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ROTARY KILN

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FIG. 1

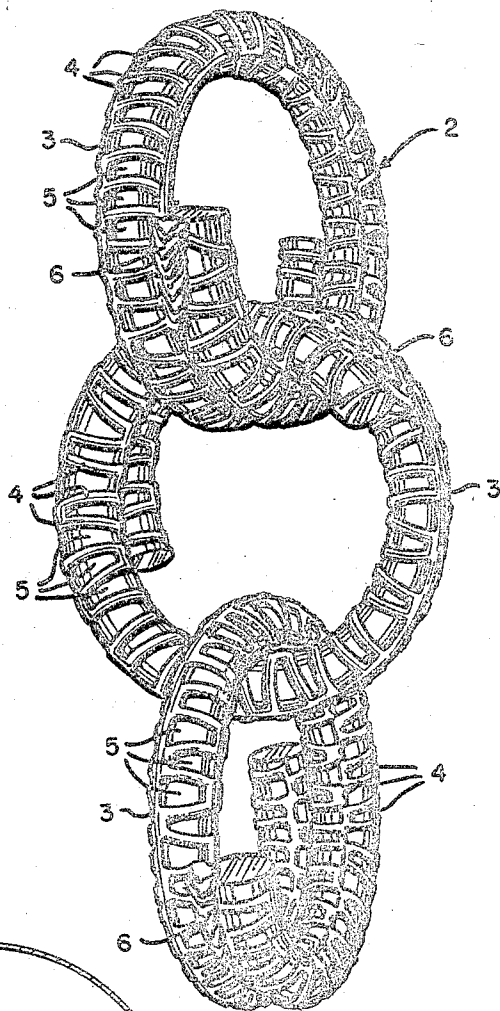
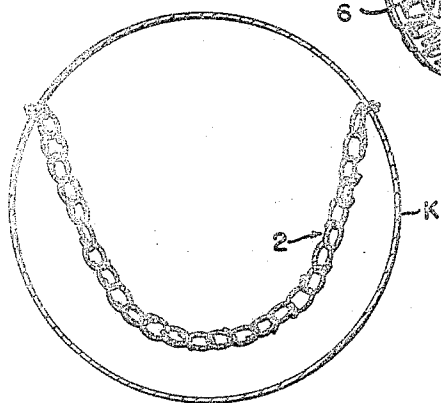


FIG. 2



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ROTARY KILN

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4 Claims. (Cl. 263—33)

This invention relates to a rotary kiln having a heat transfer element which although superficially similar to heat transfer elements for rotary kilns heretofore proposed is critically different therefrom, the difference investing the element with unprecedented heat transfer efficiency and non-clogging characteristics while at the same time the element is less costly than any heat transfer element for rotary kilns of comparable size ever before devised.

Rotary kilns used in the manufacture of cement, lime and like products have therein heat transfer elements in the form of metal chains fastened to the interior of the kiln at one or both ends of the chains or festooned so as to hang within the kiln to absorb heat from the burners during part of a revolution of the kiln and intimately contact the material being treated during another part of the revolution to transfer heat to the material and stir and agitate the material. Chains of many different kinds have heretofore been used as heat transfer elements in rotary kilns.

As a rotary kiln rotates a chain or portion of a chain which has been hanging within the kiln during part of a revolution of the kiln to absorb heat from the burners gradually collapses in the bottom of the kiln with the links of the chain lying more or less independently covered by the material being treated during which time each link transfers to the material heat previously absorbed from the burners. As the kiln continues to rotate the links move in the material being treated and stir and agitate the material while transferring heat thereto. Finally as the kiln completes a revolution the chain or portion of a chain is raised up out of the material lying in the bottom of the kiln to hang within the kiln to again absorb heat from the burners. The chains in a kiln are arranged so that portions thereof are at all times hanging within the kiln to absorb heat from the burners while other portions are collapsed in the bottom of the kiln covered by the material being treated and transferring heat thereto and stirring and agitating the material so that treatment of the material in the kiln is continuous.

The business of supplying heat transfer elements or chains for rotary kilns is highly competitive. The chains wear out and have to be replaced. Purchasers of such chains are concerned with getting maximum heat transfer capacity per dollar spent for chain. Also the links of the chains tend to become clogged or plugged with the material being treated. Inhibition of clogging is important.

I have devised a heat transfer element or chain for rotary kilns which for the first time solves the long existing problems in the art of providing optimum heat transfer per dollar of cost of the chain or, expressed otherwise, per pound of chain or per foot of length of chain of a particular size, and which at the same time obviates clogging or plugging of the links. I accomplish these results by forming a heat transfer element for rotary kilns as a chain of interlooped links of metal bars bent into link form, the links having surfaces comprising relatively projecting portions and relatively depressed portions enhancing the heat transfer efficiency of the element and inhibiting clogging of the links with the material being treated in the kiln.

The metal bars preferably have outwardly projecting ribs extending transversely of the length of the metal bars, i.e., transversely of the circumference of the links.

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I have found that ferrous metal bars of the type used for reinforcement of concrete are ideal for the formation of heat transfer chains and rotary kilns. The projections or ribs on such bars make the links formed therefrom like radiators with greatly increased heat transfer surface per link of a given size. This feature is unprecedented in heat transfer elements for rotary kilns. All kinds of link forms have been proposed in an effort to invest the links with maximum heat transfer characteristics, but despite the existence of the problem in the art over a long period of years it never before occurred to anyone to utilize bars whose surfaces have relatively projecting portions or ribs and relatively depressed portions which are typical of ferrous metal bars of the type used for reinforcement of concrete.

Not only are ferrous metal bars of the type used for reinforcement of concrete ideal for the manufacture of heat transfer elements for rotary kilns in respect of heat transfer characteristics but they are substantially lower in cost than any other material or stock adapted for that purpose. Thus I provide at a cost lower than that of any heat transfer element for rotary kilns heretofore devised a heat transfer element having heat transfer properties superior to those of all prior heat transfer elements for rotary kilns.

My heat transfer element has an additional extremely important advantage in that the relatively projecting portions and relatively depressed portions of the surfaces of the links render the links non-clogging or non-plugging. When the links are in the bottom of the kiln they lie more or less independently and are covered by the material being treated. That material may be in any form from a slurry to a paste in the initial stages of the treatment in the kiln and during a portion of the treatment the material tends to clog the links. When the chain passes from the bottom of the kiln around toward the top of the kiln the links move relatively to one another into position so that each link supports and carries upwardly the link below it, as is characteristic of all chains. However, as the links shift from relatively independent condition into position with each link supporting the link below it the surfaces of adjacent links move relatively to each other and rub against each other. When smooth surfaced links are employed such rubbing does not have any substantial effect in unclogging or unplugging links which may have become filled with the material being treated, but my links with projections or ribs on their surfaces cause relative jolting or vibration of adjacent links as the surfaces of adjacent links move in contact with each other as each link moves into position to pick up and support the link below it resulting in shaking off material tending to cling to or clog or plug the links. This action occurs at exactly the time when it is most effective for unclogging the links, i.e., just as the links are rising out of the material being treated and as the material is in the initial stages of hardening or baking on the links. In other words, any material tending to cling to or clog or plug the links tends to be shaken off before it becomes baked in the links. This is due to the relative rubbing against each other of the ribbed links as they shift from their more or less independent positions lying in the bottom of the kiln to their positions with each link supporting the link therebelow as the chain moves up toward the top of the kiln in each cycle. Thus not only is my improved heat transfer element for rotary kilns unprecedented in heat transfer characteristics and of lower cost than any such element ever before provided but it has the additional novel characteristic of inhibiting plugging or clogging of the links with the material being treated.

The ends of the metal bars forming the links preferably overlap and are preferably also welded together. This feature alone has been previously suggested but has es-

special advantages when incorporated in a heat transfer element for rotary kilns made in accordance with my invention. The ribs or projections may to some extent interlock when the bars are bent into link form with the ends of the bars overlapping, and when the ends of the bars are welded together the projections facilitate the welding whether the welding is accomplished by electric resistance welding or by deposit welding. When the welding is accomplished by electric resistance welding the projections constitute portions which are peculiarly adapted for effecting the connections with minimum supply of current. When deposit welding is utilized the ribs form pockets to receive the welding deposit.

The links are preferably designed so that the smallest internal transverse dimension of each link is equivalent to at least twice the greatest transverse dimension of the metal bars of which the links are formed. I prefer to make the links generally circular with the internal diameter of each link equivalent to at least four times the greatest transverse dimension of the metal bars. This affords the links an opportunity when lying in the bottom of the kiln covered by the material being treated to separate from one another to an optimum extent to effect maximum transfer of heat from each link to the material and also to afford optimum relative movement between adjacent links as each link begins to pick up the link below as the chain moves up the side of the kiln toward the top thereof so that the ribs or projections of each contacting link rub against the adjacent link causing vibration or jolting which dislodges material tending to cling to the links or clog or plug them before that material becomes baked in the links.

I provide a rotary kiln containing a heat transfer element in the form of a chain having portions connected with the kiln and festooned within the kiln so that as the kiln rotates the links of the chain lie on the bottom of the kiln in intimate contact with the material being treated and shift relatively to each other and thereafter are withdrawn upwardly, the chain comprising interlooped links of metal bars having surfaces comprising relatively projecting portions and relatively depressed portions in repetitive pattern bent into generally hollow form, each link having an internal space and a thickness, the links enhancing the heat transfer efficiency of the heat transfer element, the smallest transverse dimension of the internal space of each link being greater than the thickness thereof in the direction perpendicular to the general plane of the link, so that adjacent links may shift freely relatively to each other in a direction generally lengthwise of the chain as the kiln rotates whereby projecting portions of adjacent links may slidably engage each other causing jolting of the links with consequent loosening of material tending to cling thereto. The metal bars preferably have outwardly projecting ribs extending transversely of the length of the metal bars and, when the metal bars are bent into link form, transversely of the circumference of the links. The ends of the metal bars when bent into link form preferably overlap and also are preferably welded together.

In the accompanying drawings I have shown a present preferred embodiment of the invention in which

FIGURE 1 is a perspective view of three links of a heat transfer element for rotary kilns in the form of a chain in which the links are made of ribbed concrete reinforcing bars bent into generally circular shape with their ends overlapped and welded together; and

FIGURE 2 is a diagrammatic cross-sectional view through a kiln showing one of my novel heat transfer elements festooned within the kiln.

Other details, objects and advantages of the invention will become apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawing I have shown a present preferred embodiment of the invention in which the figure is a perspective view of three links of a heat transfer element for rotary kilns in the form of a chain in which the

links are made of ribbed concrete reinforcing bars bent into generally circular shape with their ends overlapped and welded together.

Referring now more particularly to the drawing, I have shown in FIGURE 2 a kiln K which is of generally cylindrical form and which may be of conventional construction, mounted to rotate about its axis and to contain material to be treated, with burners for supplying heat to the material. A chain constituting a heat transfer element is designated generally by reference numeral 2. It is festooned within the kiln as shown so that as the kiln rotates the links of the chain lie on the bottom of the kiln in intimate contact with the material being treated and shift relatively to each other and thereafter are withdrawn upwardly. Any desired number of such heat transfer elements may be provided in the kiln. Different operators treating material in rotary kilns prefer to apply the chains in different ways. However, the chains are always applied so that during one portion of the rotation of the kiln a given chain or portion of a chain hangs down from the top of the kiln to absorb heat from the burners and that chain or portion of a chain as the kiln continues to rotate moves to a position in which it lies in the bottom of the kiln with the links more or less independent to transfer heat to the material being treated, also agitating the material due to movement of the links in the bottom of the kiln caused by the continued rotation of the kiln. Those skilled in the art are well aware of the many ways in which the chain can be applied to the kiln.

The heat transfer element 2 comprises links 3. Three of the links are shown to greatly enlarged scale (about actual size) in FIGURE 1. Although only three such links are shown it is to be understood that the chain will comprise any suitable number of links. Each link 3 is formed by bending a length of concrete reinforcing bar into generally circular shape with the ends of the bar overlapping as shown. The concrete reinforcing bar has projections or ribs 4 with relatively depressed portions 5 between them as is characteristic of concrete reinforcing bars. The projections or ribs may be in a wide variety of patterns. One pattern is shown in the drawing but it is to be distinctly understood that other patterns or ribs on concrete reinforcing bars are equally adaptable for utilization according to my invention.

After the bars have been bent into circular form with their ends overlapping the overlapped ends are welded together. In FIGURE 1 the welding is shown as having been accomplished by deposit welding, the deposited weld material being designated 6. However, the overlapping ends of the bars may be welded together otherwise, as, for example, by electric resistance welding. Also, the ends of the bars may be butted instead of overlapped, and they may be but welded together.

I prefer to form the links of the chain generally circular as shown, although they may be of other than circular shape in which case the smallest internal transverse dimension of each link should be equal to at least twice the greatest transverse dimension of the metal bars. In any event the smallest transverse dimension of the internal space of each link is greater than the thickness thereof in the direction perpendicular to the general plane of the link. In the preferred form of link shown each circular link has its internal diameter equal to at least four times the greatest transverse dimension of the metal bars. While the bar stock is shown as of generally circular cross section it may have other cross sections as is characteristic of concrete reinforcing bars.

The ribs 4 with the depressed portions 5 therebetween, invest each link with the characteristics of a radiator, i.e., provide maximum heat transfer area for the size of the link. Such maximum heat transfer area has advantages in providing for both optimum heat absorbing capacity and optimum heat radiating or dissipating capacity. When the links are moving from the bottom of the kiln up toward the top of the kiln and each link is picking up the link therebelow the links move relatively to one

another and the ribs of each link moving in contact with each adjacent link cause vibration or jolting of the links which, as above explained, shakes off material tending to cling to or clog or plug the links before that material becomes baked in the links.

I have therefore provided a rotary kiln having a heat transfer element having unprecedented heat transfer and nonclogging characteristics and which is at the same time less costly than any other heat transfer element for rotary kilns of comparable size ever before proposed.

While I have shown and described a present preferred embodiment of the invention it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied within the scope of the following claims.

I claim:

1. A rotary kiln containing a heat transfer element in the form of a chain having portions connected with the kiln and festooned within the kiln so that as the kiln rotates the links of the chain lie on the bottom of the kiln in intimate contact with the material being treated and shift relatively to each other and thereafter are withdrawn upwardly, the chain comprising interlooped links of metal bars, said bars having surfaces comprising relatively projecting portions and relatively depressed portions in repetitive pattern and being bent into generally hollow form, each link having an internal space and a thickness, the links enhancing the heat transfer efficiency of the heat

transfer element, the smallest transverse dimension of the internal space of each link being greater than the thickness thereof in the direction perpendicular to the general plane of the link, so that adjacent links may shift freely relatively to each other in a direction generally lengthwise of the chain as the kiln rotates whereby projecting portions of adjacent links may slidingly engage each other causing jolting of the links with consequent loosening of material tending to cling thereto.

2. A rotary kiln as claimed in claim 1 in which the metal bars have outwardly projecting ribs extending transversely of the length of the metal bars and, when the metal bars are bent into link form, transversely of the circumference of the links.

3. A rotary kiln as claimed in claim 1 in which the ends of the bent metal bars when bent into link form overlap.

4. A rotary kiln as claimed in claim 1 in which the ends of the bent metal bars when bent into link form overlap and are welded together.

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