adapted to pass over the sheaves and around the cylinder in the same manner as though the wire ropes were continuous without enlargements therein.

It is important that the return bends of the wire ropes be relatively gradual, as disclosed, and that they be as close together as possible, in order to minimize bending or flexing of the ropes at the connectors.

The bridge connections between the adjacent ends of the rope lengths that are adapted to ride in the grooves in the sheaves and ring are also important, not only from the standpoint of adding strength (in FIG. 9) but in supporting the couplings on the sheaves against the tendency to topple, where single connectors are used. The sides of the channel portions on the connectors where the rope lengths lead into or enter the connectors also contributes to this result, and they also function to guide the rope lengths during rotation of the cylinder.

By use of the arrangement and structure described, it will be apparent that the cylinder is suspended from the wire ropes, that, in turn, extend over the sheaves **7** that are on the driven shaft **8**. The driving connection between the motor **25** and shaft **8** is sufficiently flexible to permit such vertical movement as may occur by reason of the springs **14**, and the universal couplings **29** also permit sufficient flexibility to insure against detrimental wear or strain where there is unequal vertical movement of the sheaves.

As explained earlier, the cylinder **1** may, at times, have an upward bow along its length, which, in the present instance, in a loaded cylinder the springs **14** would be substantially compressed, and should the upward bow occur at one of the points where the wire ropes support the drum, the springs **14** will expand to keep the load on the sheave or sheaves at the point where the bowing occurs. Of course, any variations of the cylinder relative to its central axis may be compensated for by the yieldable sheave mountings.

The tendency of the cylinder to roll laterally to one side, merely tends to swing the cylinder against the rollers **24**, but there is no excessive wear on supporting rollers at one side of the cylinder, as in conventional structure.

I am aware that endless chains extending over sprocket wheels and around drums and the like have been heretofore used for supporting and for rotating such drums, and that the drums and cylinders have been inclined relative to horizontal. However, the cost and maintenance of sprocket chains on cement kilns would be exorbitant and the problems that would be encountered in an installation using such structure obviously differ from those in which substantially cylindrical wire ropes are used with the elimination of all pivots except for the single pivot in FIG. 11, and in which no registration between teeth and links is required. There is, of course, no problem in making an endless chain.

The necessity for maintaining the axes of rotation of the sheaves and of the cylinder are obvious, since detrimental wear would otherwise occur as well as requiring unnecessary power to rotate the cylinder.

It is important to note that the employment of at least two lengths of wire rope and a single connector of the type shown, results in fully overcoming the possibility of the connector tilting to one side or the other in a manner in which it would strike a sheave or the ring on the cylinder. In other words, one wire of a pair thereof functions in combination with the connector as a means to prevent any twisting of the rope that would otherwise tend to swing the connector bodily about the axis of the rope, and as the surfaces of the connector that pass around the sheave in engagement therewith substantially correspond to the cross sectional contour of the rope, and are substantially continuations of the rope, they function to smoothly guide the rope into the grooves in the sheaves and in the rings around the kiln without creating a shock when they first engage the sheaves.

It is to be understood that the detailed description is not intended to restrict the scope of the invention and the claims are intended to permit any modifications and changes as may come within the scope thereof.

I claim:

1. In combination with a horizontally extending, cylindrical kiln;

(*a*) a plurality of sheaves spaced over said kiln and spaced from each other along an axis parallel with that of said kiln;

(*b*) a wire rope having an intermediate portion extending over each sheave and below said kiln suspending said kiln from said sheaves for rotation of said kiln upon rotation of said sheaves;

(*c*) supporting means supporting said sheaves for rotation about said axis;

(*d*) means connected with said sheaves for rotating them about said axis;

(*e*) said intermediate portion of each rope terminating in end portions adjacent to each other projecting outwardly relative to said kiln and the sheave over which each rope extends;

(*f*) a connector connecting the said end portions of each rope and holding the ends of said intermediate portion adjacent to the junctures between said intermediate portion and said end portions closely spaced apart in end to end alignment;

(*g*) means connected with each connector and movable therewith and with each wire rope upon rotation of said sheaves holding each wire rope against twisting and holding each connector and the pair of end portions connected therewith against lateral movement about the longitudinal axis of said rope during said rotation of said sheaves.

2. In combination with a horizontally extending, cylindrical kiln;

(*a*) a plurality of sheaves spaced over said kiln and spaced from each other along an axis parallel with that of said kiln;

(*b*) a wire rope having an intermediate portion extending over each sheave and below said kiln suspending said kiln from said sheaves for rotation of said kiln upon rotation of said sheaves;

(*c*) supporting means supporting said sheaves for rotation about said axis;

(*d*) means connected with said sheaves for rotating them about said axis;

(*e*) said intermediate portion of each rope terminating in end portions adjacent to each other projecting outwardly relative to said kiln and the sheave over which each rope extends;

(*f*) a connector projecting outwardly of each rope relative to said kiln and to the sheave over which each rope extends connecting said end portions of each rope and holding the ends of said intermediate portion adjacent to the junctures between said intermediate portion and said end portions spaced apart in end to end alignment;

(*g*) each connector including a bridge piece integral therewith within the space between said ends of said intermediate portion;

(*h*) said bridge piece having a kiln and sheave facing surface adapted to face said kiln and sheave upon movement with said connector around said kiln and sheave, which surface is substantially in continuation of the side of said intermediate portion that is adapted to face said kiln and sheave.

3. The combination as defined in claim 2,

(*i*) each of said wire ropes being disposed in a plane at right angles to the axis of said kiln; and

(*j*) means connected with each connector and movable therewith holding each connector in said plane.

4. In combination with a horizontally extending cylindrical kiln that is inclined relative to horizontal;

(*a*) a plurality of sheaves spaced over said kiln and

spaced from each other along an axis parallel with that of said kiln;

(*b*) a wire rope connected at its ends and having an intermediate portion one side of which extends in engagement with each sheave and around said kiln for suspending said kiln from said sheaves for rotation of said kiln upon rotation of said sheaves;

(*c*) supporting means supporting said sheaves for rotation about said axis;

(*d*) means connected with said sheaves for rotating them about said axis;

(*e*) a ring around and rigid with said kiln having an axially facing surface facing generally toward the lower end of said kiln;

(*f*) a support rigid relative to said kiln adjacent to said ring and

(*g*) rollers on said support engaging said axially facing surface of said ring during rotation thereof holding said kiln in a position in which said ropes are at right angles to the axis of said kiln and sheaves;

(*h*) means connecting the ends of each wire rope including a rigid member disposed between said ends having a surface substantially defining a continuation of said one side of said intermediate portion.

5. In the combination as defined in claim 4,

(*i*) said ring being adjacent to the elevated end only of said kiln.

6. The combination as defined in claim 4, plus;

(*i*) means for holding said ropes in yieldable supporting relation to said kiln at all times during rotation of said sheaves.

7. In combination with a horizontally extending cylindrical kiln that is inclined relative to horizontal;

(*a*) a plurality of sheaves spaced over said kiln and spaced from each other along an axis parallel with that of said kiln;

(*b*) a wire rope connected at its ends and having an intermediate portion one side of which extends over and in engagement with each sheave and around said kiln for suspending said kiln from said sheaves for rotation of said kiln upon rotation of said sheaves;

(*c*) a shaft supporting said sheaves for rotation about said axis and to which said sheaves are secured;

(*d*) means connected with said shaft for rotating the latter;

(*e*) means yieldably supporting said shaft for vertical movement and yieldably holding said ropes taut against said kiln in supporting relation to the latter during said rotation of said sheaves and kiln,

(*f*) means connecting said ends of each rope having a surface substantially in continuation of the side of each rope that is adapted to engage each sheave in a direction longitudinally of each rope.

8. In combination with a horizontally extending cylindrical kiln that is inclined relative to horizontal;

(*a*) a plurality of axially aligned sheaves each having a plurality of annular, coaxial, outwardly opening grooves for receiving therein a plurality of wire ropes;

(*b*) a plurality of axially aligned rings coaxial with and extending around said kiln, each having a plurality of annular coaxial outwardly opening recesses corresponding in number and positions axially relative to each other to the grooves in each of said sheaves;

(*c*) supporting means supporting said sheaves spaced over said kiln and spaced from each other for rotation on an axis parallel with the axis of said kiln;

(*d*) means connected with said supporting means for rotating said means and said sheaves about said axis;

(*e*) said rings being respectively opposite to said sheaves in spaced opposed planes respectively common to each sheave and the ring opposite thereto.

(*f*) a plurality of sets of parallel wire ropes, there being one rope in each groove in each sheave and in a recess in the ring opposite thereto suspending said cylinder from said sheaves;

(*g*) the ropes in each set terminating in end portions projecting outwardly of relative to said cylinder and the sheave for each set and at substantial angles relative to the lengths of rope intermediate said end portions,

(*h*) the ends of each of said lengths that are intermediate said end portions substantially at the junctures between said lengths and said end portion being in alignment longitudinally of said lengths for successive passage into said grooves and recesses free from obstruction and variation in the tension on said ropes,

(*i*) means connecting said end portions of the ropes in each set including means disposed between said end portions having surfaces respectively substantially in continuation of the side of each rope that is in each groove and recess opposite thereto.

9. In combination with a wire rope having opposite end portions;

(*a*) a connector for connecting said end portions to provide a substantially endless rope structure adapted to pass over a sheave and to be held in the radially outwardly opening groove in the outer periphery of such sheave;

(*b*) said connector being a body having a pair of axially aligned and axially spaced channel portions formed in one side thereof and opening oppositely outwardly of said body at the ends of said channel portions that are remote from each other;

(*c*) a pair of correspondingly curved passageways in said body one of the sides of each passageway being in axial continuation of one of the sides of each of said channel portion,

(*d*) said passageways extending away from said channel portions to one and the same side thereof and in a plane common to both of said passageways with the convex sides of their linear contours being adjacent to each other,

(*e*) the cross-sectional contours of said channel portions and said passageways being substantially the same as the cross sectional contour of said wire rope,

(*f*) said end portions of said rope being positioned and secured within said passageways, and

(*g*) the parts of said wire rope adjoining and at the junctures between said end portions and the intermediate portion of said rope carrying said end portions being disposed within said channel portions whereby said parts will be in axial alignment,

(*h*) and a bridge piece on said body extending between said parts, said bridge piece having a surface substantially in continuation of the surfaces of said parts that face outwardly of said channel portions whereby said piece will function to form a substantially uninterrupted extension of the parts of said rope adapted to be received within said groove in said sheave.

10. A connector for connecting a plurality of wire ropes that are adapted to extend around a sheave and cylinder for suspending such cylinder therefrom for rotation of the latter said connector comprising:

(*a*) a body formed with separate pairs of passageways of corresponding shape, size and positions in which said pairs are in side by side relation in a row of parallel planes,

(*b*) each pair of passageways opening oppositely outwardly of the same side of said body for receiving therein the opposite end portions of said wire ropes when the portions of said ropes adjoining the open ends of said passageways and extending away from said body are in axial alignment,

(*c*) the passageways of each pair being curved oppositely away from said open ends and from each other,

(*d*) means for securing the end portions of each of

such ropes within said passageways against withdrawal from said open ends thereof.

11. In a connector as defined in claim 10,

(*e*) a bridge piece on said body between the open ends of each pair of passageways having a surface in continuation of the surfaces of the portions of such ropes that are adapted to adjoin said open ends of said passageways whereby said body will be adapted to pass around such sheave and cylinder at the end portions of said ropes as an unbroken continuation of such ropes.

12. In a construction as defined in claim 11,

(*f*) wire ropes of equal lengths having their end portions secured within said passageways,

(*g*) said body including projections into which the ends of said passageways opposite to said open ends thereof extend and within which the terminating ends of said ropes are held, and

(*h*) bands around said projections reinforcing the latter against breakage of said projections upon tension being placed on said ropes.

References Cited in the file of this patent

UNITED STATES PATENTS

134,268	Goodrich	Dec. 24, 1872
2,079,280	Couch	May 4, 1937
2,536,054	Harrington	Jan. 2, 1951

FOREIGN PATENTS

340,025	Germany	Aug. 30, 1921