April 8, 1958

G. C. DAVIS, JR

REFRACTORY

2,829,877

Filed Sept. 9, 1955

2 Sheets-Sheet 1

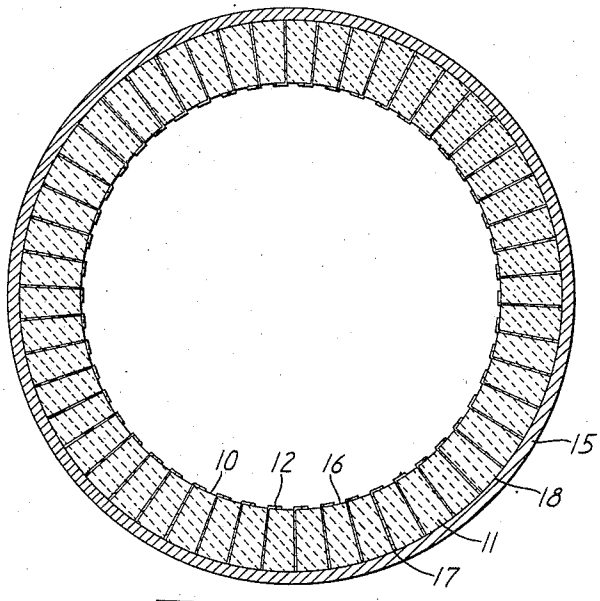

FIG. 1.

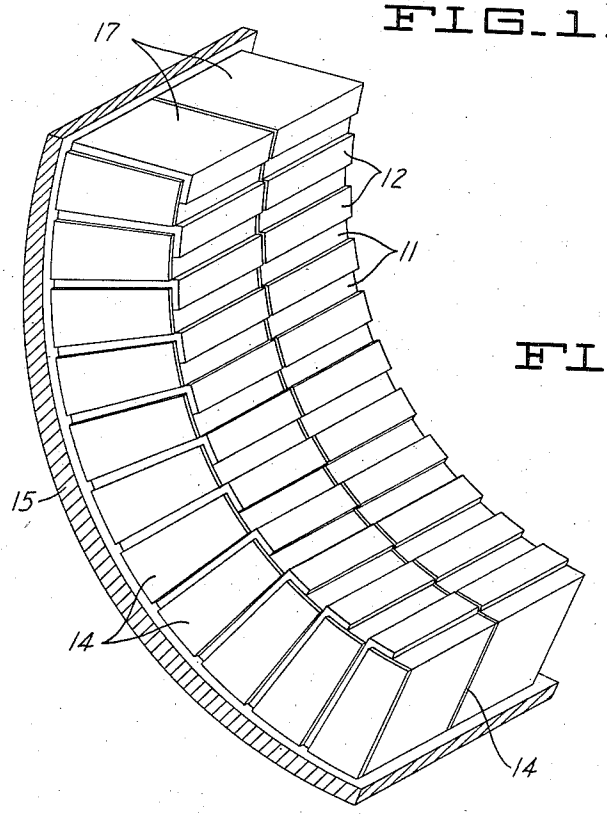

FIG. 2.

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2 Sheets-Sheet 2

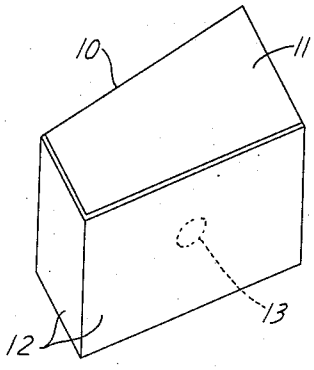

FIG. 3.

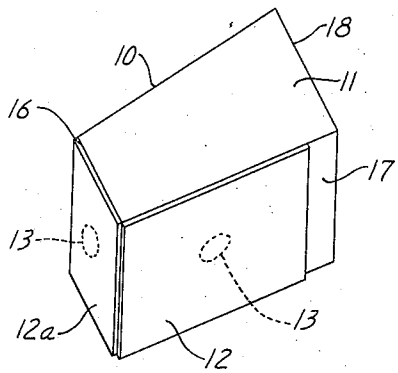

FIG. 4.

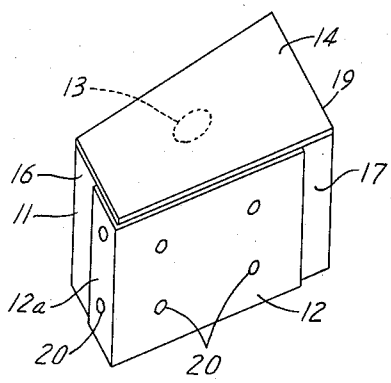

FIG. 5.

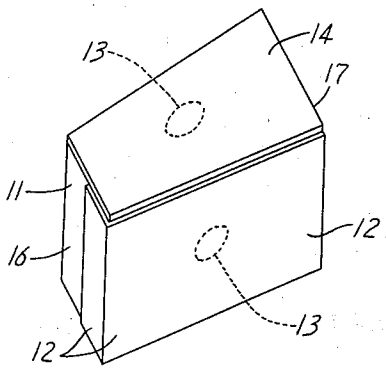

FIG. 6.

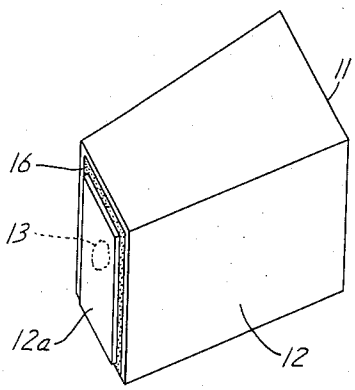

FIG. 7.

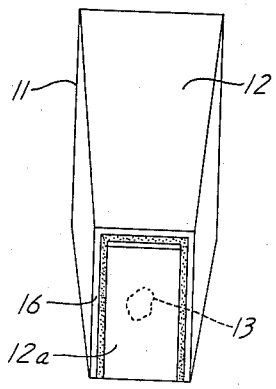

FIG. 7A.

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United States Patent Office 2,829,877 Patented Apr. 8, 1958

2,829,877

REFRACTORY

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Application September 9, 1955, Serial No. 533,475

13 Claims. (Cl. 263—33)

This invention relates to refractory linings for rotary kilns, and to refractory members useful for forming such linings, and to processes for making the same.

It has been known in the past to line rotary kilns with refractory blocks, especially nonacid or basic refractory bricks, and to interpose an oxidizable metal plate between these blocks to prevent cracking or spalling of the blocks. However, in practice it has often been found that the life of the lining is too short, and frequently it has been found that a relatively minor, but effective, portion of the lining will have eroded or worn away, requiring shutting down of the kiln and repair of the lining. The short life of such linings and the interruption of operations which ensues are believed due especially to two difficulties.

One difficulty found in past installations of linings has been the failure of the worker and of the supervisor to recognize the end of a brick which should face the hot zone, as installed, and therefore the failure to install brick properly. Bricks for such linings are usually or very often tapered, the face toward the hot zone, or the so-called hot face, being smaller in area than the face toward the kiln shell, or the so-called cold face, but the taper is slight or moderate and the difference in area between these faces is not readily recognized, especially where speed is required in lining a kiln and getting it back into service. Another difficulty has been that the desired metal spacer plates have not been uniformly and consistently set in place.

It has now been found that points of weakness and ultimate lining failure develop where an oxidizable metal plate is omitted in a ring of brick, and where the brick is improperly installed with its larger, or cold, face toward the interior of the kiln. Where the metal plate is omitted, the adjacent brick do not bond together properly and, under the influence of the heat of the kiln in service, cracks develop in these brick with resultant spalling or even loss of the brick. This also occurs when the brick are installed improperly, with the cold face inward, because the brick will fall out and also proper bonding of brick to brick by way of the spacer plates does not occur.

It is accordingly an object of this invention to provide a rotary kiln refractory lining which has substantially increased resistance to cracking, spalling, erosion and wearing; and which has, therefore, increased life. It is a further object to provide a rotary kiln refractory lining wherein a metal spacer plate is consistently placed between adjacent bricks in a ring or in a course, or both, if desired, whereby human failure to insert such plates is avoided and the resistance of the lining is correspondingly ensured. It is a still further object to provide a refractory member for such linings whereof the hot face, that is, the face to be exposed to the furnace zone and directed away from the kiln shell, is consistently and readily identifiable, to ensure that the member will always be properly installed. It is a further object to reduce time and cost of installation of a lining and to provide for the expansion that occurs as the plates oxidize when subjected to heat which object is achieved by the use of a combustible adhesive to affix the plates to the individual bricks, which adhesive combusts to provide spaced for relieving any undue stresses which might cause cracking and spalling of the bricks.

It is another object of the invention to provide a metal plate covering a substantial portion of the hot face of the refractory block, i. e., in a sufficient amount whereby formation of an oxidized coating on such face is enabled and accelerated. In order to extend the life of the refractory lining in a kiln employed in burning, for example, Portland cement, limestone, dolomite or the like, the lining is usually provided in a preliminary treatment with a coating of such burned materials or of the burned rock used in making the cement. Depending upon the chemistry or composition of the kiln feed, it is sometimes difficult to form this coating on the surface of the new brick. It has been common practice for many years to induce such a coating on a new lining by bringing an iron compound, usually introduced as iron pyrites or mill scale into intimate contact with the hot face of the brick thereby forming iron oxide and then a calcium ferrite which will promote the bonding of the burned rock to the hot face of the brick. This has sometimes been accomplished by making a wet slurry, half of Portland cement and half of the iron pyrites or mill scale, which slurry was painted on the brick before the furnace was started up. Another method has been to place piles of the dry mixture uphill from the nonacid hot zone so that as the material worked down the kiln under fire, it would wash the face of the nonacid refractories and promote the formation of a permanent coating. It is an object of the present invention to provide a more uniform coating for the hot face of the brick, and in a more simple and effective manner.

It is a still further object to ensure that an adequate number of combustible spacers will be provided in the courses of the brick and, if desired, also in the rings, as will be apparent from the description which follows; and to reduce the time and cost of installing such combustible spacers.

According to the invention such objects are attained and the disadvantages of the prior art are avoided by providing a lining, for the hot zone of a rotary kiln, which comprises refractory blocks, oxidizable metal plates disposed between adjacent blocks and an oxidizable metal plate which extends over at least one-third of the area of the hot face of the block. The annexed drawings illustrate some embodiments of the rotary kiln lining of this invention and of refractory members useful in making such linings. Preferably the metal plates are affixed to the refractory block. Preferably also, a combustible sheet or spacer is affixed to at least one face of the block, as will be further described herein.

In the drawings:

Figure 1 shows a transverse section of a rotary kiln having a refractory lining according to the invention;

Figure 2 shows a perspective view of a section of a rotary kiln having a refractory lining according to the invention, and including also cardboard sheets or spacers between adjacent courses of brick;

Figure 3 represents a refractory block or brick to which is fixedly attached a metal plate according to this invention;

Figure 4 represents another embodiment of such refractory block and attached metal plate;

Figures 5 and 6 represent embodiments wherein a side face and the hot face of the brick are covered with a metal plate and a side face adjacent the metal-coated side face is coated with cardboard fixedly attached thereto,

the means for attaching the metal plate differing in Figure 5 from the means shown in Figure 6;

Figures 7 and 7*a* are perspective and end views, respectively, of another embodiment of this invention wherein a metal case covers 3 sides of the kiln block, with a metal tab separately affixed to the hot face.

The refractory brick can be made of any nonacid refractory material, that is, it can be made of magnesite, periclase, chromite, magnesia-chrome, chrome-magnesia, alumina, magnesia spinels, mixtures of these substances with each other or other basic or nonacid refractory material as known to the art. The brick is made by known processes. There can be employed fired, unfired, fused or chemically bonded bricks, as desired. In the present state of this art, there are generally employed refractory bricks or blocks which are in shapes known in commerce as wedges, arches or keys, but the present invention is useful with any desired shape of refractory block or brick for rotary kiln linings. The faces of the block or brick can, for example, be either flat, or arcuate to conform to the curvature of the kiln.

The metal plate useful in this invention is an oxidizable metal, preferably iron or steel. Other metals such as nickel, zinc, aluminum or other can be used, but steel or iron is usually employed because of the ready availability, satisfactory performance and lower cost of such plates. The metal plate covers at least one-third, preferably at least one-half, of the area of the hot face. The plate can be so formed as to continuously cover such face areas, for instance as shown in Figures 1 and 2; but two pieces can also be employed, whereby one plate or sheet covers at least the major portion of a side surface and another covers at least one-third of the end area. The metal plates are preferably fixedly attached to the refractory bricks. A small number are, in some embodiments, not attached, whereby they can be inserted after the last few bricks are installed in a ring, and enable keying in of these bricks. Suitably, the plates are of metal which is about 28 gauge to 10 gauge in thickness. Preferably, the metal plate is disposed at a side face within a ring; but, if desired, it may be disposed at a side face in the course instead of or in addition to a metal plate affixed to a face within the ring.

The metal plate covers at least a major portion of at least one side face of the block. Preferably, the plate covers the whole of a side face; but if it is desired to reduce conduction of heat to the shell, advantageously the metal plate does not extend the whole length of the side face and it then terminates at a point on the side face spaced from the cold face of the brick. In a novel unitary refractory member according to this invention, the metal plate is fixedly attached to the refractory block. It can be attached by providing apertures in the plate, placing the plate in a mold, filling refractory material into the mold and pressing to cause a portion of the refractory mass to extrude into the apertures and effect attachment upon setting of the refractory. A suitable method for molding in this manner is described in Macallum U. S. Patent 1,106,725, granted August 11, 1914. In another mode of procedure, a sticky, rubbery adhesive is disposed between the brick and the metal plate, whereby the plate is adhesively attached to the brick. Such a mode of attaching a metal plate to a brick is described in the co-pending application of Earl D. Wilkins, Serial No. 345,219, filed March 27, 1953. Plates can be adhesively attached in this manner to burned brick, as well as to unburned or chemically bonded brick; and the rubbery adhesive is particularly advantageous in attaching a metal plate to the side face and separately attaching a metal plate to the hot face. The rubbery adhesive can be, for example, polymerized isoprene, natural rubber latex, polyethylene, butadiene-styrene copolymer, or vinyl resin latex, for example, of polyvinyl acetate and polyvinyl chloride, or mixtures of any of these with each other or with a resin or resins thereof. In still another embodiment, a metal plate is attached to each of two opposite side faces of the brick in such a manner that each plate is disposed within the ring of brick in the kiln and in such embodiment a metal tab also covers at least one-half of the hot face and can be provided as described with reference to the three-sided cases. In another embodiment, metal plates can cover two adjacent side faces and at least one half of the hot face of the brick. There can also be applied to the brick 2 metal U-shaped cases to substantially cover 4 side faces of the brick, and whereby a metal tab or plate is affixed also over at least one-half of the hot face of the brick either as an extension of one or both of the U-shaped cases or as a separate piece.

Another feature of this invention is the provision of a combustible sheet attached to at least one side face of the refractory brick. In a preferred embodiment, such side face is adjacent the side face to which the metal plate is applied. When the refractory member is installed there is then a combustible sheet between a brick and the adjacent brick in the next course. Upon firing in place, such sheet is consumed and space is provided for expansion of the refractory. The combustible liner also protects the brick during handling and shipping. Suitably, cardboard is employed as the combustible liner but any other combustible sheet material can be employed. The combustible liner is preferably attached to the brick by the rubbery adhesive described above, a small amount of the latter being disposed between such liner and the brick. To compensate for longitudinal expansion, i. e. in the direction of the axis of the kiln, combustible plates are attached to all bricks on at least one side face adjacent the next course of brick in the kiln, in such a manner that at least one combustible spacer is present between such adjacent bricks. Suitably, less expansion is provided for in the ring of brick and, for this reason, combustible spacers are attached to only a portion of the brick faces within the ring or, alternatively, a very thin spacer is applied to each such brick face. It is sometimes advantageous to affix a combustible spacer to every side face of the brick which is not covered by a metal spacer, to provide protection for the brick during handling and shipping. It is also sometimes suitable to affix a combustible spacer over the metal plate, which provides also space for expansion when the brick is in place in the kiln.

The annexed drawings will illustrate more clearly the article of this invention and modes of affixing the various spacers.

It is an advantage of the present invention that a coating of the burned raw materials, which have been fed to the kiln, is very rapidly formed upon and well bonded to the brick lining. Another advantage is that the life of the lining is increased because the coating which is formed protects the surfaces of the brick. It is a still further advantage that the metal tabs which form an oxidized coating uniformly over the face of the brick, rapidly and strongly bond the burned coating thereto, and thereby cut down greatly on heat losses through the kiln walls in a very efficient manner. Still other advantages of the use of members having affixed metal plates, and if desired combustible plates, are the saving in labor in installation of the linings because the plates do not have to be separately set in place, and the assurance that the metal and combustible plates will be present as needed.

Figure 1 represents a transverse section of a rotary kiln for burning cement and having a refractory lining according to the invention. The means for supporting and actuating the kiln are not shown, being conventional and well known in the art and not necessary for illustrating the present invention. The kiln comprises a metal shell 15 within which the refractory lining is placed. According to this invention, the refractory lining is made up of refractory elements 10 which are composed of refractory bricks 11 having metal plates or spacers 12 fixedly attached thereto. A portion of each plate 12 extends over at least one-half of the area of the hot face 16 of each brick;

and the metal plate extends over a major portion of the side face 17 of each brick, separating it from the adjacent brick in the course. The cold face 18 of each brick rests upon the shell 15 in this embodiment. Alternatively, if desired, an insulating material, for example, a layer of insulating brick (not shown) can be disposed between the shell and the refractory lining of this invention, to reduce heat losses through the shell, in the known way.

Figure 2 is a perspective view of the portion of the rotary kiln shown in Figure 1, and shows the bricks or kiln blocks in place in the lining, along with cardboard sheets placed between bricks in adjacent courses. The thickness of the spacers is exaggerated with respect to the size of the brick, in these views.

The refractory elements employed in the embodiment of Figures 1 and 2 are made as illustrated in Figure 6. The kiln block 11 in this embodiment is an unburned, chemically bonded periclase chrome brick, in the shape known as a "wedge," and it has attached to it metal plate 12 which is a continuous sheet of steel shaped to conform to and substantially entirely cover side face 17 and hot or end face 16 of the brick. The steel plate 12 is attached to the brick by means of a small amount of rubbery adhesive 13. The kiln block also bears a cardboard sheet or plate 14 which is attached to it by a small amount of the adhesive 13. The cardboard plate is applied to side face 19 of the brick adjacent the side face bearing metal plate 12.

The lining of the kiln is formed by placing successive kiln blocks 10 in a course, in the manner known to the art which will not, therefore, be explained in more detail except as it pertains especially to the present invention. In this installation procedure, the metal clad end faces are all placed so that they face the interior of the kiln. The metal cladding of the ends insures ready recognition of the hot face and proper placing of the blocks. When the course is about to be completed, 5 or 6 blocks 11, without metal plates are placed in the kiln to enable installation of the total number of blocks required by a course. This results in extra space, and separate metal plates 12 are then inserted between the blocks which do not have metal cladding, and are pounded in to fit tightly against the end faces and to cause the bricks to fit snugly together in the course. The bricks or blocks which do not have attached metal plates, are provided with attached cardboard plates or sheets 14. The cardboard sheets separate adjacent courses, as better shown in Figure 2. If desired, and to ensure that there will be metal plates between all bricks in a course, every brick installed is provided with attached metal plate 12, and after all possible bricks are placed, some space will be left. Metal plates of substantially the size of the metal clad side faces of the bricks are then inserted between the last few bricks in a course and are pounded in to insure snug fitting of the bricks and plates in a course. When all of the courses have been installed, the furnace is ready for operation.

During operation of the furnace, the metal plates oxidize and unite with the refractory material of the kiln block, providing a strongly bonded structure. The metal tab, that is, the portion of the metal plate, covering the hot face of the brick, is in a sufficient amount that it melts and flows over the hot face of the refractory and oxidizes at the same time, to cover the face of the refractory, and bond cement clinker or burned rock to the hot face, forming a coating which protects the brick lining, especially protecting it from attack by the cement materials which are being burned in the furnace and which flow over the lining at high temperatures and in intimate contact therewith. The cement materials contain aluminous materials and silica, among other components, and the two substances named react fairly readily with magnesia or periclase, for instance, under the conditions of operation, which in prior practice has led to severe erosion of the furnace lining with necessity for frequent patching and repairs. More especially, the metal tabs being readily visible upon inspection ensure that there is at least one plate between each two adjacent bricks in a course and that, therefore, oxidation of the plates and formation of a bond between the bricks is ensured, and cracking and spalling is prevented or greatly decreased. Early failures of basic or nonacid brick linings for kilns of this type have almost invariably been found to occur at points where hasty or inattentive installation has resulted in the omission of metal spacer plates. This invention avoids this result because visual inspection will rapidly detect spots where plates might be missing, as in placing the last few bricks in a course. During the firing operation the cardboard plates or liners burn away and provide space for the expansion of the brick, which occurs upon firing of basic brick particularly. The burning of the cardboard forms principally carbon dioxide and water vapor and is not objectionable.

Figures 3, 4, 5 and 6 represent various embodiments of the unitary refractory element 10 according to the invention. It will be understood that any desired number of bricks or blocks can be employed in the lining, depending upon the size of the kiln, the size of the blocks, etc. The metal plate is applied to a longitudinal side face and to the hot face of the block or brick; and the cardboard plate or liner 14, where used, is applied to a transverse side face of the brick or block. In Figure 3, a refractory block 11 which can be of magnesite, periclase or magnesia, chromite, chrome-magnesia, magnesia-chrome or other refractory material is coated with metal plate 12, which is fixedly attached to block 11 by rubbery adhesive 13, further described above, and the adhesive can be applied under both the side plate and the end plate or at only one of these two locations. In the element of Figure 3, the plate covers substantially entirely each of the faces to which it is applied and the plate is a continuous piece of metal suitably shaped to conform to and fit upon the brick.

In the embodiment of Figure 4, to the block 11 are applied two pieces of metal, 12 and 12*a*, each being adhesively attached to the block by rubbery adhesive 13, the metal tab or plate 12*a* covering substantially all of hot face 16, and metal plate 12 is terminated at a point on side face 17 spaced from the cold end or face of the brick, indicated by 18, whereby heat conduction to the kiln shell will be reduced when the unitary refractory element is installed therein.

In the refractory element of Figure 5, metal plate 12 is provided with apertures 20. In molding the brick, the plate 12 is placed in the mold and the refractory material is then filled in and pressed, whereby some of the refractory is pressed into apertures 20 (of which any desired number can be employed) and upon setting forms a firm connection or attachment between the block and the plate. In Figure 5, a cardboard liner is also provided on side face 19 of brick 11, which face is adjacent that side face 17 to which the metal plate is applied. In this embodiment the end tab 12*a* of plate 12 covers at least one-third the area of the end face 16. Figure 6 has been described above.

In Figures 7 and 7*a* there are shown an embodiment of this invention wherein a refractory block 11 has affixed thereto a 3-sided or U-shaped metal case 12 which is held to the brick by the springing action of the sides of the U; and metal tab or plate 12*a* is separately attached to the hot face of the brick by means of adhesive 13 as described with respect to Figure 4, for example. Alternatively tab 12*a* can be an extension of a side of plate 12, bent to conform to the shape of block 11.

It is believed that the metal plates or tabs on the hot faces of the brick melt and flow over the faces and simultaneously oxidize, whereupon the oxide of the metal of the tab combines with the non-acid, for example basic, brick composition on the one hand or with the components of the burned kiln feed on the other, strongly bonding

a coating of the latter to the hot face of the lining. Likewise, the metal plates between the bricks oxidize and bond the bricks to each other. Where iron or steel plates are employed, iron oxide is formed which combines with magnesia or periclase of a magnesia-containing brick, for example, to form magnesioferrite bonding agent. Iron oxide is also soluble in chromite and therefore compatible therewith; and it likewise combines with silica if the latter should be added with the feed, for example. The metal plates or tabs made of other oxidizable metals also form oxides reactive with components of suitable bricks and with the burnt kiln feed materials, to effect the desired bonds and to cause coating of the hot face of the brick.

The terms "brick" and "block" are used interchangeably herein to refer to the refractory shaped piece to which the metal plate and, if desired, the cardboard sheet are applied. The rubbery adhesive employed herein strongly bonds the plates or sheets to the bricks and maintains its strength until fired, at which time it oxidizes to yield principally carbon dioxide and water, which go off with the furnace gases and are not objectionable. The refractory blocks shown herein are wedge-shaped but, if desired, blocks of other shapes can be employed in this invention, as further described above. Where the terms "chrome-magnesia" and "magnesia-chrome" are employed they are intended to include also reference to such compositions known as "chrome-magnesite" and "magnesite-chrome" or "chrome-periclase" and "periclase-chrome".

In this specification and claims, the term "ring" of brick is intended to mean each circle of brick laid around the circumference of the kiln, in a plane at right angles to the axis of the kiln; and the term "course" of brick is intended to mean a row of brick running lengthwise in the kiln. The "hot" face of the brick is that face which is exposed to the interior of the furnace, while the "cold" face is that face directed toward the shell of the kiln, and the side faces are the other, remaining faces longitudinally of the brick. Although reference has been made above more specifically to the use of the article of this invention in lining rotary kilns for burning cement raw materials to clinker, the article is also useful for linings of such kilns to be employed in burning limestone, dolomite, magnesite, alumina and other like materials.

Having now described the invention, what is claimed is:

1. A rotary cement kiln having a metallic shell and a refractory lining disposed in the hot zone of said shell comprising non-acid refractory blocks disposed around the periphery of said shell in rings and metal plates disposed between adjacent blocks in each ring and over at least one-half of the hot face of each block, said metal plates being fixedly attached to at least one face of a major number of said blocks, and combustible plates disposed between blocks in adjacent rings and being fixedly attached to the faces of the blocks in at least one of said rings.

2. A rotary cement kiln is in claim 1 wherein said combustible plates are cardboard.

3. A rotary kiln as in claim 1 wherein said refractory blocks are made of basic refractory material.

4. A rotary kiln as in claim 1 wherein said metal plates are of ferrous metal.

5. A rotary kiln and a lining therefore comprising a series of concentric adjacent rings formed from a plurality of identical composite refractory articles, each of said articles including a refractory body having end faces and side faces, one of which end faces is disposed toward the inner hot zone of the kiln, a steel plate covering at least a major portion of at least one side face and a portion of that end face of said body disposed toward the inner hot zone of a kiln and being present thereover in a sufficient amount to melt and flow over said end face in response to exposure to the heat of a kiln to form a heat resistant coating thereover, a combustible plate means covering a further side of said refractory body, a rubbery combustible adhesive fixing both said steel plate and said

combustible means to the respective side faces of the refractory body, said composite article being so oriented in the kiln lining that said steel plates are disposed between adjacent similar articles defining a lining ring while said combustible means is disposed between adjacent similar composite articles defining a next adjacent ring of the lining.

6. A composite refractory article for lining rotary cement kilns comprising a wedge-shaped, non-acid refractory body having side faces two of which are in opposed diverging relation, and end faces, one of which end faces is smaller than the other and disposable toward the inner hot zone of a kiln, a steel plate covering at least a major portion of at least one of said divergent side faces and a portion of the smaller end face of said body, the steel plate means covering said end face being present in a sufficient amount to melt and flow over said end face in response to exposure to heat of a kiln to form a heat resistant coating thereover, a combustible plate means covering a further side of said refractory body adjacent to that substantially covered by said steel plate, a combustible adhesive fixing both said steel plate and said combustible means to the respective side faces of the refractory body, said composite article adapted to being oriented in a kiln lining such that said steel plates are disposed between adjacent similar articles defining a lining ring while said combustible means is disposed between adjacent similar composite articles defining a next adjacent ring of the lining.

7. A composite unitary refractory article as defined in claim 6 wherein said steel plate means is L-shaped in configuration, the shorter leg of the L covering the smaller end of the refractory body, the longer leg of which overlies said divergent face.

8. A composite refractory article as defined in claim 6 wherein said steel plate means is comprised of two flat plates one of which is fixed to the said divergent face, the other of which is fixed to the smaller end of the refractory body.

9. A rotary kiln or the like and a lining therefor comprised of a series of identical composite refractory articles arranged around the interior circumferential wall of the kiln to define a series of adjacent, concentric rings, each of said composite articles comprising a refractory body having side and end faces, one of which end faces is disposed toward the interior hot zone of the kiln and the other of which is disposed away from said hot zone, and a metallic oxidizable means permanently united to at least one of the faces of said refractory body lying within a ring and being oriented with respect to said refractory body such that said means overlies and covers a major portion of the surface area defined by one of the side faces of said refractory body, said means also overlying that end face of the refractory body which is disposed toward the hot zone of the kiln and forming thereover a rapidly oxidizable constituent, said means being present in an amount sufficient to melt and flow completely over the end surface of the refractory body under the influence of heat developed within the kiln while oxidizing to form a heat resistant coating, and means covering substantially all of a further side face of said refractory body, said means being a combustible spacer member affixed to said body by means of a combustible adhesive.

10. In a rotary cement kiln having a metallic shell, the combination of a non-acid refractory lining disposed in the hot zone of said shell comprising a plurality of identical, composite, wedge-shaped refractory articles disposed about the shell in rings and courses, each of said articles including a wedge-shaped refractory body having end and side faces, one of said end faces being smaller than the other, at least two of said side faces being in divergent relation with respect to one another and lying within a ring, the smaller end face being disposed toward the hot zone, meltable oxidizable metal means permanently attached to one of said side and end faces, said means being

so oriented with respect to said refractory body that said means overlies a major portion of one of said diverging faces and at least part of the area defined by said smaller end face and being present thereon in an amount such that upon exposure of said oxidizable means and body to the heat of the hot zone of the kiln said means overlying said end face will melt and flow completely over said end face while oxidizing to form a heat resistant coating thereover, and a further side face being provided with a combustible spacer means affixed thereto.

11. A composite refractory article according to claim 6 wherein said plate means covers at least one-third of said smaller end face of the body.

12. A composite refractory article for lining rotary cement kilns comprising a wedge-shaped, non-acid refractory body having side faces two of which are in opposed diverging relation, and end faces, one of said end faces being smaller than the other end face and adapted to be disposed toward the hot zone of a kiln, an oxidizable metal plate means covering at least a major portion of one of said divergent side faces and a portion of said smaller end face of the body, the oxidizable plate means covering the portion of said smaller end face being present in amount sufficient to melt and flow over said end face when exposed to heat of a kiln to form a coating thereover, and a combustible adhesive affixing said oxidizable plate means to said side face of the refractory body, said composite article adapted to be oriented in a kiln lining such that the plate means covering said side face is disposed between adjacent similar refractory articles defining a lining ring.

13. A composite refractory article according to claim 12 wherein said oxidizable plate means is composed of steel and wherein said means covers at least one-third of said smaller end face of the refractory body.

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