Sept. 26, 1967 G. P. REINTJES 3,343,319

REFRACTORY LINER ANCHORAGE

Filed April 29, 1965

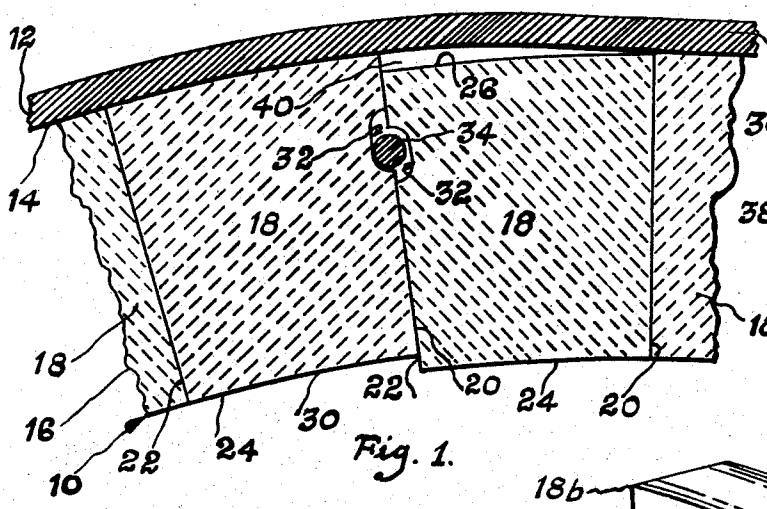


Fig. 1.

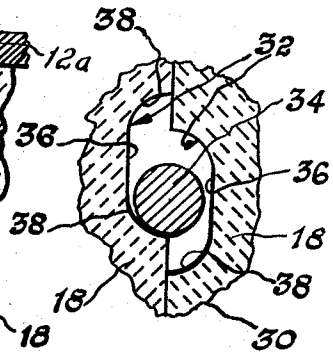


Fig. 2.

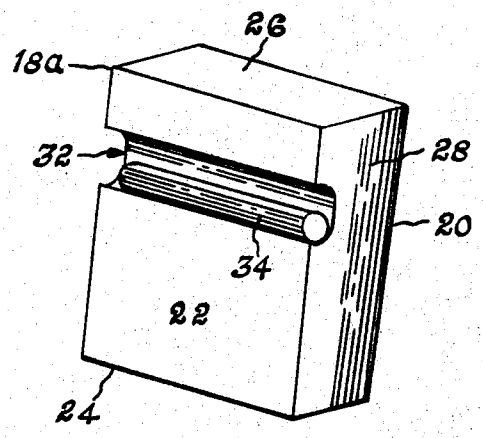


Fig. 3.

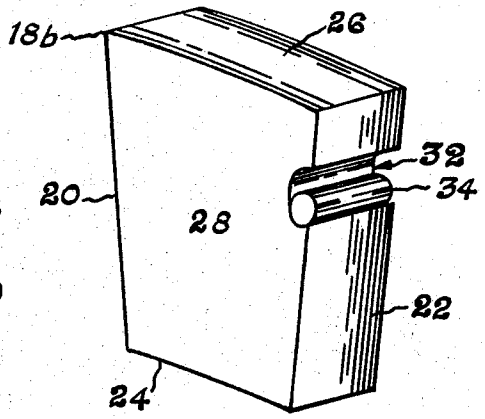


Fig. 4.

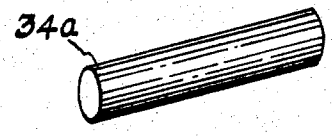


Fig. 5.

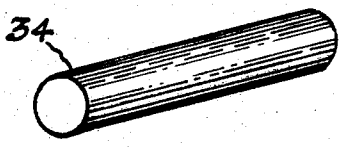


Fig. 6.

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REFRACTORY LINER ANCHORAGE

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ABSTRACT OF THE DISCLOSURE

An anchorage for refractory liner brick where the brick are laid in courses with each brick having a face in abutting relationship with a face of its next adjacent brick, there being a groove formed in one face of each brick, the grooves of adjacent bricks being in alignment whereby to define a keyway between two bricks with a pin fitted loosely in the keyway to permit relative shifting of adjacent brick, the grooves defining the keyway each having a central, generally flat portion of a width greater than a first dimension of the pin and a pair of side portions of a depth less than a second dimension of the pin whereby, when the bricks shift, the pin is retained in the keyway but is movable along said central portions so that said faces are maintained in abutting relationship.

This invention relates to structures formed from a series of aligned, abutting blocks and, more particularly, to a lining for the inner surface of a kiln or the like.

In the construction of kilns, the inner surface of the shell of a kiln is lined with refractory bricks which are arranged in a series of continuous rings or courses in side-by-side relationship throughout the length of the shell. Each brick of such a lining has a pair of tapered faces which cooperate with the tapered faces of adjacent bricks in the same ring or course to provide a wedging action, whereby the bricks are held in alignment and those bricks in the upper portion of the lining are prevented from dropping out of place and away from the upper part of the shell. The bricks in the lower part of the shell, of course, will be supported from beneath by the shell itself and thereby will be retained in place.

As the kiln is used, the innermost or hot faces of some of the bricks, especially those in the burning zone of the kiln, are subjected to intense heat which results in spalling or crumbling of the refractory material used in the bricks. When this occurs, the bricks progressively wear away, and thereby are reduced in size so that the tapered faces thereof become shorter in length and the wedging or holding capabilities of these faces are proportionately diminished. The bricks will thus fall out of place if the lengths of their tapered faces become too short and such a situation presents a problem if the kiln is of the rotary type, since all of the bricks of the lining will, during a certain part of each cycle of rotation of the kiln, be in the upper half of the kiln. If one of the bricks of a course falls out of place, the remaining bricks of that course will also fall because each brick of the course depends upon the pressures exerted on its tapered faces by the bricks abutting these faces. The lining will then require repair and replacement of the badly worn bricks, and the kiln must be shut down for this purpose. Moreover, vibrations and small displacements of the bricks, due to rotation of the kiln shell during its use, oftentimes cause the bricks to be reduced in size by crumbling so that the bricks work loose from the lining and fall out of place after the bricks have become worn.

This problem of falling bricks within a kiln becomes acute when the diamter of a rotary kiln is relatively high, such as a diameter of the order of 25 feet. At this diameter, the curvature of the inner surface of the kiln shell

is relatively small and, in view of the relatively small dimensions of conventional bricks, the taper of the bricks will necessarily be small also. Thus, the wedging action of the tapered faces will be minimal at best, and any reduction in size of a brick due to spalling, increases the probability that the bricks of a course will fall out of place. The operational life of a lining is, therefore, relatively short compared with that of a kiln of small diameter.

The present invention overcomes the aforesaid problem by providing an anchorage system for the tapered blocks of a circular lining for a building structure wherein the blocks are held in place against removal from the lining even though the taper of the blocks becomes ineffective. Thus, the invention is suitable for use in the lining of a rotary kiln to retain the blocks thereof in place even if the blocks wear away in the usual manner and even if the diameter of the kiln is relatively large. This is accomplished by the use of aligned grooves in the abutting faces of each pair of adjacent blocks in every course or ring of the kiln lining, and a key or pin fitted in the grooves in a manner to interlock the blocks even after the wedging action of their tapered faces has failed. The bricks will thus be retained in place after they have been substantially reduced in size by wear and by vibrations and small displacements due to rotation during use of the kiln. As a result, the operative life of the lining will be considerably extended beyond that of a conventional lining in a rotary kiln.

The anchorage system inherently provides the added advantage of permitting small displacements of one of the grooved blocks relative to the other block of a given pair, such displacements being toward the horizontal center axis of the kiln. Hence, the lining may compensate for irregularities in the structure of the shell, such as an out-of-round condition, due to faulty manufacture or resulting from the use of the kiln itself. This is accomplished by fitting the key loosely in the grooves to allow for relative movement of the bricks through a limited distance away from the kiln shell.

Another advantage is that the anchorage system augments the holding action of the tapered faces of the bricks through the use of the key or pin in the grooves. This feature eliminates the need for the relatively high pressures on the tapered faces of the bricks to retain the bricks in place during rotation of a rotary kiln.

It is, therefore, the primary object of this invention to provide an anchorage system for a course of liner bricks in a kiln to interlock the bricks so that they will not fall out of place after the tapered faces of the bricks have become worn and ineffective to retain the bricks in the course.

Another important object of the present invention is the provision of an anchorage system of the aforesaid character wherein one of a pair of abutting bricks of the course may be displaced through a limited distance relative to the adjacent brick so as to be self-aligning in the event that the blocks are near an irregularity in the kiln shell, such as an out-of-round condition.

Still another basic aim of this invention is to provide an anchorage unit for the lining of a kiln which includes a pair of abutting, relatively shiftable liner bricks having grooves in substantial alignment with each other to provide a keyway for a pin loosely fitted in the grooves to permit one brock to shift relative to the other brick toward or away from the kiln shell whereby to compensate for an out-of-round condition or other irregularity in the shell itself.

Yet a further object of the present invention is the provision of a hollow building structure having a lining of blocks provided with the above-mentioned anchorage sys-

tem, whereby the relatively high pressures necessary to retain the blocks in place in conventional structures of this type, are not required when the anchorage system is employed to thereby extend the operational life of the lining and minimize maintenance to the structure.

In the drawing:

FIGURE 1 is a fragmentary, vertical section through a kiln or the like showing the anchorage unit in a course of abutting blocks or bricks lining the shell of the kiln;

FIG. 2 is an enlarged, fragmentary, cross-sectional view of the anchorage unit showing a pair of grooved blocks and the key or pin in the grooves of the blocks to interlock them;

FIG. 3 is a perspective view of one form of the block forming a part of the anchorage unit;

FIG. 4 is a perspective view of another form of the block;

FIG. 5 is a perspective view of one form of the key or pin; and

FIG. 6 is a view similar to FIG. 5 but illustrating another form of the pin.

Although the anchorage system of this invention has a number of different applications in the construction and building trades as will hereinafter become apparent, the system is, for purposes of illustration, applied to and used with a rotary kiln **10** shown fragmentarily in FIG. 1. Kiln **10** includes a cylindrical, rotatable shell **12** having a continuous inner surface **14** lined throughout its length with a plurality of continuous rings or courses **16**, each comprised of a number of circumferentially aligned refractory liner bricks **18**. Courses **16** are installed by following the steps of any one of a number of different well-known methods, each of which generally includes the step of placing a key brick in the last space of each course to complete the same. Each brick of the course will be subjected to pressure on opposed sides thereof from the adjacent bricks.

Although bricks **18** need not be of the same size and configuration, they generally are substantially identical for convenience of installation. The key brick may have to be cut to size, depending upon the size of the space it is to fill. Bricks **18** are formed in the usual manner for bricks of this type and may be comprised of any suitable refractory material. For instance, the concepts of the invention may be illustrated by the use of a basic brick **18***a* shown in FIG. 3, or by the use of a clay brick **18***b*, one form of which is shown in FIG. 4, although the clay brick **18***b* could be of the same configuration as the basic brick **18***a*. These two brick types differ in the size of their tapered faces to be described and the material from which they are formed, the basic brick being formed from various mixtures of chrome and magnesite. The basic brick has been found to be more suitable for use in the burning zone of a rotary kiln while the clay brick is suitable for use in the relatively cooler burning and drying zones of the kiln.

Each of the bricks **18** includes a pair of opposed, tapered, generally flat faces **20** and **22** which are relatively convergent as the inner or hot face **24** of the brick is approached. Face **20** of each brick **18** abuts face **22** of the adjacent brick **18** and cooperates with the latter to provide a wedging action, whereby, when keyed, bricks remain in the course and will not fall out of place. Also, each brick **18** has an outer or cool face **26** and a pair of side faces **28** spanning the distance between tapered faces **20** and **22** and the distance between faces **24** and **26**.

The anchorage system of this invention is more advantageously illustrated where course **16** is formed from a plurality of pairs of bricks **18** and it will be presumed that each course **16** will have an even number of bricks **18**. If each course had an odd number of bricks, the last or odd brick would not be employed in carrying out the teachings of the invention.

Since each course **16** is presumed to be comprised of a plurality of pairs of bricks **18**, each pair will form a part of an anchorage unit **30** wherein each of the abutting faces **20** and **22** thereof will be provided with a groove **32** spanning the distance between the corresponding side faces **28** and being disposed adjacent to the corresponding outer face **26** as shown in FIG. 3. Grooves **32** of the bricks **18** of unit **30** are in substantial alignment with each other and cooperate to provide a keyway for a key or pin **34**, whereby bricks **18** of unit **30** are interlocked against falling out of place if the wedging action of the tapered faces **20** and **22** becomes ineffective to hold bricks **18** in place.

Grooves **32** may be of a suitable configuration and the surface forming each groove is illustrated in FIGS. 1 and 2 as having a central, generally flat portion **36** and a pair of arcuate side portions **38** which merge with central portion **36**. Pin **34** is cylindrical and has a diameter less than the width of each groove **32** and greater than the depth of each groove. Thus, one brick **18** of each unit **30** may shift relative to the other brick of the unit toward or away from surface **14** through a limited distance and along a path transversely of pin **34**. Side portions **38** provide shoulders engageable with pin **34** to restrict the relative movements of bricks **18** of the corresponding unit **30**. Portions of pin **34** are disposed in both grooves **32**, so that side portions **38** will be effective to limit the travel of bricks **18** relative to each other so long as faces **20** and **22** thereof are in abutting relationship.

The elliptical form of the pin, denoted by the numeral **34***a* and shown in FIG. 5, may be used instead of the cylindrical form **34**. Pin **34***a* is sometimes easier to handle during installation of course **16** inasmuch as it will not roll out of the reach of a workman as might be the case with cylindrical pin **34**. In using pin **34***a*, it is required that portions thereof extend at all times into both grooves **32** while its transverse size and configuration permits one brick **18** to move relative to the other brick **18** toward or away from surface **14** through a limited distance.

In use, courses **16** of kiln **10** are applied to the inner surface **14** by following the steps of any one of a number of well-known methods of installation, each course **16** being comprised of a plurality of pairs of abutting bricks **18**, each having cooperating grooves **32** and a pin **34** received within the grooves as shown in FIG. 1. As each pair of bricks **18** is put in place in the corresponding course **16**, a pin **34** is manually inserted in the cooperating grooves **32**. The bricks **18** of each unit **30** are thus interlocked against substantial movement relative to each other and toward and away from surface **14**. If an odd number of bricks **18** is in a particular course **16**, the last or odd brick **18** is not employed in carrying out the teachings of the present invention.

If an irregularity in the structure of shell **12** is present when course **16** is applied thereto, the bricks **18** of unit **30** adjacent to the irregularity will align themselves to compensate for such defect in the shell structure. For instance, as shown in FIG. 1, the out-of-round condition shown in the shell at **12***a* prevents face **26** of one of the bricks **18** of a unit **30** from completely or substantially engaging surface **14**. Thus, this brick will shift away from surface **14** relative to the adjacent brick **18** of the corresponding unit **30** inasmuch as the corresponding pin **34** will allow this relative movement at least through a limited distance. A gap **40** will then be defined between at least a portion of the corresponding face **26** and inner surface **14** as shown in FIG. 1.

Similarly, other irregularities in the shell structure will be compensated for by relative movements of the bricks **18** of other units **30**. In this way, the bricks of a course **16** do not have to be modified in order to be put in place during the formation of the various courses.

Irregularities in the shell structure may arise during use of kiln **10**, such irregularities being in the nature of out-of-round conditions along the length of shell **12**. When this occurs, the bricks of units **30** of the various courses

16 shift relative to each other to compensate for the presence of these conditions. Since the diameter of shell 12 will, in most cases, be considerably greater than the distance between the tapered faces 20 and 22 of each brick 18, it is clear that the relative movements of the various bricks will be quite small, although great enough to allow the bricks to compensate for the presence of out-of-round conditions in the shell structure.

As bricks 18 are subjected to heat they will, by their very nature, wear away by spalling and as they wear away, the wedging or holding action of tapered faces 20 and 22 of the various bricks progressively diminishes. However, the presence of pin 34 in grooves 32 augments the holding action of the tapered faces 20 and 22 and actually replaces these faces when they become too short to be effective in holding the bricks in place. Thus, the lining made up of the various courses 16 of kiln 10 will have a longer operational life than a lining having no interlocking means such as pins 34 in respective grooves 32.

Heretofore, it has been necessary to hold bricks 18 in place by applying relatively high pressures to the tapered faces 20 and 22 thereof. However, with the use of the aforesaid interlocking means at abutting tapered faces 20 and 22 of each unit 30, such relatively high pressures are not required inasmuch as pins 34 will hold the various bricks of a course 16 against inward movement relative to surface 14 of shell 12.

The anchorage system comprised of the various units 30 of kiln 10 provides several distinct advantages therefor which extend the operating life of the kiln and reduces shutdown time for maintenance purposes. All of the foregoing is accomplished with a minimum of modification to the bricks themselves inasmuch as the same may be formed in the usual manner except that the grooves are provided in certain of the tapered faces thereof, a step which can be accomplished at minimum expense and with no extension in manufacturing time. Moreover, the bricks are interchangeable inasmuch as each brick of a unit may be inverted and used to replace the other brick of the same unit.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A refractory liner anchorage comprising:

a pair of liner bricks, each brick having a first pair of spaced, opposed side faces, a second pair of spaced, opposed side faces spanning the distance between said first side faces, a pair of spaced, opposed end faces at proximal extremities of respective first and second side faces, and a groove formed in one of the first side faces thereof, said groove spanning the distance between the second side faces, said one of the first side faces of one of the bricks being in abutting relationship throughout its surface area to said one of the first side faces of the other brick with said grooves of said bricks being in alignment with each other to define a keyway between said bricks; and

a pin fitted loosely within, and extending longitudinally of, said keyway, each groove having a central, generally flat portion of a width greater than a first transverse dimension of the pin and a pair of side portions of a depth less than a second transverse dimension of the pin, whereby one of the bricks may shift relative to the other brick along said one face thereof in opposed directions transversely of said pin, and portions of said pin will be disposed in both of said grooves to limit the travel of said one brick relative to the other brick to a predetermined distance, said pin being movable along said central, generally flat portion of the groove as the shifting of the bricks occurs whereby to maintain said first side faces of the bricks in abutting relationship throughout their surface areas.

2. In a rotary kiln:

a cylindrical shell;

a refractory lining on the inner surface of the shell, said lining including a plurality of courses in side-by-side relationship, each course including a number of circumferentially aligned pairs of refractory liner bricks, each brick having a pair of spaced, opposed tapered faces cooperating with the proximal tapered faces of adjacent bricks, whereby the bricks are retained in place in the corresponding courses before the bricks become worn, one of the tapered faces of each brick having a groove formed therein, the grooves in the bricks of each pair being in alignment to present a keyway;

a pin fitted loosely within said keyway to interlock the bricks of the corresponding pair, each groove having a central generally flat portion of a width greater than a first dimension of the pin and a pair of side portions of a depth less than a second dimension of the pin, whereby one of the bricks may shift relative to the other brick along the proximal tapered face thereof in opposed directions transversely of said pin, and portions of said pin will be disposed in both of said grooves to limit the travel of said one brick relative to the other brick to a predetermined distance, said pin being movable along said central, generally flat portion of the groove as the shifting of the bricks occurs.

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