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G. E. SEIL

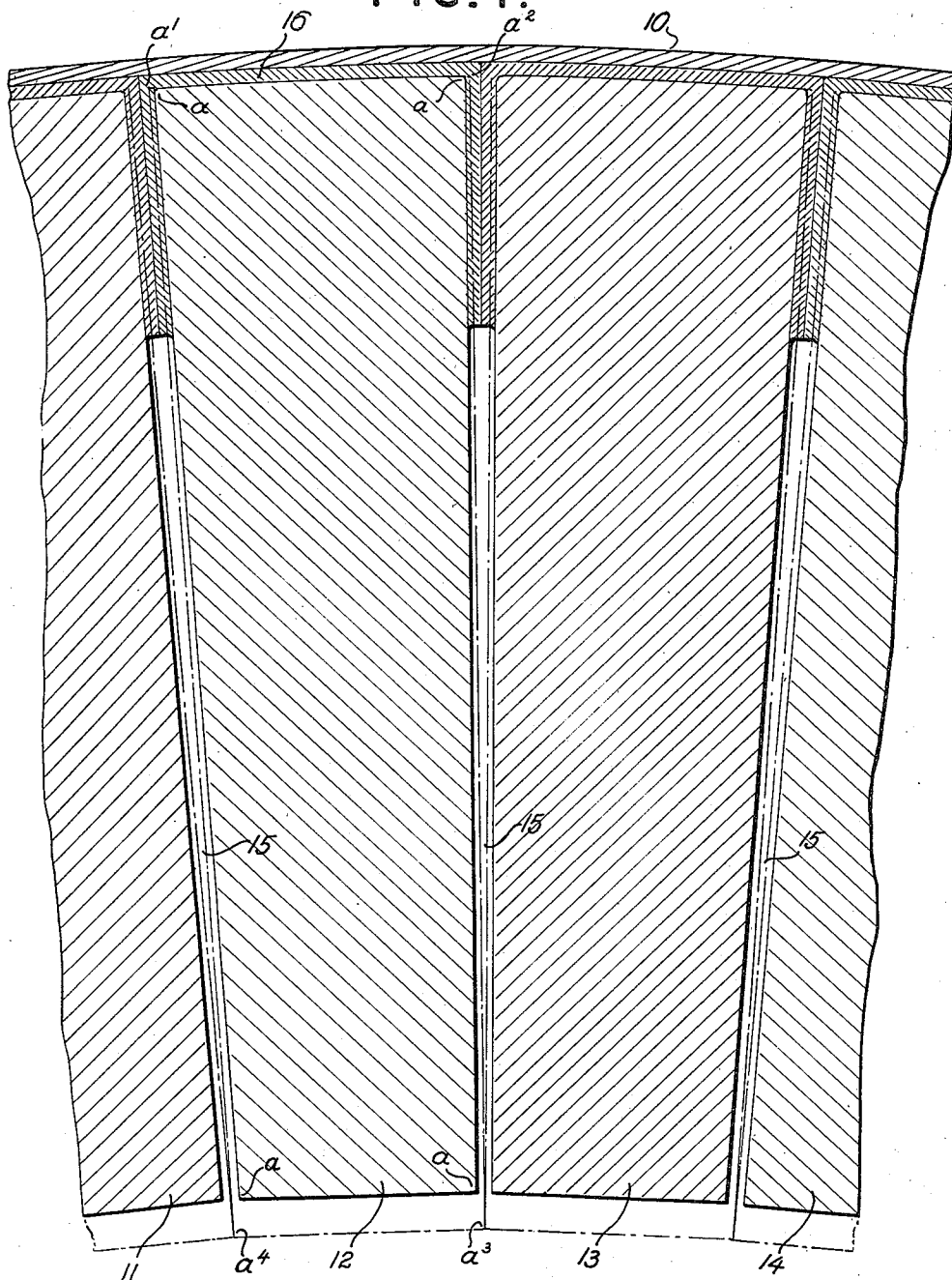
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FURNACE CONSTRUCTION

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FIG. 1.



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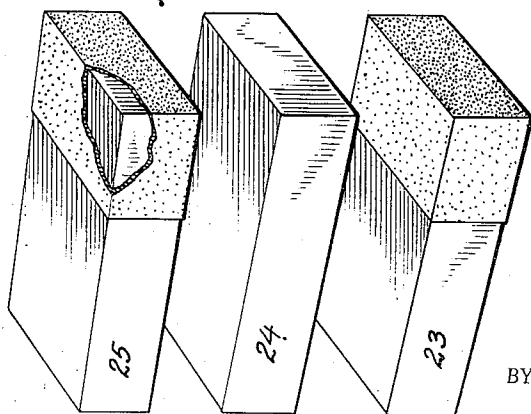
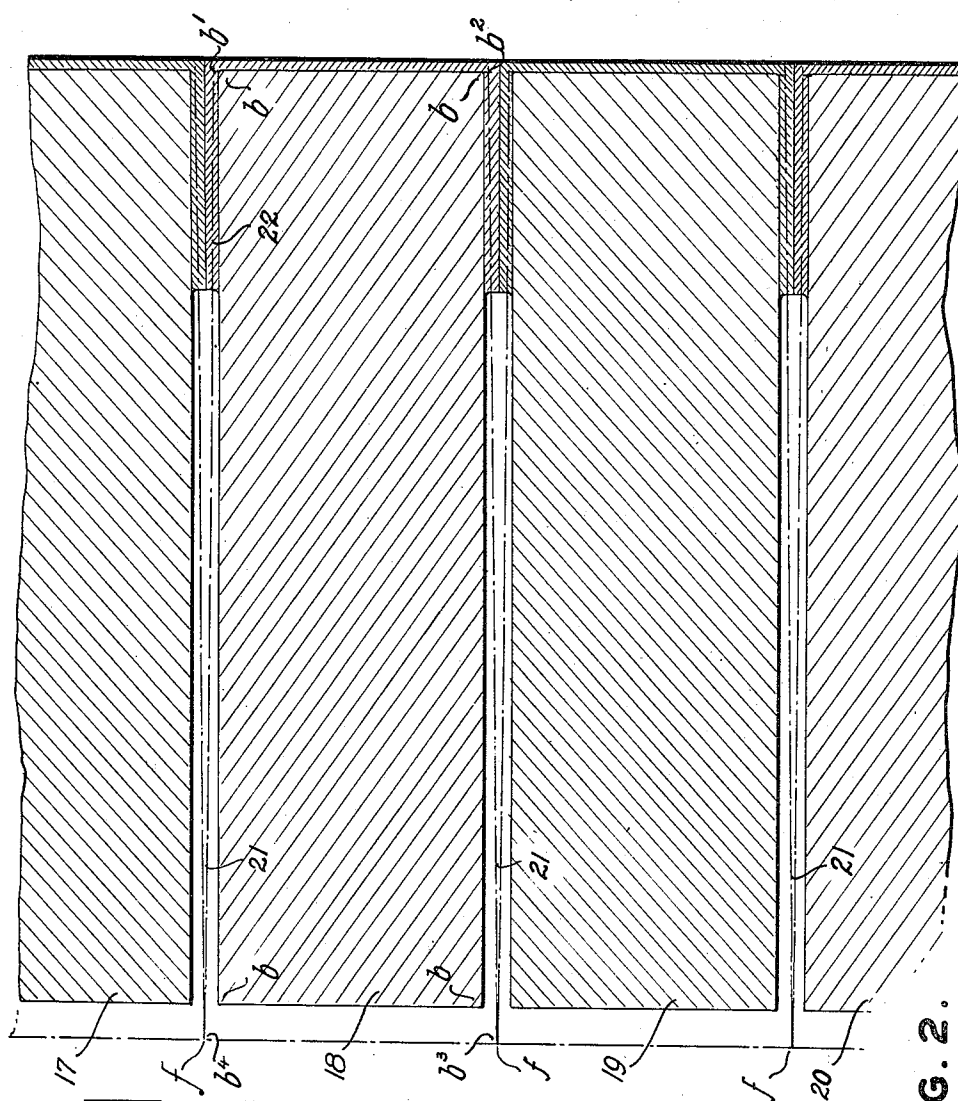
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FURNACE CONSTRUCTION

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5 Claims. (Cl. 72-101)

This invention relates to refractory units or bricks for furnace construction and to the linings produced thereby, and has for an important object thereof the relief of the pressures due to the difference in expansion between the hot ends and the cold ends of refractory units in service, which pressures result, when the bricks are installed in the usual manner, in a continuous loss of refractory material during periods of service due to crushing and to pinching-off of the hot ends of the brick or other construction units. The invention is particularly applicable to curved portions of furnace structures, such as arched roofs, arches, etc., and to structures which are cylindrical in shape, such as rotary kiln linings.

Furnace structure such as walls, roofs, arches, and rotary kiln linings are usually built from standard refractory shapes known as straights or squares, arch brick, key brick, wedge brick, furnace blocks, etc. The number and shapes of the brick required for the construction of any portion of a furnace varies with the size and shape of the structure desired, and the methods of calculating the brick count for a furnace structure are general knowledge to those skilled in the art. Merely by way of example we can consider the count for a rotary kiln, the shell of which is 6'-0" inside diameter, and which is to have a 9" lining. Reference to the published tables shows that a refractory ring 6'-0" outside diameter by 4'-6" inside diameter by 4½" wide can be built from 91 standard No. 1 wedge brick, which are 9" x 4½" and the edges of which are tapered from 2½" to 1⅞". The number of rings needed is determined by dividing the length of the kiln in inches by 4½". When tables are not available the number of 2½" wedge brick needed for the ring can be calculated by dividing the outside circumference of the circle (226.2" when the kiln is 6'-0" in diameter) by 2½" or 91. Then dividing the inside circumference of the circle (169.6" in this case) by 91 we obtain 1⅞" as the average thickness of the inside face of the wedge required. Since 2½" to 1⅞" is the taper on a standard No. 1 wedge brick, the count per circle of brick is 91 No. 1 wedge brick.

When used to form a circle as is commonly recommended for lining rotary kilns, such as the kiln described in the example given above, the brick count is calculated so that the brick have full face to face contact when they are installed, that is, when the furnace is cold. At operating temperatures, however, one end of the brick is exposed to the furnace temperature and the

other end of the brick is subjected to the cooling effects of radiation, and there is a temperature differential between the ends of the brick. In rotary kiln service temperature differentials of 1500° F. to 2000° F. are not uncommon. It is obvious therefore that under such conditions the hot end of the brick must have a greater percentage of total expansion than the cold end of the brick, and that the hot ends of the brick are subjected to terrific pressures causing a continuous loss of a portion of the refractory.

The difference in the percentage of total expansion in the hot end and the cold end of a brick during periods of service changes the angular relationship between the opposite faces of the brick, and therefore changes the angular relationship between the opposite faces of the brick, and therefore changes the angular relationship between the contacting faces of adjacent brick. Consider, for example, the brick in an arched roof installed so as to have full face to face contact when cold. At furnace operating temperatures, the hot ends have a greater percentage of total expansion than the cold ends, the brick then have only approximately line to line contact at their hot ends and the hot ends therefore must carry the total weight of the roof.

The present invention has for its primary objects the elimination of the loss due to pinching off the hot ends of refractory units in service, and of conditions which compel the hot ends of the brick to carry all the load, and contemplates for the attainment of these objects (1) the provision of a refractory structural unit which compensates for the differential expansion in refractories during service due to temperature differential between the ends of the brick, (2) a method of furnace construction in which the above units are used and (3) a furnace structure composed of the above refractory units.

These objects are attained by providing what will herein be called "pressure relief clearances" between adjoining heat exposed or inner end portions of the bricks. More specifically, a spacing material, for instance refractory cement, is interposed between the outer end portions of the brick, in such a manner that the inner end portions of any brick will have sufficient clearance with adjoining brick, to allow for substantially free thermal expansion of the inner end portions of the brick under operating temperatures without undue encroachment of the brick upon one another.

According to one feature a refractory structural unit or brick is capped, or has its one end

portion partly encased or surrounded by or coated with a layer of refractory cement, the thus conditioned brick constituting a prefabricated unit or article of manufacture.

According to another feature a refractory wall or lining is built up of a combination of plain and partly coated brick in alternating order.

Still another feature has to do with a method of constructing refractory walls or linings in a manner to allow for freedom of expansion of the potentially hot end portion of the brick. More specifically, refractory cement which is interposed between or surrounds the outwardly located end portions of the brick, will weaken somewhat under the influence of heat, thus causing pressure inequalities between the brick to compensate themselves, yet without interfering with the desired freedom of thermal expansion of the inner end portions of the brick.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit. In the accompanying drawings there has been illustrated the best embodiment of the invention known to me, but such embodiment is to be regarded as typical only of many possible embodiments, and the invention is not to be limited thereto.

The novel features considered characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings in which:

Fig. 1 is a cross-section of a number of tapered brick disposed in arch formation as inside the shell of a rotary kiln, indicating outlines (exaggerated) of the brick, assumed because of thermal expansion.

Fig. 2 is a section similar to that of Fig. 1, although through a straight wall.

Fig. 3 is a positive view indicating the assembly of a series of conditioned and plain brick in alternation.

Referring to the cross-section shown in Fig. 1, the numeral 10 designates the shell of a rotary kiln having a cylindrical lining of tapered bricks, a number of which are indicated by the numbers 11, 12, 13 and 14. The dot and dash lines shown to surround the bricks, are to indicate the tendency of thermal expansion of the brick under service conditions. Brick 12 for example, defined by the four corners, each marked "a", when cold would, under operating temperatures, expand in three dimensions, and the expanded cross-section of brick 12 would be defined by four new corners a^1 , a^2 , a^3 , a^4 , the inner or heat exposed end portion of the brick, of course, expanding at their greater rate than the outer colder or off-end of the brick, and the difference between the expansion of the cold and the hot ends of the brick will herein be called "differential expansion". In other words, since the total expansion is the product of the temperature, the coefficient of expansion, and the linear dimension, the hot ends of the brick, if free to move, will have a greater percentage of total expansion than the cold ends, and brick 12, for instance, would tend

to assume outlines as defined by the corner points a^1 , a^2 , a^3 , a^4 . The dimensions shown are illustrative only and have been exaggerated for the purpose of clarity. The "pressure relief clearances" appearing between the brick when cold have been designated by the numeral 15.

As shown, the bricks have normally provided between them sufficient clearances 15 so that in their expanded state they will practically not more than touch one another, whereas without such relief clearances provided according to the invention, the inner or hot end portions of the brick expanding at a relatively greater rate than the cooler outer end portions, would tend to encroach upon one another, and consequently the brick load would shift more and more on to the expanding hot end portions. Every brick in the circle of the lining would thus be affected in exactly the same fashion, and since it is impossible for the ring of bricks to move to compensate for this tendency, the cumulative effect of the differential thermal expansion is a crushing effect which results in the continuous pinching of the hot ends of the brick, thus reducing the service rendered by the refractory lining.

In Fig. 1, in order to eliminate forcing the hot ends of the brick to carry the load, and also the pinching of the hot ends of the brick, each brick, for example brick 12, has the end portion which is to be relatively cold in service, coated with a predetermined thickness of a solid refractory cement 16. That is to say, by combining the refractory brick and cement in the manner according to this invention, or, as otherwise expressed, by a particular distribution of the cement or spacing material with respect to the refractory bricks, it is possible to eliminate the pinching difficulties otherwise occurring in the generally accepted method of refractory installation.

In one preferred embodiment the coating 16 covers from one-third to one-fourth of the length of the brick on the end which will not be exposed directly to the heat of the furnace, as distinguished from the fire facing end of the brick.

In constructing a furnace wall or lining with the aid of refractory units or bricks of this type, the hot ends of the expanded bricks will substantially merely touch upon one another, while substantially the bulk of the load will still be carried by that portion of the brick which has been encased in cement. Moreover, the cement coating being physically weaker than the body of the brick to which it is applied, when subjected to compression will be forced to some extent into the clearances 15 between the hot edges of the brick. In this way objectionable pressure inequalities are being compensated, and the tendency to compel the hot ends of the brick to carry the load and pinch off the operating temperatures is virtually eliminated.

In Fig. 2 there is shown the embodiment of the invention as applied to the construction of straight walls, the bricks used therein being the so-called "straights" or "squares." This shows a section through a series of bricks for example indicated by the numerals 17, 18, 19, 20, which as installed and in the cold state have the outlines defined by the points "b" at each corner of the cross-section, but which at operating temperatures, due to differential expansion between the hot ends and the cold ends of the brick move into positions b^1 , b^2 , b^3 , b^4 . The hot ends of the brick may touch one another at points f , the ex-

pansion of the hot ends being allowed for by pressure relief clearances 21 between the brick, again (as in Fig. 1) due to the layers of refractory cement being interposed between the relatively cold ends of the brick, each brick 17, 18, 19, 20 again being indicated as having its cold end portion surrounded by or encased in a coating 22 of refractory cement. The bricks in service are in contact with one another, not only at their hot ends, but also at the portions coated by the cement, and in fact the major portion of the weight of the wall is thus carried by the comparatively cold ends of the brick. With the materials and under conditions herein contemplated for use, as a matter of example, the cement coating being physically weaker than the body of the brick to which it is applied will let itself be compressed and forced into the clearances extending between it and the hot edges of the brick. In this way, the tendency to compel the hot ends of the brick to carry the load and to pinch off at operating temperatures, is virtually eliminated.

The method of constructing the refractory wall or lining by the use of partly coated or conditioned brick in alternation with plain brick, is illustrated in Fig. 3 by showing in vertically superposed sequence a coated brick 23, a plain brick 24 above it, and again a coated brick 25 on top of this. By breaking part of the coating away from brick 25 the character thereof is more clearly indicated.

Although the practice of this invention may not compensate exactly for all the changes in shape of refractory bricks or shapes due to temperature differentials between the end exposed to the source of heat and the other end, it does eliminate concentration of the load on the hot end of the brick and prevents pinching off during service of the hot ends of the bricks or shapes due to differential expansion.

It is within the scope of my invention to provide furnace structures in which the partially coated shapes are used with regular uncoated shapes or with fully coated shapes in definite proportions, as for example a structure in which alternate bricks are provided with the partial coating described herein, and the balance of the bricks are not so coated, (or completely coated) when the furnace temperatures and the coefficient of expansion of the refractory shape warrant such construction.

I have described the partially coated bricks of my invention as having been provided with a dry

and rigid coating before delivery to the place of installation, but my invention also contemplates the application of the coating by dipping, troweling, spraying or by any of the known methods at the place of installation and immediately prior to installation, even permitting the drying of the coating in place.

Although this invention is particularly applicable to chrome and magnesite refractories, the principles also apply to all others.

For example, on chrome brick I can use any of the better known chrome cements, which may contain in addition to chrome ore such materials as clay, sodium silicate, periclase, nitre cake, water soluble sulphates, water soluble chlorides, starch or possibly others. On magnesite brick I can use any of the better known magnesite or periclase cements, which may contain, in addition to magnesite or periclase, such materials as sodium silicate, iron oxide, nitre cake, aluminum sulphate, water soluble sulphates or chlorides, or possibly others.

I claim:

1. As an article of manufacture a refractory unit for use in furnace linings which comprises a brick or shape having a portion thereof opposite the face to be exposed to the source of heat of the furnace carrying a cementary adhering coating, said coating being designed and adapted, after a number of said brick are assembled to form a wall section of refractory lining, to act as spacing material between the brick in a manner to discourage undesired pressure due to thermal expansion, upon the undercut heat exposed end portions of the brick, while in turn effective to transmit the load pressure directly from brick to brick.

2. A unit according to claim 1, wherein the coating is rigid but weaker than the brick or shape.

3. A unit according to claim 1, wherein the coating surrounds a minor portion of the brick or shape.

4. A unit according to claim 1, wherein the coating surrounds at least all side faces of said coated end portion of the brick.

5. A unit according to claim 1, wherein the coating is of sufficient thickness to discourage pinching-off of the uncoated ends of the bricks or shapes assembled in said furnace lining during periods of service.

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