Jan. 17, 1967 D. R. BYFIELD ETAL 3,298,155

APPARATUS FOR LINING KILNS

Filed Feb. 15, 1966 3 Sheets-Sheet 1

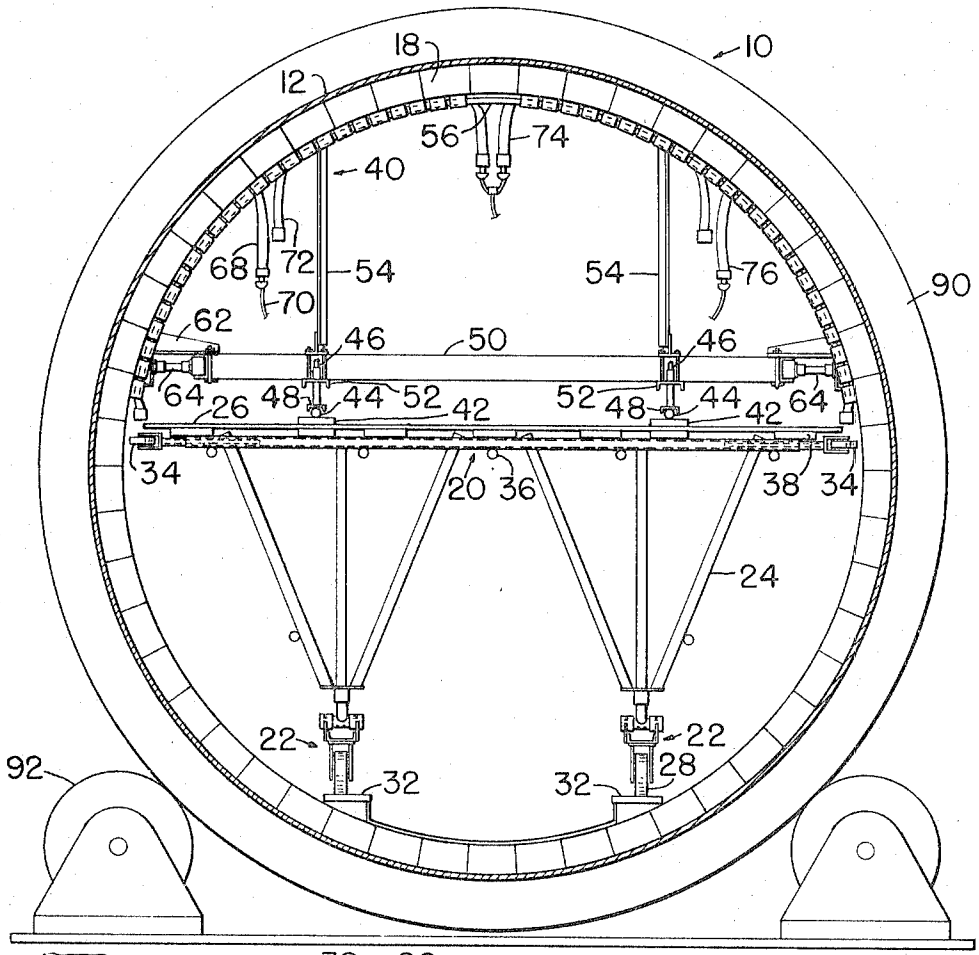


Fig. 1

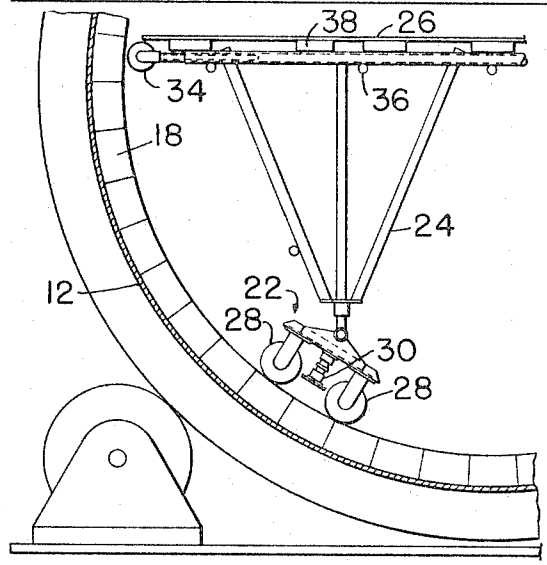


Fig. 2

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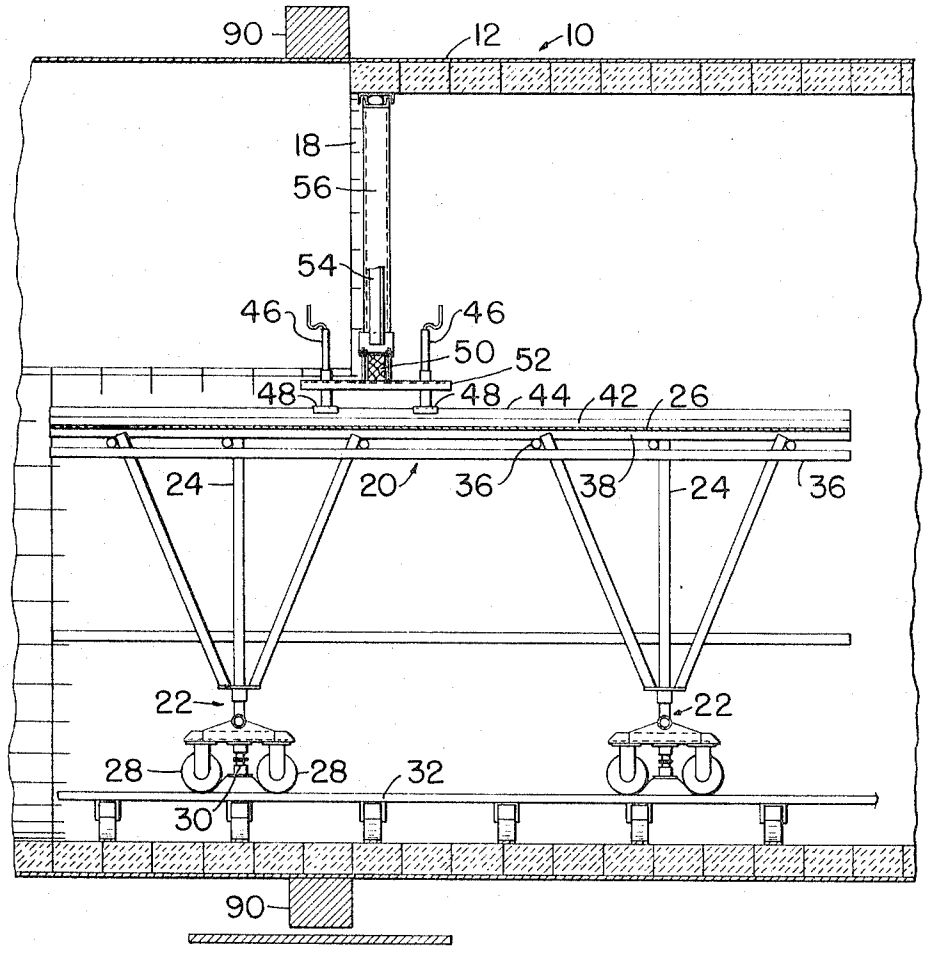


Fig. 3

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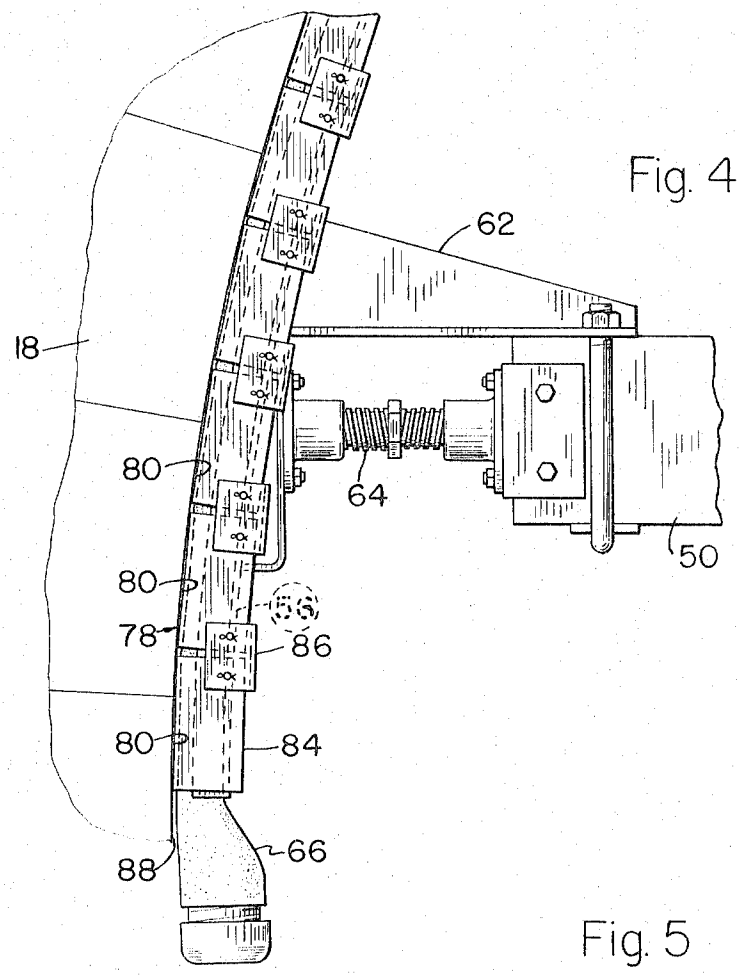


Fig. 4

Fig. 5

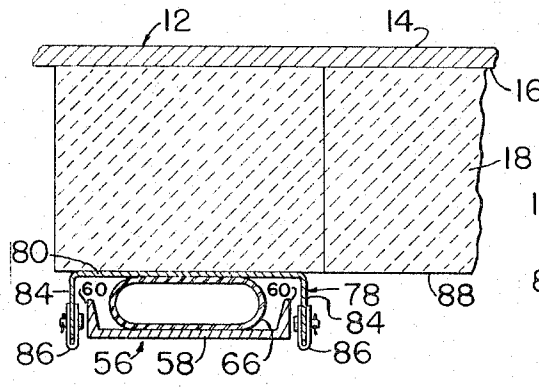
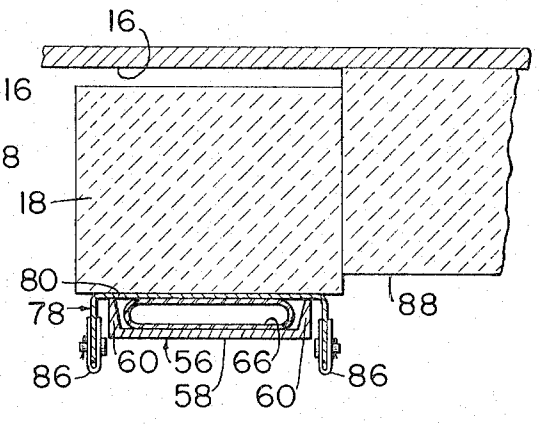


Fig. 6



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APPARATUS FOR LINING KILNS

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6 Claims. (Cl. 52—749)

This is a continuation-in-part of our application Serial No. 262,701, filed March 4, 1963, and entitled "Method and Apparatus for Lining Kilns," now abandoned.

This invention relates to a method and apparatus primarily intended for use in lining rotary kilns with brick or the like whereby a tight-fitting lining is provided for the kiln through the exertion, upon the liner brick, of a simultaneous, substantially equal pressure as the brick are placed in position abutting the interior face of the kiln shell.

While the use of the present method and apparatus is hereinafter described in connection with the lining of a rotary kiln, it will be appreciated that the subject method and apparatus can be utilized to place brick or similar lining material in any area where the same must be retained against gravity, such as in a tunnel roof, a furnace roof, or a sewer lining, as well as in other areas where the brick or equivalent structural material must be positioned and held in an overhead position against a backing member. Thus, while the lining of a rotary kiln is hereinafter described as a particularly embodiment of the present method and apparatus, the same could be utilized in a wide variety of applications.

It is the primary object of this invention to provide a method and apparatus for lining rotary kilns wherein, after the liner brick is positioned adjacent the interior face of the upper half of the kiln shell, at a spaced distance therefrom, a simultaneous, substantially equal pressure is exerted upon the liner brick positioned adjacent the upper half of the kiln shell whereby to move the same into tight engagement with the interior face of the kiln shell.

It is yet another object of this invention to provide a method and apparatus for lining kilns where, when temperature and environmental conditions otherwise permit the same, it will not be necessary to rotate the kiln during the lining thereof as has heretofore been necessary during the lining of most kilns.

A yet further aim of the invention is to provide a method of lining a rotary kiln wherein the liner brick is positioned adjacent the interior face of the kiln shell upon a brick-supporting unit, means associated with the brick-supporting unit then being actuated to exert a simultaneously, substantially equal pressure upon the brick carried by the unit whereby to move the same into tight engagement with the interior face of the shell, the brick then being keyed in its final, fixed position, prior to removal of the brick-supporting unit.

Yet another object of this invention is to provide apparatus for lining rotary kilns which includes a rigid member spaced from the interior face of the kiln shell, there being a supporting assembly so positioning said rigid member, the rigid member supporting a flexible, expandable member in the nature of a hose or the like, there being an articulated frame formed from a plurality of interconnected shoes disposed in overlying relationship to the flexible, expandable member, the liner brick being supported on the shoes whereby to initially position the brick adjacent the interior face of the kiln shell, the hose being coupled with a source of fluid, such as air or other equivalent, the fluid being under pressure whereby the same may be delivered into the flexible, expandable member to thereby cause expansion thereof and move the brick into engagement with the interior face of the kiln shell, all of the brick of a given ring being simultaneously so moved under substantially equal pressure.

It is a yet further aim of this invention to provide apparatus for lining kilns which may be disposed within the kiln and moved longitudinally therealong during the lining operation, but yet permit free access to the remainder of the kiln area during the lining operation, the apparatus being easily shifted from one position to another.

Other objects will become apparent from the following specification and accompanying drawings, wherein:

FIGURE 1 is a front elevational view of a rotary kiln, looking thereinto and showing the apparatus for lining the kiln in position therewithin;

FIG. 2 is a fragmentary, elevational view showing a portion of the apparatus and particularly to manner in which the same is supported within the kiln;

FIG. 3 is a longitudinal, sectional view through the kiln and the apparatus, showing the apparatus positioned therewithin;

FIG. 4 is an enlarged, fragmentary view showing a portion of the apparatus and its relationship to the liner brick;

FIG. 5 is a sectional view through a portion of the apparatus illustrated in FIG. 4 showing the flexible, expandable member in its collapsed position and the brick positioned away from the interior face of the shell; and

FIG. 6 is a view similar to FIG. 5 but showing the flexible member in its expanded condition with the liner brick positioned against the interior face of the shell.

It is well known that rotary kilns of an elongated, cylindrical configuration and now used in many industries for the purposes of drying or heating materials, are subject to relining from time to time due to the deterioration of the refractory tile or brick which is disposed along the major portion of the interior face of such kilns. Such relining has become a tedious and expensive task due to the fact that rings of brick must be laid in complete circumscribing relationship to the interior face of the kiln shell and, therefore, means must be provided for holding the brick of a portion of a given ring in position while the remaining brick of said ring is laid. Such means have heretofore taken the form of jack assemblies which are positioned in such a manner as to hold one-half of a ring of brick in position, the kiln then being rotated, while another one-quarter of the ring of brick is laid and subsequently again rotated, while the final one-quarter of the ring of brick is laid and the entire ring keyed.

Other methods and apparatus for lining rotary kilns with brick have taken the form of arcuate members having a plurality of jackscrew assemblies associated therewith, which assemblies each retain in position a given course of brick as the same is laid in place. All of the previously known methods and apparatus have been costly, time-consuming, and have, upon occasion, resulted in the kiln shell being forced to an out-of-round condition.

It is, therefore, contemplated by the present invention that apparatus will be provided which will eliminate the necessity of rotating a kiln during the lining thereof with brick and which, as a result of the simultaneous, substantially equal application of pressure upon a given ring or rings of brick as they are laid into place, will not cause the kiln shell to assume an out-of-round condition but rather, will snugly and tightly fit the liner brick against the shell whereby the ring or rings may then subsequently be keyed into a final fixed position.

The apparatus for accomplishing the foregoing is adapted to be positioned within a rotary kiln **10**, which kiln has an outer shell **12** normally of metal of suitable strength and of an elongated, cylindrical configuration, the shell **12** having an exterior face **14** and an interior

face 16, the liner brick 18 being positioned against the inferior face 16 of the shell 12 when the shell is lined.

To position the liner brick 18 pursuant to the present invention, there is provided a scaffolding rig, broadly designated 20, which rig 20 includes a wheeled carriage assembly 22 and suitable upright such as 24 whereby to support, in a horizontal position at substantially the center line of kiln 10, a platform 26.

The wheeled carriage assemblies 22 are four in number in the embodiment of the invention chosen for illustration, each assembly including a pair of wheels 28, there being a jack 30 disposed between the wheels 28. As seen in FIGS. 1 and 3 of the drawings, the wheel assemblies 22 are supported within the kiln 10 by a pair of spaced trackways 32, two of said assemblies resting on each of the trackways whereby, when the wheel assemblies 22 are in the position shown in FIGS. 1 and 3 of the drawings, the entire rig 20 may be rolled longitudinally of the kiln 10 on the trackways 32 to thus move the same from one position to another along the kiln 10.

When the rig has been moved to the desired position within the kiln, the jacks 30 are lowered to thereby raise the wheels 28 from engagement with trackways 32 and thereby preclude rolling of the rig 20 while the lining operation takes place at a given position within the kiln. If it is necessary to rotate the kiln during the lining operation, the wheel assemblies 22 can be turned to the position shown in FIG. 2 of the drawings, whereby they extend transversely of the kiln and may ride along the liner brick as the kiln is rotated to maintain platform 26 in a constantly horizontal position. Movement of the kiln with respect to the rig 20 when the kiln is rotated, is also facilitated by the provision of casters 34 which are carried at the outer ends of the framework which supports the platform 26. The uprights 24 are coupled with suitable longitudinally and transversely extending frame members, such as 36, whereby to provide support for a plurality of beams such as 38, the beams in turn, supporting the platform 26. Thus, it will be seen that there is provided a supporting assembly for the platform 26 which is sufficiently strong for the purposes intended, but which is also mobile so that it may be moved from one position to another during the lining operation. Note also, that the uprights 24 are spaced sufficiently apart, viewing FIG. 1, so that a forklift truck or other means may be driven therebetween longitudinally of the kiln to deliver bricks to platform 26 as this becomes necessary.

The brick-supporting unit, broadly designated by the numeral 40, is carried by the framework members 36 through a pair of longitudinally extending beams 42, each having a pipe 44 resting thereupon, each of the pipes 44, in turn, supporting a pair of jacks 46, it being noted that jacks 46 all have a saddle 48 at the lower end thereof so that the brick-supporting unit 40 may be shifted longitudinally of the kiln or the framework members 36 by moving said saddles 48 longitudinally along their corresponding pipes 44.

Each pair of jacks 46 is coupled with a transversely extending jack beam 50 by means of a plate 52, which plate 52 extends longitudinally of the kiln as shown in FIG. 3 of the drawings. Jack beam 50 is in substantially parallel relationship with the platform 26 and extends transversely of the kiln. The jack beam 50 carries a pair of spaced-apart supports 54 which extend vertically from the jack beam 50 and cooperate to support, adjacent the normally uppermost interior face of the kiln shell, a rigid member 56, such rigid member 56 being arcuate in configuration and conforming to the arc of the upper portion of the kiln to be lined.

In the embodiment chosen for illustration, the rigid member 56 is in the nature of a channel whereby to present a web 58 and a pair of laterally extending flanges 60, said flanges 60 extending from the web toward the interior face of the kiln. The arcuate rigid member is connected to the jack beam 50 adjacent the outer ends thereof by a pair of brackets 62, there also being a jack

64 extending between each of the ends of jack beams 50 and the corresponding end of the arcuate rigid member 56.

The rigid member 56, particularly the web portion 58 thereof, supports at least one flexible, expandable member 66 in the nature of a hose or the like, the embodiment of the invention chosen for illustration showing four such elongated, flexible, expandable members 66 used in connection with the kiln lining apparatus. In the illustrated embodiment, the first length 68 of the expandable member extends from one end of the rigid member to a point substantially one-quarter of the length thereof, the member 68 then passing through an opening in the web 58 of the member 56 to present a coupling 70 which may be connected to a source of fluid under pressure. The second length 72 of member 66 extends from length 68 to the next length 74, and length 74 extends onwardly around arcuate member 56 to the fourth length 76 whereby, in essence, a continuous, flexible, expandable member is provided, the same having four individual lengths in the embodiment shown, although it will be appreciated that two lengths may be utilized or, for that matter, a single length could be utilized. The flexible, expandable member 66 is coupled with a source of air under pressure whereby, when air is introduced thereinto, said member will expand.

Disposed in overlying relationship to the member 66 is an articulated frame 78, the articulated frame 78 taking the form of a plurality of interconnected shoes 80, each of the shoes being U-shaped in transverse, cross-sectional configuration whereby to present a bight 82 and a pair of normally depending legs 84, the legs being in opposed relationship and embracing the flanges 60 of the rigid member 56, all as best shown in FIG. 6 of the drawings.

Shoes 80 are interconnected by coupling plates 86 as best shown in FIG. 5 of the drawings, said plates 86 interconnecting the shoes 80 in such a manner that the shoes may shift relative to one another as the same are moved into a position against the inner or hot face 88 of the liner brick 18. It will be noticed that the member 66 is, therefore, confined between the rigid member 56 and particularly the web 58 thereof, and the shiftable, articulated frame 78, the liner brick 18 being disposed in overlying relationship to the frame 78 and between said frame 78 and the interior face 16 of the kiln 10.

The apparatus hereinabove described is used to carry out the following method of lining the kiln with brick. The apparatus is initially moved into the kiln to the position where it is desired to line the interior face of the kiln with brick. The apparatus is locked into position through the utilization of jacks 30, and the rigid member 56 is moved into the desired spaced relationship from the interior face 16 of kiln 10 by means of the jacks 46 and the jacks 64. Once the rigid member has been moved into the desired position, the member 66 is placed in overlying relationship thereto, the member 66, or the individual lengths thereof, being coupled with a source of air under pressure (not shown), it being contemplated that an air compressor may be supported by the rig 20 at a suitable location whereby to present a completely integral lining unit.

The articulated frame 78 is then disposed in overlying relationship to the member 66 and the liner brick are placed on the articulated frame at a position spaced from the interior face 16 of the kiln 10 in the manner shown in FIG. 5 of the drawings. The positioning of the brick commences from each side of the kiln and starts atop the previously laid lower half section of brick. The brick are then laid in a continuous ring and in as many courses as may be desired toward the top of the kiln which is commonly known as the key point.

During laying of the brick about the upper half of the kiln, air pressure may be introduced into the flexible member 66 whereby to retain the brick in tight-fitting engagement to the interior face 16 of the kiln shell 12. It

will be appreciated that such air pressure will not be applied until the brick have first been positioned atop the articulated frame 78 in the manner shown in FIG. 5 of the drawings.

Once this positioning has been accomplished and a sufficient number of brick laid in a ring or a course, air pressure is introduced into member 66, or, if member 66 includes a plurality of lengths, such as shown in the drawings, air pressure is simultaneously introduced into each of the lengths 68, 72, 74 and 76 of member 66, whereby to expand the same and thereby cause the shifting movement of the articulated frame 78 and the individual shiftable shoes 80 thereof toward the interior face 16 of the shell 12. Expansion of member 66, or the individual lengths thereof, is all in an outward direction inasmuch as the rigid member 56 is securely fixed in position by means of the jack beam 50 and the supports 54 as hereinabove described. Thus, as the member 66 expands, frame 78 is moved outwardly, the individual shoes being allowed to move with respect to one another whereby a continuous, simultaneous and substantially equal pressure is brought to bear on each of the plurality of bricks which have been previously positioned adjacent the interior face 16 of kiln 10.

In this regard, it will be appreciated that the provision of an articulated frame such as 78, formed from a plurality of individually shiftable, but interconnected shoes such as 80, allows compensation for brick of varying sizes, although it will be appreciated that it is desirable to have all of the brick 18 of substantially the same size and configuration. Furthermore, the application of simultaneous, substantially equal pressure on each of the brick which have been positioned in overlying relationship to the frame 78 as they are moved into engagement with the interior face 16 of the shell 12, prevents forcing of the shell into and out-of-round condition and assures a snug fit between the cold face of the brick and the interior face 16 of shell 12.

Once a ring of brick has been moved into position by the method hereinabove described, the brick forming the ring are keyed into a final and fixed position in the conventional manner which may be accomplished by positioning a jack between the spaced-apart brick at the open end of the ring and, through exerting pressure by the jack, tightening the bricks in a given ring prior to inserting the key brick or bricks.

Once the brick have been keyed into a final and fixed position, the air pressure within member 66 is released whereby to allow the same to collapse, thereby moving the frame 78 out of engagement with the inner face of the brick 18 to then allow the assembly to be moved to the next zone of brick to be applied as a liner to the shell. This procedure is repeated until such time as the kiln is completely lined with brick and it will be appreciated that, at no time during the lining procedure, is it necessary to rotate the shell and that, therefore, a kiln may be easily, quickly and economically lined through the utilization of the method and apparatus hereinabove described. In certain instances, however, due to the location of a kiln, such as outdoors, it is necessary to rotate the kiln during the lining thereof to prevent temperature changes in the portion thereof exposed to the sun, for instance, but this may be readily and easily accomplished by moving the wheel assemblies of the rig 20 into the position shown in FIG. 2 of the drawings and thus rotating the kiln, it being noted that the kiln is rotatable as a result of a plurality of ribs 90 which circumscribe the kiln at spaced-apart points, the ribs each riding on a set of opposed trunnions 92 to thereby permit rotation of the kiln the desired amount, if such is necessary due to temperature conditions or other factors.

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

1. Apparatus for lining the interior face of the shell of a rotary kiln with brick comprising:
   - a rigid member spaced from the interior face of the kiln shell;
   - means for adjustably positioning said rigid member with respect to said face of the shell;
   - at least one flexible, expandable member overlying said rigid member and carried thereby;
   - an articulated frame overlying said flexible member, the liner brick resting upon said frame; and
   - means for expanding said member to exert a simultaneous, substantially equal pressure upon the liner brick and thereby cause the same to move into engagement with said interior face of the kiln shell.

2. Apparatus as set forth in claim 1, wherein said rigid member has a web and a pair of opposed flanges, said flanges extending toward said frame, said flexible, expandable member being carried on said web and between said flanges.

3. Apparatus as set forth in claim 2, said frame comprising a plurality of interconnected shoes shiftable with respect to one another.

4. Apparatus as set forth in claim 3, wherein each of said shoes is U-shaped in transverse cross section whereby to present a bight and a pair of legs.

5. Apparatus as set forth in claim 4, the bights of the shoes being in opposed, overlying relationship to the web of the rigid member, the legs of the shoes embracing the rigid member.

6. Apparatus as set forth in claim 5, the flexible, expandable member being confined between the rigid member and the articulated frame.

References Cited by the Examiner

UNITED STATES PATENTS

1,296,312	3/1919	O'Rourke	61—84 X
1,382,668	6/1921	O'Rourke	61—84 X
3,075,359	1/1963	Clark	52—749 X
3,206,824	9/1965	Cerutti	61—84 X

FOREIGN PATENTS

1,163,356	12/1958	France.
1,251,314	12/1960	France.
856,356	12/1960	Great Britain.

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