United States Patent

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[54] **MATERIALS LIFTER CONSTRUCTION AND INSTALLATION IN KILNS**
11 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **263/33,** 263/46
[51] **Int. Cl.** **F27b 7/00;** F23m 5/00
[50] **Field of Search** ..... 263/32, 33, 46; 110/1 (A), 1 (B)

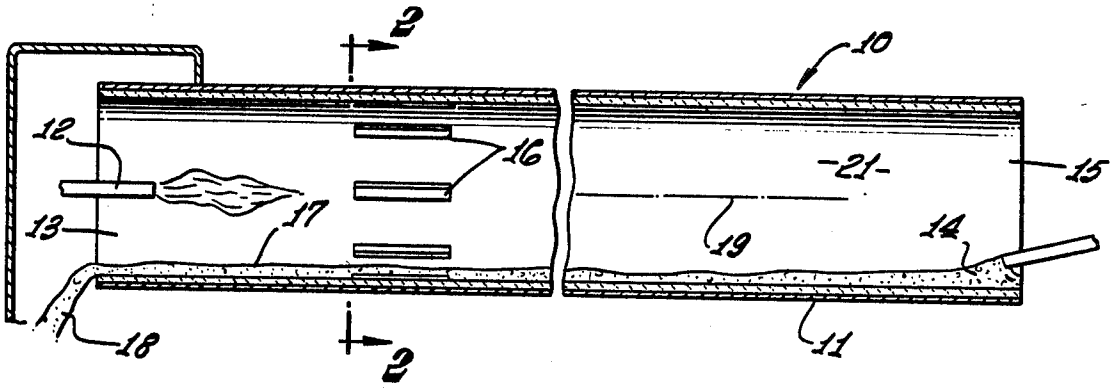
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ABSTRACT: The disclosure concerns apparatus and methods enabling rapid installation of materials lifters in a kiln, with desirably positive connection of the lifters to the kiln shell.



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FIG. 1.

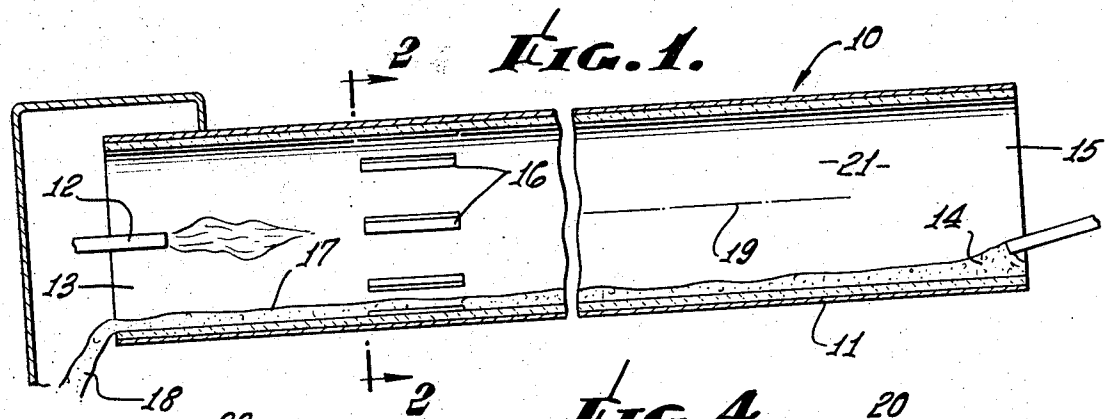


FIG. 4.

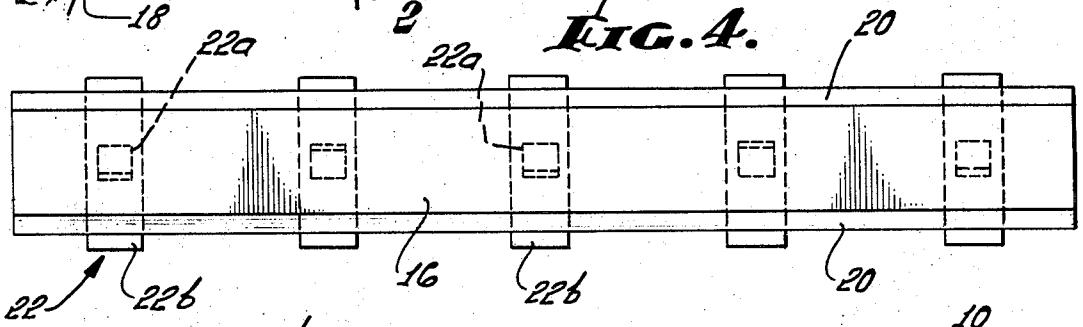


FIG. 2.

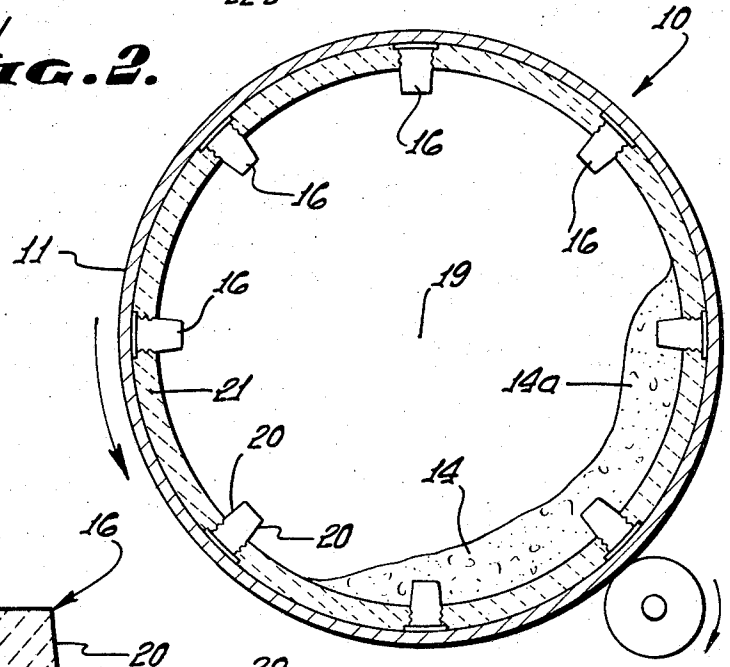
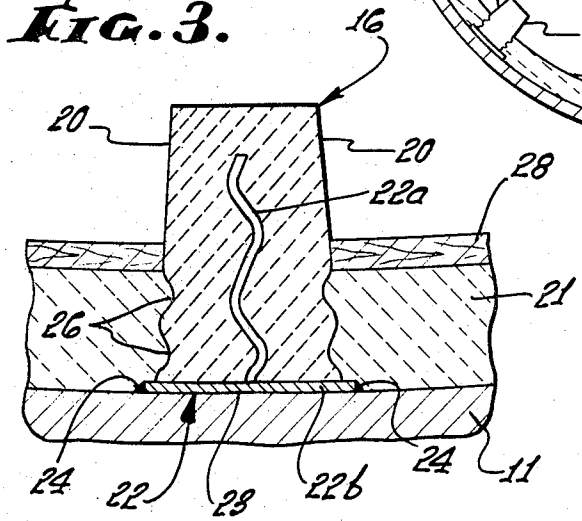


FIG. 3.



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MATERIALS LIFTER CONSTRUCTION AND INSTALLATION IN KILNS

BACKGROUND OF THE INVENTION

This invention relates generally to materials transportation in rotary kilns, and more particularly concerns the installation of lifters operable to elevate and cascade materials during kiln rotation to secure more desirable heat treatment of those materials.

The operation of rotary kilns typically includes the feeding of materials into the kiln at one end followed by slow travel of those materials lengthwise as the kiln rotates, the materials being subjected to heat treatment therein. Such gases may for example be introduced into the opposite end of the kiln and repeatedly contact the materials as they are agitated with cascading in the kiln interior; and, in the production of portland cement, the calcareous materials may slowly travel toward the burner at the exit end of the kiln, and the temperature of such materials is raised to an extent necessary to produce an exothermic reaction with consequent production of clinker.

It has long been recognized that the production of overburned or overheated materials, or the formation of otherwise undesirable clinker, is a result of improper heat transfer to the materials as they travel along the kiln length. Attempts have been made to overcome such problems through mechanical agitation of the materials at selected locations; for example, mechanical lifters have been installed in kilns to positively lift and cascade the materials as the kiln rotates, thereby securing better control of heat transfer to the materials. However, the installation of such lifters has been found to be time consuming and expensive inasmuch as they normally consist of refractory material which is cast in place in the kiln interior, requiring the installation and removal of complex forms, the lifters being cast in sequence and the kiln being indexed rotatably to position the forms for casting. Further, it has been found that adherence of the lifters to the kiln shell has not been sufficiently positive to prevent dislocation and destruction of the lifters in operation, requiring expensive shutdown of the kiln.

SUMMARY OF THE INVENTION

It is a major object of the invention to obviate the above as well as other problems encountered in kiln operation. Through the provision of apparatus and methods enabling rapid installation of lifters in the kiln, with desirably positive connection of the lifters to the kiln shell. As will be seen, the invention proceeds from the concept of preforming the lifters outside the kiln and rapidly installing them in the kiln in such manner that they become locked in position by virtue of attachment to the kiln refractory lining as well as attachment to the kiln shell.

Basically, then, the method of the invention may be considered to involve the steps of forming outside the kiln an elongated lifter member comprising refractory material sized to be carried into and installed within the kiln to extend proximate the kiln inner wall and to be protuberant toward the kiln interior lengthwise of the lifter member; installing that member (or a number of such members) in the kiln; and thereafter installing within the kiln refractory lining covering the exposed extent of the kiln wall inner surface, that installation being carried out to bring the lining into interfitting relation with the previously installed lifter member so as to effectively block member displacement toward the kiln interior during rotation. The method advantageously may further include the additional step of attaching the lifter member to the kiln wall at locations spaced lengthwise of the member and exposed at the member side, prior to lining installation, that installation then being carried out to cover such attachment locations whereby only refractory material is presented toward the kiln interior, the lifters being locked in place by attachment to the lining as well as to the kiln shell.

In its apparatus aspects, the invention may be considered to extend to precast lifters installed in the kiln, with lining retaining the lifters in position as described. In one unusually advantageous form of the invention, the lifter member and kiln lining have interfitting flutes extending lengthwise of the member, the lifter being preformed to have such flutes. Further, means may be provided to attach the lifter to the kiln shell independently of the lining, such means typically including metallic elements spaced along the lifter to extend adjacent the shell, as for example to be welded to the shell, such metallic elements having portions embedded in the lifter refractory as cast outside the kiln. As will be seen, those portions of the metallic elements to be connected to the kiln project to be completely covered by, or underlap, the later installed kiln lining.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following detailed description of the drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a vertical elevation taken in section through a kiln incorporating the invention;

FIG. **2** is an enlarged section taken on line **2–2** of FIG. **1**;

FIG. **3** is an enlarged fragmentary section taken through a lifter member showing its attachment to the refractory lining as well as to the kiln shell; and

FIG. **4** is a plan view showing a lifter member as formed outside the kiln.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to FIG. **1**, an elongated kiln is shown at **10** as having a tubular metallic outer shell **11**, with a burner apparatus **12** at the hooded exit end **13** of the kiln. Calcareous materials **14** are introduced at the entrance end **15** of the kiln, to be slowly traveled lengthwise leftwardly toward end **13** in response to kiln rotation, the materials receiving heat transfer from the hot gases traveling rightwardly in the kiln interior. Elongated lifters **16** may be used anywhere in the kiln, but in the example shown are located just to the right of the zone **17** wherein the materials reach their highest temperature, prior to exit as clinker **18**.

As better seen in FIG. **2**, the lifter members are spaced about the kiln axis **19**, and extend endwise, lengthwise of the kiln, so as to effect lifting and cascading of the materials as indicated at **14*a*** as the kiln rotates. Note that the lifters have opposite sides **20** which taper inwardly toward the interior of the kiln, with protuberance beyond the kiln lining **21**.

In accordance with the invention, and referring to FIG. **4**, the lifter members are formed outside the kiln, as by casting refractory material in appropriate molds or cavities. A refractory slurry suitable for casting may for example consist of a dry mix containing from 10 to 40 percent by weight calcium aluminate cementitious agent, from 0 to 20 percent plasticizer such as pulverized clay or grog, and the remainder of the mix being calcined fire clay granules between 1 inch mesh and 65 mesh (Tyler screens), together with sufficient water to give a casting consistency (i.e. from 8 percent to 15 percent of the slurry weight). The casting is carried out in such manner in relation to a series of metallic (as for example stainless steel) elements generally indicated at **22** that the latter are spaced along the liner member. Those elements include certain anchor portions **22*a*** embedded in the member and other base portions **22*b*** extending at the undersides **23** of the liners and projecting freely therefrom, as is clear from FIG. **4**.

The anchor portions **22*a*** may advantageously comprise corrugated strips connected to the base portions **22*b*** and projecting upwardly throughout the major height of the lifter refractory. Successive anchor portions **22*a*** along the lifter have their corrugations reversed, i.e. define planes which are out of lengthwise alignment in order to preclude problems of refractory cracking along the length of the lifter during use.

The base portions **22*b*** project sidewardly at the bottom of the lifter member in order to facilitate quick and secure at-

tachment to the steel shell of the kiln, as by the welds indicated at **24**. Spot welds may also be used. In this regard, the precast lifter members may, after curing, be carried into the kiln and quickly attached to the shell at the lowermost position shown in FIG. **2**, the kiln being indexed or rotated sufficiently for the attachment of the lifters in sequence.

It is a further feature of the invention that the casting of the lifters is carried out to provide them with flutes **26** running endwise at opposite sides of the lifters, such flutes for example taking the form of elongated corrugations. It then becomes possible to provide for positive, "keystone" locking of the lifter members in attached position by casting refractory liner material against the flutes while lining the kiln shell to cover the inner metallic surface thereof. Such casting then provides an interlock of the lining with the lifter, after curing, for stability. The lining composition may be the same as that of the lifter refractory.

FIG. **3** illustrates the use of curved forms **28** extending between successive lifter members, in spaced relation to the shell **11**, to facilitate pouring of the lining refractory slurry in position as shown, to interlock with the lifter flutes. Such forms may be easily installed and removed. Note that the lining **21** completely covers the metallic anchor portions **22***b* which are welded to the shell.

From the foregoing, it is clear that the invention provides for substantial savings in lifter installation time and in time required to install forms in the kiln; less form material need be installed between the lifters; no snap ties are needed to hold the form lumber in position; the tapered and fluted configuration of the lifters precludes the possibility that the lifter will separate from or migrate relative to the liner; the lifters are also held in place by attachment of the metallic elements **22** to the shell; and the reinforcing portions **22***a* anchor the lifters to the metallic base portions **22***b* and are so positioned as to preclude cracking or spalling of the refractory lifter material, during kiln operation.

I claim:

1. In a rotary kiln having a tubular shell defining a central axis and adapted to receive materials to be subject to heat treatment within the kiln interior, the combination comprising:

multiple elongated lifter members each including refractory material precast and cured outside the kiln and thereafter installed in the kiln to be spaced about said axis and to extend endwise generally axially proximate the shell inner surface;

refractory lining cast in place in the kiln to have cast and arching continuity between said members and to cover inwardly exposed extent of said shell surface and characterized as extending in such retaining relation with said members as to block displacement thereof toward the kiln interior during said rotation, the lifter members being protuberant toward the kiln interior relative to said lining so as to displace said materials in response to kiln rotation; and

metallic means attaching said members to the shell independently of said refractory lining.

2. The combination of claim **1** wherein said member and said lining have interfitting shoulders extending lengthwise of said member.

3. The combination of claim **2** wherein said shoulders define smoothly contoured flutes.

4. The combination of claim **1** wherein said metallic means include retainers having anchor portions projecting into said member and base portions extending transversely relative thereto to protrude in underlying relation to said lining and shoulders, said retainers joined to the shell.

5. The combination of claim **4** wherein said anchor portions are corrugated, the corrugations of selected anchor portions defining endwise extending planes which are out of direct alignment, said retainers being spaced lengthwise of said members.

6. The combination of claim **3** wherein said metallic means include metal straps extending transversely with respect to said members and having terminals welded to said shell and underlapping said lining.

7. The combination of claim **1** wherein there are at least six of said members equally spaced about said axis.

8. The combination of claim **3** wherein each member tapers toward the kiln interior throughout the major extent of the member length and inwardly of said flutes.

9. For combination in a rotary kiln having a tubular shell defining a central axis and adapted to receive materials to be subject to heat treatment within the kiln interior, the kiln to receive installation of refractory lining to cover exposed extent of the shell interior surface, an elongated lifter member including refractory material precast and cured outside the kiln and sized to be installable therein to extend endwise proximate the shell interior surface and to be protuberant toward the kiln interior relative to the lining for displacing said materials in response to kiln rotation, the member having flutes extending lengthwise at opposite sides thereof to interfit with said lining upon said installation thereof so that said member will be blocked against displacement toward the kiln interior during kiln rotation, and metallic retainers spaced along said member to extend adjacent the shell upon said installation and to be attachable to the shell, said retainers including certain portions embedded in said member and other portions projecting free of the refractory in positions at opposite sides of the member to be independently attached to the kiln wall and to be retained and covered by said lining.

10. The method of providing a rotary kiln with refractory structure operable to line the kiln and to displace materials which are subject to heat treatment in the kiln, the kiln being tubular and defining a central axis, said method comprising:

forming outside the kiln multiple elongated lifter members each comprising refractory material sized to be carried into and installed within the kiln, to extend proximate the kiln inner wall and to be protuberant toward the kiln interior, lengthwise of the lifter member;

installing said lifter members in the kiln as aforesaid, with said members spaced about the kiln axis; and

casting within the kiln refractory lining covering the exposed extent of the kiln wall inner surface, and with continuity between successive members, said installation being carried out to bring the lining into interfitting relation with said previously installed lifter members so as to effectively block displacement of said members toward the kiln interior during kiln rotation.

11. The method of claim **10** including attaching said members to the kiln wall at locations spaced lengthwise of said members and exposed at the side thereof, prior to said lining casting and carrying out said lining casting to cover said locations.