Jan. 28, 1941. R. E. LONGACRE 2,230,142

ROTARY KILN LINING

Filed Oct. 24, 1939 2 Sheets-Sheet 1

Fig. 1.

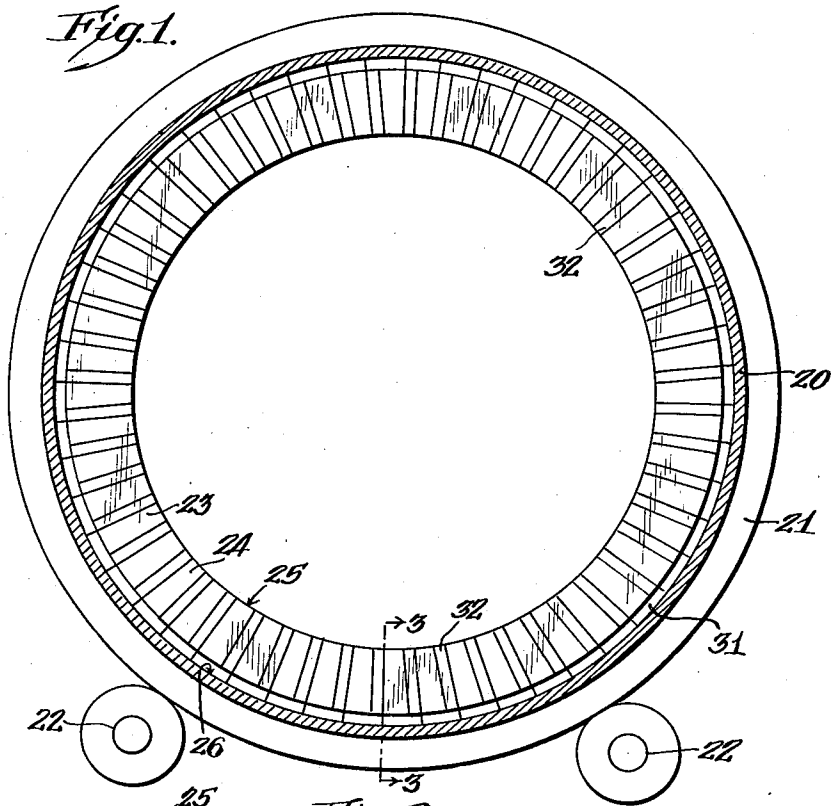


Fig. 2.

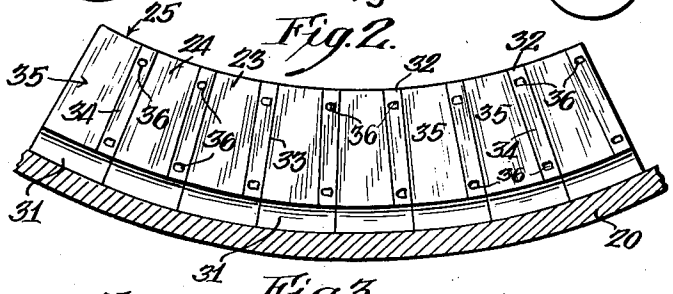
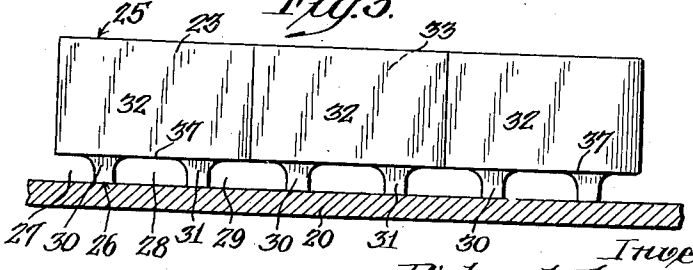


Fig. 3.



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Fig. 4.

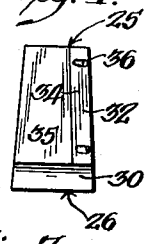


Fig. 5.

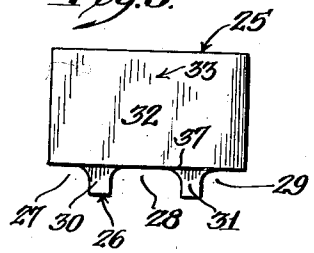


Fig. 7.

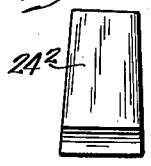


Fig. 6.



Fig. 8.

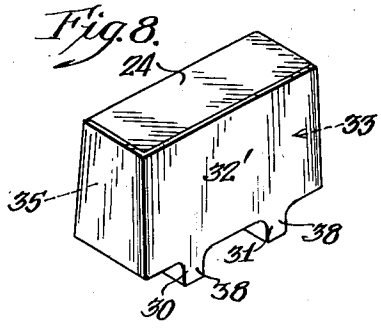


Fig. 9.

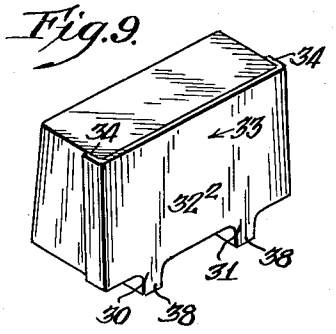


Fig. 10.

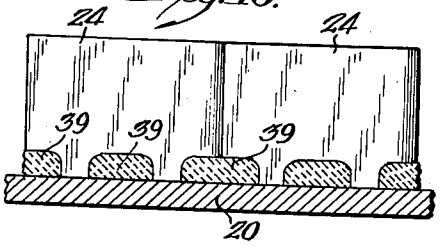


Fig. 11.

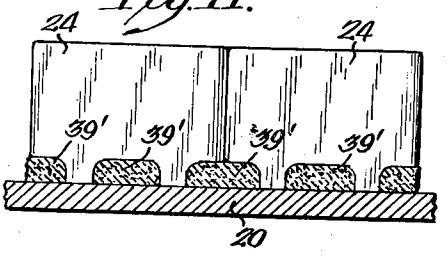


Fig. 7a

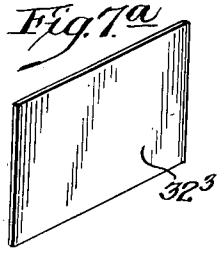
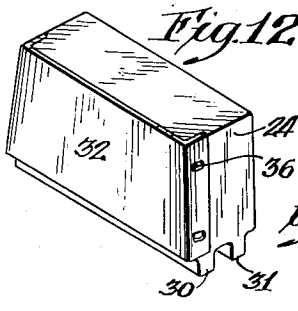


Fig. 12.



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Patented Jan. 28, 1941 2,230,142

UNITED STATES PATENT OFFICE

2,230,142

ROTARY KILN LINING

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Application October 24, 1939, Serial No. 300,998

7 Claims. (Cl. 263—33)

The invention relates to refractory linings for rotary kilns.

A purpose of the invention is to obtain column support of the hot face of a rotary kiln lining directly from the metallic shell of the kiln while providing heat insulating means to restrict heat transfer from the lining to the shell.

A further purpose is to heat insulate the lining of a rotary kiln from the metallic shell while avoiding structurally-intervening insulation material which would prevent direct column support of each brick of the lining from the metallic shell.

A further purpose is to provide rotary kiln lining bricks with heat transfer-restricting legs which rest directly on the metallic shell of the kiln.

A further purpose is to rest the cold face of a rotary kiln lining brick directly on the metallic shell of the kiln while reducing the area of the cold face with respect to the cross sectional area of the brick at a point nearer the hot face.

A further purpose is to space the supporting legs on the cold face of a rotary kiln brick substantially equally with respect to one another and to adjoining legs of adjoining brick at either side.

A further purpose is to recess the cold face of a rotary kiln brick at intervals, between the recesses extending legs to the cold face and in contact with the shell of the kiln, and to fill the recesses between the legs with heat insulating material either in premolded or loose form.

A further purpose is to support a rotary kiln lining brick on a pair of spaced legs resting directly on the metallic shell of the kiln and to integrate the brick with an adjoining brick by means of an oxidizable metallic spacer plate.

Further purposes appear in the specification and in the claims.

In the drawings no effort is made to illustrate all possible embodiments of the invention. The forms shown have been chosen largely from the standpoint of convenience in illustration and satisfactory operation.

Figure 1 is a transverse section, largely diagrammatic, of a rotary kiln. The section is not precisely a vertical section as the kiln is inclined to the horizontal.

Figure 2 is an enlargement of a portion of Figure 1.

Figure 3 is an enlarged section of Figure 1 on the line 3—3.

Figure 4 is an end elevation, Figure 5 is a side elevation, and Figure 6 is a top plan view of one of the bricks shown in Figures 1 to 3 inclusive.

Figure 7 is an end elevation of a variant form of brick.

Figure 7*a* is a perspective view of a variant form of plate.

Figures 8 and 9 are perspective views of other variations.

Figures 10 and 11 are views corresponding to Figure 3, showing variant forms of heat insulation in the recesses on the cold faces of the bricks.

In the drawings like numerals indicate like parts throughout.

The description is in illustration and not in limitation.

When a rotary kiln is referred to herein, it is intended to designate a kiln of the cement kiln variety, or a kiln of the type used to calcine ores, building materials, refractory materials and the like.

Until the recent past, rotary kilns were ordinarily lined with fire clay or high alumina brick which were never insulated in the burning zone. Insulation in the burning zone proved to be undesirable because it increased the temperature of the hot face of the brick beyond the point which the brick would stand when brought in contact with lime and other fluxes present in the charge. In the zone of intermediate temperature, between the burning zone and the preheating zone, heat insulation was sometimes employed in the form of a separate annular layer between the refractory and the metallic shell of the kiln.

Nonacid brick such as magnesite brick have been recently installed in rotary kilns, thus raising the permissible operating temperature at the hot face. With such magnesite brick in the refractory lining, the burning zone has been insulated by inserting, between the lining and the shell of the kiln, an annular course of insulating brick ranging from one inch to two and a half inches in thickness, and suitably consisting of asbestos or the like.

Such insulating linings were quick to fail, apparently due to the shifting of the relative positions of refractory bricks in the lining with respect to individual bricks in the heat insulating layer. With each rotation of the kiln, an individual brick in the lining passes through a condition of no load, to a condition of maximum load under which it is bearing the load of the charge and the lining. Relative shifting of the refractory lining and heat insulating layer has produced unevenness in the base of support for the

cold face of the brick in the refractory lining. Thus at one time the individual brick in the refractory lining may be supported fully and evenly on an individual heat insulating brick, whereas at another time the cold face of the refractory brick may be opposite a junction of two or of four heat insulating bricks, with almost inevitable uneven support. The crushing strength of the heat insulating brick being lower than that of the refractory brick, this uneven support means concentrated stress on the heat insulating brick, and relatively early failure of the weaker heat insulating brick through crushing. Crushing of an individual heat insulating brick then destroys the lateral support of an adjoining heat insulated brick, causing progressive failure of the heat insulating layer, and further concentration of stress in the lining until lining bricks themselves fail.

By the present invention, adequate column support of the individual refractory brick is assured directly from the metallic shell without interposing relatively more friable heat insulated material in the structural column, and without providing any heat insulating layer which might shift to produce an uneven base for the lining bricks.

In accordance with the invention, each refractory brick has an adequate base on the metallic shell of the kiln and a base which cannot shift with respect to that brick since it is integrally united with the brick. At the same time heat transfer is prevented at the cold face.

This result is accomplished by constructing legs, suitably integral with the refractory brick, on the cold face and extending these legs to the metallic shell. The legs are desirably widely enough spaced so as to prevent any tendency of the brick to tilt, the most desirable spacing being such that the legs are substantially equally spaced from one another and from adjoining legs of adjoining brick at each side (end).

Figure 1 shows a rotary kiln having a metallic shell 20 and band 21 supported on rollers 22 and driven by means not shown. Within the shell is placed a refractory lining 23 consisting of bricks 24 of suitable type. Figures 1 to 11 indicate wedge bricks while Figure 12 shows a key brick 24', otherwise similar.

The bricks 24 have a hot face 25 and a cold face 26. At the cold face the cross sectional area is restricted by recesses 27, 28, and 29 extending clear across the cold face and forming spaced legs 30 and 31. The legs 30 and 31 directly contact the metallic shell 20 and thus produce direct column support of the bricks 24 clear through from the shell 20 to the hot face 25 without interposing any heat insulating material in the structural column, and particularly without interposing any separate heat insulating layer which might crush under the load on the bricks.

The legs 30 and 31 themselves function as heat insulating means for the cold face against the metallic shell.

The legs 30 and 31 also form a base for the individual brick which is integral with the brick and, therefore, unshiftable with respect to it.

It has been found to be very desirable to space the legs substantially equally with respect to one another and with respect to the legs of adjoining bricks on either side (end). This insures maximum stability of support with minimum supporting span between the legs. This condition may be seen in Figure 3, where the distance between any two legs of an individual brick is substantially twice the distance from any leg to the nearest end of the brick. The legs 30 and 31 are preferably formed on the brick during the process of molding.

The bricks 24 are very desirably of nonacid variety, such as magnesite (magnesia), chromite (chrome iron ore), chrome-magnesite, or magnesite-chrome. Preferably the bricks will be unfired, that is, merely dried and not subjected to firing temperatures before use in the rotary kiln.

Suitable brick for the present purpose are described in Heuer United States Patents No. 1,714,506, granted May 28, 1929, for Brick and cement for furnace use; No. 1,845,968, granted February 16, 1932, for Chrome refractory and its method of manufacture; No. 1,851,181, granted March 29, 1932, for Dense mix for refractories and process of preparing the same; No. 1,859,512, granted May 24, 1932, for Refractory and method of making it; No. 1,942,483, granted February 26, 1935, for High-pressure chrome refractory; No. 2,068,411, granted January 19, 1937, for High-pressure nonplastic refractory and method of making the same; No. 2,087,107, granted July 13, 1937, for Chrome-magnesia refractory and method; No. 2,154,813, granted April 18, 1939, for Suspended furnace roof; and No. 2,155,165, granted April 18, 1939, for Furnace roof. Each of these patents is incorporated herein by reference and is made a part hereof.

Where nonacid refractory brick are employed and particularly where nonacid refractory brick predominantly consisting of magnesite are used, it is very desirable to place oxidizable metallic spacer plates between adjoining brick faces to integrate the refractory lining. The use of such spacer plates between faces of unburned nonacid refractory brick is particularly desirable, as such unburned brick exhibit relatively great shrinkage. The oxidizable metallic spacer plates on the other hand, grow when they oxidize, since the oxide occupies more volume than the original metal, thus compensating for the shrinkage of the unburned nonacid refractory bricks and filling what otherwise might be spaces between the bricks.

In Figures 1 to 6 inclusive, the oxidizable metallic spacer plates 32 cover only the longitudinal faces 33 of the bricks, with side arms 34 extending around the lateral or end faces 35. Any suitable means may be provided to secure the spacer plates 32 to the bricks. For example, in Figures 2, 4, and 6, spacer plates are shown which were co-molded with the bricks, that is, placed in the mold before the bricks were molded, so that metallic fingers 36 from the side arms 34 of the plates are embedded in the bricks. Co-molding of plates and bricks is shown in Heuer United States patent application Serial No. 198,426, filed March 28, 1938, for Refractory brick process, machine and structure and Serial No. 238,505, filed November 3, 1938, for Refractory brick structure.

The metallic spacer plates may be secured to the brick in any other suitable manner, not necessarily molded on the brick. Figure 8 illustrates an oxidizable metallic spacer plate 32' which is cemented to the surfaces of the refractory brick and Figure 9 shows an oxidizable metallic spacer plate 32^2 which is held on the plate by the resilient gripping of the side arms 34. It will be evident that the plate in Figure 9 can be conveniently applied at the point of use.

It is not essential to secure the spacer plate to the brick. The plate may simply be put between adjoining bricks at the time the roof is assembled. To indicate this, an unattached spacer plate 32³ is shown in Figure 7a, to be used between the bricks of Figure 7.

It is desirable to have only a single thickness of oxidizable metallic spacer plate interposed between two refractory faces of bricks. For this reason the oxidizable metallic spacer plates will preferably cover only a single face of the brick (with minor extensions for gripping purposes on two other faces), or at most two faces. In the form of Figures 1 to 6 and 9, only the single longitudinal face 33 is predominantly covered by the spacer plate, whereas in Figure 8 both one longitudinal face 33 and one end face 35 are covered by the spacer plate 32'.

The spacer plate need not entirely cover the face over which it chiefly extends. From the standpoint of reducing heat losses, it is preferable to terminate the spacer plate at 37 above the legs as shown in Figures 3 and 5, thus avoiding metal to metal contact between the spacer plate and the metallic shell. This has the disadvantage, however, that cooling of the spacer plate by heat conduction is restricted. For higher temperature installations, it is desirable to have metal to metal contact between the metallic spacer plate and the shell 20 to prevent melting out of the unoxidized portion of the metallic spacer plate. This is shown in Figures 8 and 9 where the spacer plate is extended at 38 to cover the legs 30 and 31 and thus is in position to contact the metallic shell 20.

The spacer plate will preferably be of sheet iron or sheet steel of moderate thickness, preferably $\frac{1}{8}$, $\frac{1}{4}$, or $\frac{3}{8}$ inch thick. For most purposes, the $\frac{1}{8}$ inch thickness is best. For further description of the spacer plate see Heuer United States Patent No. 2,154,813 and No. 2,155,165 above referred to.

While the use of the spacer plate is desirable, it is not essential. To indicate this fact, Figure 7 illustrates a brick 24² which is not provided with a spacer plate, but otherwise is identical with the brick of Figures 1 to 6. This type of brick may be assembled with mortar as in usual practice.

The recesses 27, 28, and 29 at the cold face of each brick will in many instances simply be filled with dead air which has a desirably low rate of heat transfer. If desired, these spaces may be filled with premolded blocks 39 of heat insulating material such as asbestos, diatomaceous earth or a heat insulating refractory of the type of kaolin or fire clay having high pore space, as for instance due to the ignition of organic matter or the evolution of gas as well known in the art. The heat insulation bricks 39 have the desirable effect of slightly increasing the stability of the refractory bricks against rocking endwise. Instead of premolded bricks 39, loose powdered material such as slightly calcined magnesite may be used at 39' as shown in Figure 11. Such loose material 39' may either be put in dry or in plastic form.

The present inventor assures column support for the individual refractory brick directly from the metallic shell without the necessity of supporting the refractory brick upon a layer of heat insulation material, and particularly without using a separate heat insulation layer which may shift its position relative to the refractory.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structures shown, and I, therefore, claim all such in so far as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. A rotary kiln having a metallic shell, in combination with a refractory lining consisting of individual bricks whose hot faces are exposed to the interior of the lining, there being at the cold faces spaced legs directly in contact with the metallic shell and spaced substantially the same distance from one another as from the legs on adjoining bricks at either side.

2. A rotary kiln having a metallic shell, in combination with a refractory lining consisting of nonacid bricks having hot faces exposed to the interior of the lining and having spaced legs integral with the bricks at the cold faces, directly in contact with the metallic shell, and oxidizable metallic spacer plates interposed between refractory faces of adjoining bricks.

3. A rotary kiln having a metallic shell, in combination with a refractory lining consisting of nonacid bricks having hot faces exposed to the interior of the lining and having spaced legs integral with the bricks at the cold faces, directly in contact with the metallic shell, and oxidizable metallic spacer plates interposed between refractory faces of each pair of adjoining bricks and extending along the sides of the legs into metallic contact with the shell.

4. A rotary kiln having a metallic shell, in combination with a refractory lining within the shell consisting of refractory bricks having their hot faces exposed to the interior of the lining, recessed at their cold faces and having spaced supporting legs in direct contact with the metallic shell between the recesses, the distance between legs on each brick being substantially equal to the distance of each leg to the nearrer leg on the adjoining brick, and heat insulating material occupying the recesses between the legs on each brick and between the nearer legs on adjoining bricks.

5. A rotary kiln having a metallic shell, in combination with a nonacid refractory lining within the shell consisting of refractory bricks having their hot faces exposed to the interior of the lining, recessed at their cold faces and having spaced supporting legs in direct contact with the metallic shell between the recesses, the distance between legs on each brick being substantially equal to the distance of each leg to the nearer leg on the adjoining brick, and molded bricks of heat insulating material occupying the recesses between the legs of each brick and between the nearer legs on adjoining bricks.

6. A rotary kiln brick having at its cold face a pair of integral spaced legs, the distance between the legs being substantially twice the distance from each leg to the adjoining end of the brick.

7. A rotary kiln brick of nonacid character having hot and cold faces and side faces, and having spaced supporting legs at its cold face, and an oxidizable metallic spacer plate secured to one of the side faces of the brick.

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