April 12, 1966 F. E. KIMBLE 3,245,131

CONTINUOUS KILN

Filed July 9, 1964 3 Sheets-Sheet 1

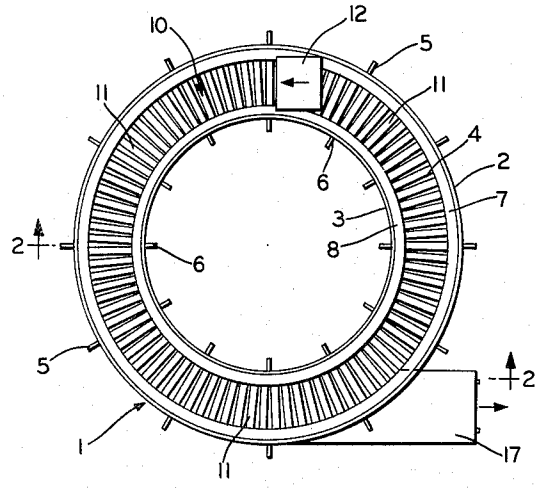


Fig. 1

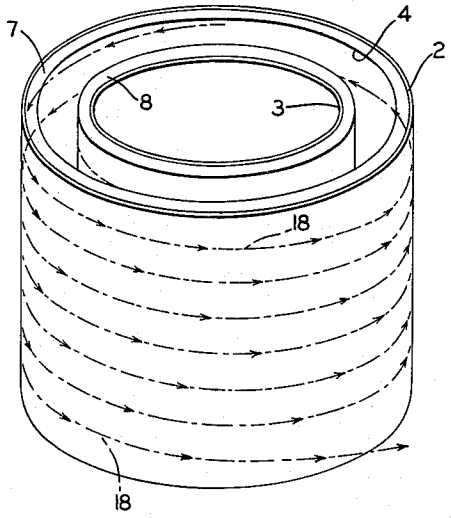


Fig. 3

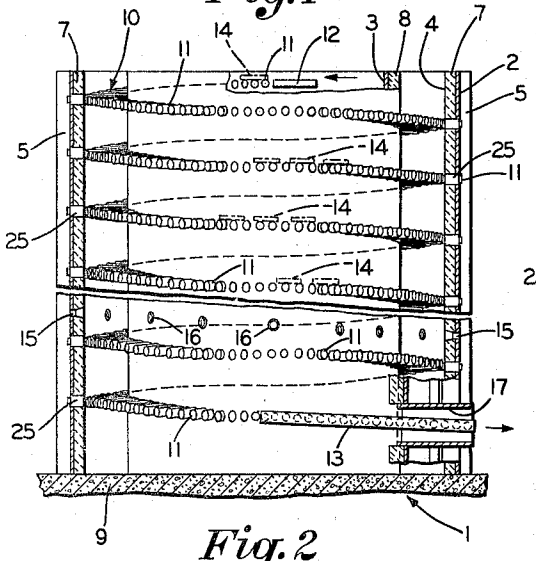


Fig. 2

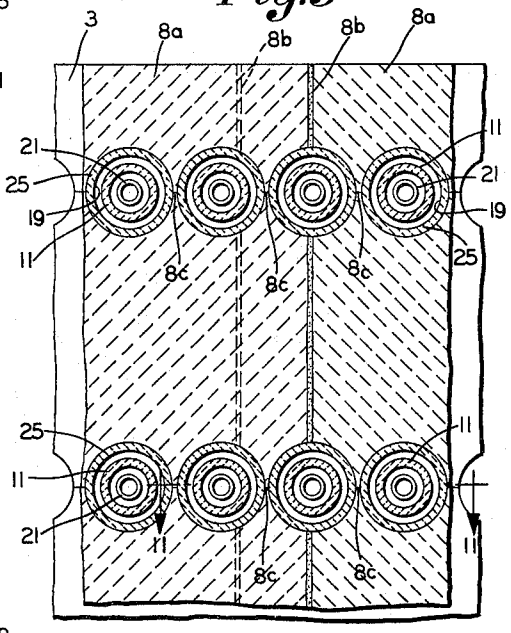


Fig. 10

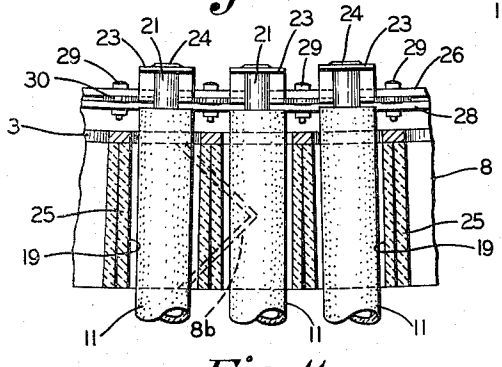


Fig. 11

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CONTINUOUS KILN

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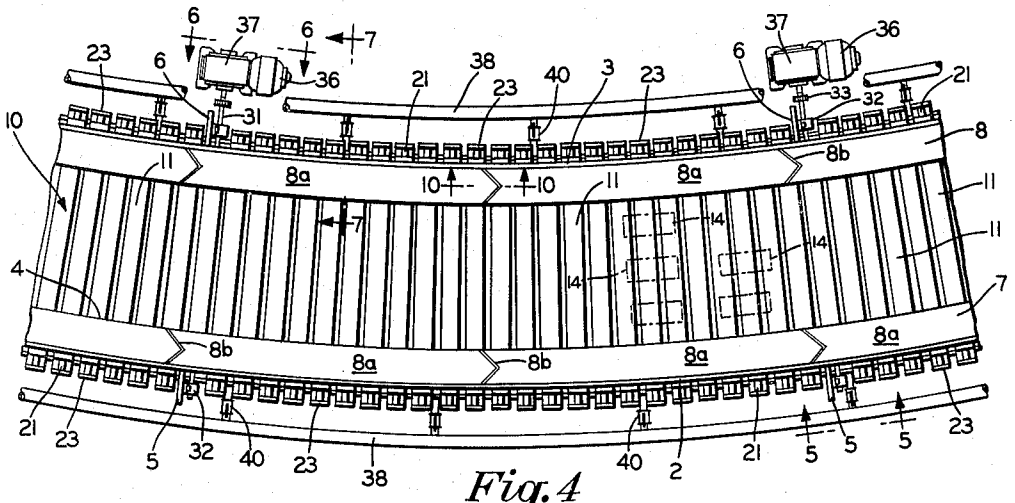


Fig. 4

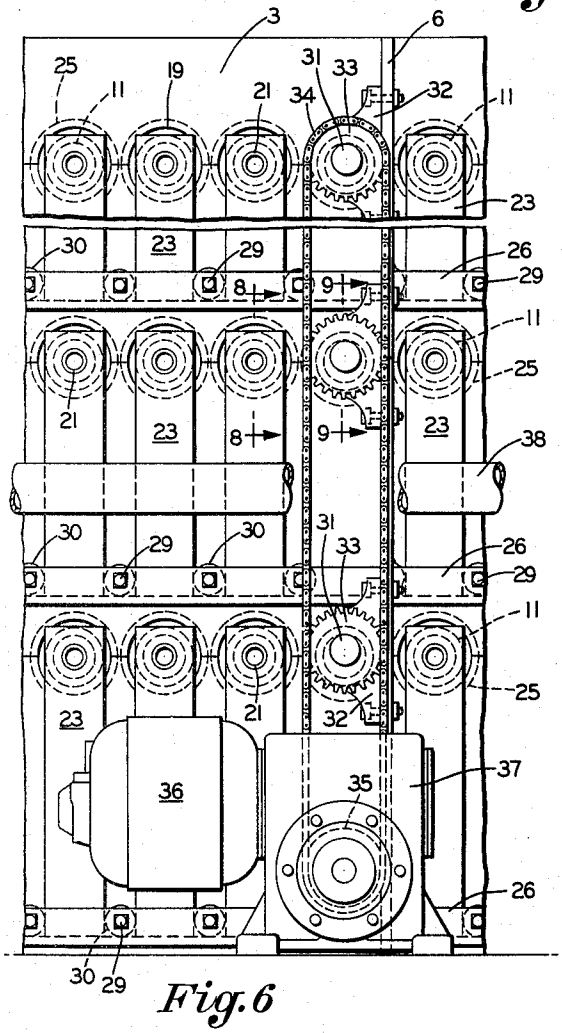


Fig. 6

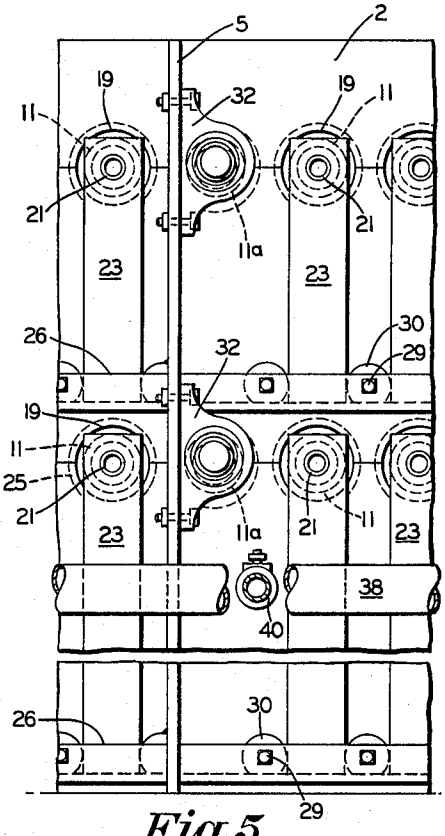


Fig. 5

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CONTINUOUS KILN

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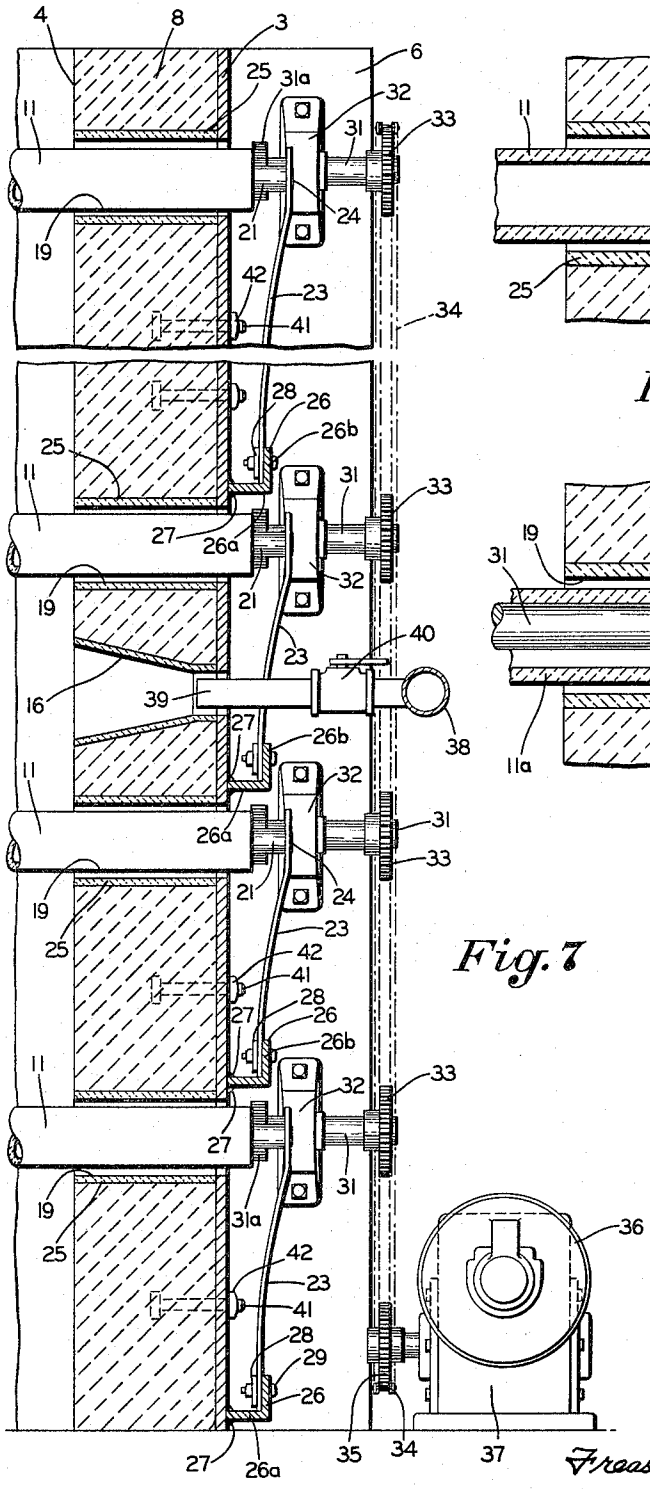


Fig. 7

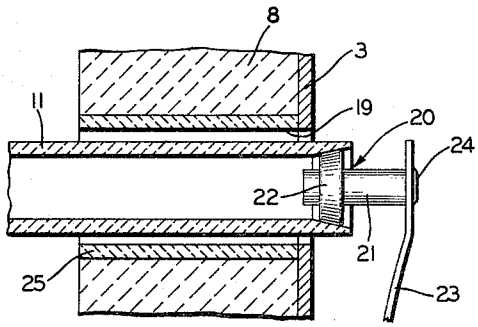


Fig. 8

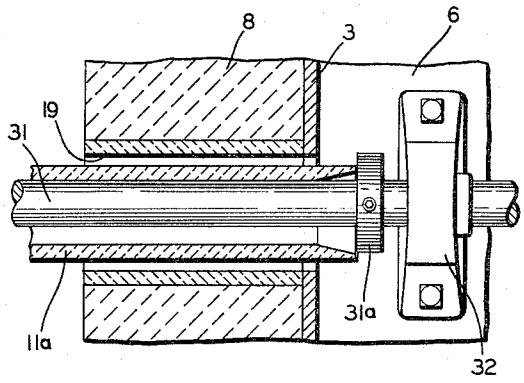


Fig. 9

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3,245,131

CONTINUOUS KILN

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Filed July 9, 1964, Ser. No. 381,423
10 Claims. (Cl. 25—142)

This invention relates to a kiln for burning bricks as well as all kinds of clay products. More particularly, it pertains to a continuous kiln.

The procedure of drying and firing bricks or other similar clay products has heretofore involved the process of manually stacking bricks in a kiln chamber in which the temperature is raised to the desired level. The primary disadvantage of such a batch type kiln has been the time-consuming cycle involved. After the kiln is loaded, it is sealed and the heating period begins during which the preliminary drying and the oxidizing of impurities occurs. The brick is then fired. Thereafter the heat is turned off and more time is consumed during subsequent cooling of the kiln and brick and removal of the brick from the kiln. Such a procedure is cyclical and involves inefficient use of labor and material.

In addition to the foregoing batch type brick kiln, a continuous kiln has been used which involves a long low tunnel built in the form of a parallelogram with rounded ends. The tunnel is divided into several chambers with each chamber having an entrance at each side and two firing ports. Thin partitions are used to secure the correct movement of the draft.

The economy of the continuous method is a considerable output without stopping the cycle of operation. However, a disadvantage of such prior continuous kilns has been the necessity of providing fans with auxiliary dampers for supplying the necessary air.

It has been found that the foregoing disadvantages may be overcome by the provision of a cylindrical kiln which is operated continuously and thereby reduces labor and other expenses. Such a kiln has a vertical cylindrical chamber in which a spiral path of rollers is provided for permitting the gradual descent of bricks from the upper to the lower end of the chamber. During the descent the temperature gradually increases and the bricks are subjected to three processes including drying, oxidation, and firing. In the preliminary drying period up to about 700° F. all moisture remaining in the green bricks is driven out.

During the oxidation period of higher temperature between 700° F. and 1500° F. impurities such as sulphur and carbonaceous matter are oxidized and ferrous iron is changed to ferric iron. At higher temperatures ranging from 1700° F. to 2400° F. the brick is fired and the chemical changes necessary to complete vitrification are made to develop the desired color and hardness. Thereafter, the bricks enter a cooling zone within the kiln and are gradually cooled to room temperature and then leave the kiln. Such a procedure may involve up to twenty-four hours and is conducive to a minimum of labor costs.

Associated with the foregoing is the necessity of providing an adequate means for supporting and permitting descent of the brick through the several stages of the firing process. At the same time large volumes of air are needed to facilitate the drying of the brick. By providing sufficient air, the moisture and impurity oxides are more readily driven off during the preheating period and thereby avoid subsequent defects, such as cracking, which sometimes occur in brick due to improper drying. The continuous kiln involved thus requires large volumes of air intake means to perform the preheating, drying, and oxidizing functions of the kiln prior to the firing and burning operation.

Accordingly, it is a general object of this invention to provide a continuous kiln having a cylindrical firing chamber through which bricks are lowered through successive stages of drying, oxidizing, and firing.

It is another object of this invention to provide a continuous kiln in which gases used for firing bricks are thereafter used for oxidizing and preliminarily drying the bricks.

It is another object of this invention to provide a continuous kiln having a spiral roller conveyor by which bricks are lowered and through which the hot gases rise from the firing zone to the upper end of the kiln.

It is another object of this invention to provide a continuous kiln having a plurality of air inlet apertures in the wall of the kiln whereby copious quantities of air are introduced with the rising gases to perform the oxidation and drying operations.

It is another object of this invention to provide a continuous kiln in which ceramic air-cooled tubes are used for conveying the bricks down the spiral conveying means.

It is another object of this invention to provide a continuous kiln in which drive means are provided for spaced rollers in order to control the rate of descent of bricks on the spiral conveyor.

Finally, it is an object of this invention to provide an improved continuous kiln which accomplishes the foregoing objects and desiderata in a simple and effective manner.

These and other objects and advantages, apparent to those skilled in the art from the following description and claims, may be obtained, the stated results achieved, and the described difficulties overcome, by the apparatus, constructions, arrangements, combinations, subcombinations, elements, parts, and principles, which comprise the present invention, the nature of which is set forth in the foregoing general statements, a preferred embodiment of which—illustrative of the best mode in which applicant has contemplated applying the principles—is set forth in the following description and shown in the drawings, and which is particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

Generally, the improved continuous kiln construction of the present invention may be stated in general terms as including a vertical annular chamber formed by concentric cylindrical walls, a spiral conveyor mounted in the chamber and composed of a plurality of separately mounted brick conveying ceramic rollers, the conveyor having an upper brick inlet end and a lower brick outlet end, the chamber having an upper preheating zone for preliminarily drying the brick, an intermediate zone for firing the brick, and a lower cooling zone, means for heating the intermediate firing zone, the concentric walls having a plurality of spaced aligned openings disposed in a spiral path, one brick conveying roller extending through each pair of aligned openings and having outer ends detachably mounted on the corresponding wall, the conveyor having driven rollers at spaced intervals for controlling the speed of descent of the bricks, and the apertures through which the rollers extend providing air inlet spacing between the apertures for the rollers.

Referring to the drawings forming part hereof in which the preferred embodiment is shown by way of example:

FIGURE 1 is a schematic plan view of the kiln showing the spiral conveyor rollers having upper inlet and lower outlet means;

FIG. 2 is a vertical sectional view taken on the line 2—2 of FIG. 1;

FIG. 3 is a perspective view showing the many convolutions of the spiral conveyor within the kiln;

FIG. 4 is an enlarged fragmentary plan view of the conveyor rollers;

FIG. 5 is an enlarged fragmentary elevational view taken on the line 5—5 of FIG. 4;

FIG. 6 is an enlarged fragmentary elevational view taken on the line 6—6 of FIG. 4;

FIG. 7 is an enlarged fragmentary vertical sectional view taken on the line 7—7 of FIG. 4;

FIG. 8 is an enlarged vertical sectional view showing the means of mounting the ceramic rollers taken on the line 8—8 of FIG. 6;

FIG. 9 is an enlarged vertical sectional view showing the many driven ceramic rollers taken on the line 9—9 of FIG. 6;

FIG. 10 is an enlarged vertical sectional view through several adjacent rollers taken on the line 10—10 of FIG. 4; and

FIG. 11 is a fragmentary horizontal sectional view taken on the line 11—11 of FIG. 10.

Similar numerals refer to similar parts throughout the various figures of the drawings.

In FIGS. 1 and 2 a kiln is generally indicated at 1. It is a cylindrical structure having an outer wall 2 and an inner wall 3. The walls 2 and 3 are concentrically disposed and provide an inner cylindrical chamber 4 which extends from the upper end to the lower end of the kiln. The inner and outer walls 2 and 3 are preferably composed of ⅛" steel plates and are reinforced by similar vertically spaced wall supports or beams 5 and 6, respectively. The inner surface of the wall 2 is provided with a ceramic liner 7 and the inner wall 3 is provided with a similar ceramic liner 8. Accordingly, the vertical cylindrical chamber 4 is enclosed between a pair of ceramic walls, the lower ends of which are supported on a base 9 and the upper end of which may be open to the atmosphere.

Brick conveyor means generally indicated at 10 are provided in the chamber 4. The means includes a plurality of separately mounted conveyor rollers 11 which are disposed in a spiral path, the upper end of which is adjacent a brick loading station 12 and the lower end of which terminates at a brick unloading conveyor 13. The station 12 may represent the end of a brick conveyor belt or other continuous brick loading means where bricks 14 are brought to the upper end of the conveyor means for descent through the several flights of the conveyor. Most of the rollers 11 are freely rotatable; i.e., bricks move by gravity to the lower end of the kiln.

During their descent the bricks 14 pass through a preliminary drying zone in the upper end of the chamber 4, which zone is heated by hot gases rising from the lower end of the chamber through spaces between the rollers 11. As the bricks continue to descend the temperature increases to between 1000° F.–1500° F. and there impurities such as sulphur and carbon are oxidized and removed from the bricks. As shown in FIG. 2, a plurality of gas ports 15 and 16 are provided in the walls 2 and 3, respectively, between the flights of rollers 11. The ports 15 are preferably staggered with respect to the ports 16. As the bricks descend they leave the oxidation zone and enter the firing zone where the ports 15 and 16 are disposed. In the latter zone the temperature reaches the brick firing temperatures ranging from 1700° F. to 2400° F. or more depending upon the composition of the bricks.

The hot bricks leaving the firing zone raise the temperature of the fresh air entering and rising through the cooling zone in the lower end of chamber 4. This increases the combustion air temperature and lowers the fuel input, which in turn reduces the air (inert nitrogen) quantity to be heated to flame temperature in the firing zone. Ultimately, the bricks are carried out of the firing zone and are cooled to room temperature. The bricks then move out of the kiln 1 on the conveyor 13 at the outlet opening 17 at the lower end of the kiln. Between the upper and lower ends of the conveyor 10 the bricks travel over several convolutions or flights of rollers 11, as shown by the broken line 18 in FIG. 3.

Each of the several rollers 11 is separately mounted

with opposite end portions extending through aligned openings in the concentric walls 2 and 3. The rollers 11 are preferably tubular in construction and are composed of ceramic or refractory material. As shown in FIG. 8, for the inner wall of the kiln the end portion of the roller 11 extends through an opening 19. The roller is centrally mounted on roller mounting means generally indicated at 20 which means includes a stub shaft 21, a bearing 22 on the inner end of the shaft, and a shaft mounting strap 23. The shaft 21 and bearing 22 hold the roller 11 centrally within the opening 19.

The opposite end of the roller 11 is similarly mounted within an opening in the outer wall 2. The shaft 21 is tubular and its outer end extends through the strap 23 and is welded at 24 to the strap. Thus, air may enter the interior of the roller through the shaft 21 and help to cool the roller. The air may subsequently pass out of the roller 11 through a similar shaft at the other end thereof. As shown in FIG. 8, each opening 19 is lined with a sleeve 25.

Each strap 23 is an elongated member preferably composed of spring steel and having its lower end mounted on a bracket 26 which is an angle member having a horizontal portion 26*a* and a vertical portion 26*b*. The inner end of the portion 26*a* is secured by welds 27 to the outer surface of the wall 3. The lower end portions of each strap 23 are secured between the bracket 26 and a strap 28 which is secured to the bracket 26 by spaced nut and bolt units. The opposite edges of the lower end portion of strap 23 are clamped between spacers 30 disposed on the bolts 29 and between the bracket 26 and strap 28. The lower end of the strap 23 abuts the portion 26*a*. Thus, the bracket 26 clamps the strap 23 in place in an upright position.

By providing the roller mounting means 20 with the spring strap 23 each roller 11 may be replaced when necessary by pulling the stub shaft 21 and bearing 22 out of the open end of the roller 11, dislodging the lower end of the strap 23 from the bracket 26 and pulling the roller longitudinally out of the chamber through the opening 19 and inserting another roller 11 in its place and reassembling the mounting means 20. Opposite ends of the rollers are similarly mounted on the outer and inner walls 2 and 3.

At equal intervals the rollers 11 include a driven roller 11*a* (FIGS. 4 and 6) which is similar in construction and composition to that of the rollers 11. As shown in FIG. 9, the rollers 11*a* are mounted on elongated shafts 31 which extend through aligned openings 19 in the inner and outer walls 2 and 3. The shafts 31 are rotated and are mounted in journals 32 on opposite walls. Thus, the inner wall of the roller 11*a* rests upon and turns with the shaft 31. The roller 11*a* is cooled by air that enters and leaves the interior of the roller through its open ends. A collar 31*a* holds the roller in place.

As shown more particularly in FIGS. 5 and 7, the journals 32 are attached to the beams 5. The end portion of each shaft 31 on the inner wall 3 is provided with a drive sprocket 33 which sprocket is driven by a continuous drive chain 34 which engages vertically spaced sprockets 33 at each flight of the rollers 11*a*. The lower end of the chain is attached to a similar sprocket 35 (FIGS. 6 and 7) which is driven by a motor 36 through a reduction gear unit 37.

The combination of gravity and the driven rollers 11*a* serve to control the descent of the bricks 14 on the conveyor. If the rate of descent of the bricks is slower than desirable, the driven rollers 11*a* move the bricks at a speed comparable to the rate of rotation of the rollers. As a result, there is no back-up of bricks or a possibility of a subsequent avalanche due to accumulation of bricks which have backed up. The driven rollers control and keep the bricks moving down the conveyor.

The kiln 1 is heated by gas which is supplied through a manifold 38 to which burners 39 are connected and

extend into the ports **15** in the walls **2** and **3**. A gas control valve **40** is preferably provided between the manifold **38** and the burner **39**. The ports **15** with the burners **39** are disposed between several convolutions or flights of the rollers **11** and preferably extend through at least one complete cycle thereof.

The ceramic liners **7** and **8** are preferably composed of blocks **8***a* of refractory material as shown in FIGS. 4 and 10. The blocks are provided with upper and lower horizontal end surfaces and with vertical edge surfaces forming interfitting V-shaped edge portions which dovetail together to form vertical joints. The blocks **8***a* are composed of 80% refractory grog and 20% aluminate cement. Adjacent blocks **8***a* are placed together with an expansion joint **8***b* provided to compensate for expansion and contraction of the liner blocks during heating and cooling. Upper and lower ends **8***c* of the vertical adjacent blocks **8***a* are mounted upon each other and are provided with aligned hemispherical grooves which receive the ceramic sleeves **25**. Each block is held in place against the inner surface of the walls **2** and **3** by anchor bolts **41** which are imbedded in the blocks and extend through bolt-receiving apertures in the walls **2** and **3** and are retained in place by nuts **42**.

The foregoing construction provides a continuous kiln having a vertical cylindrical chamber into which green bricks are continuously fed. Within the chamber as they descend on the spiral conveyor the bricks are subjected to the heat of the exhaust gases rising from the firing zone. As a result, the bricks are preliminarily dried as they descend toward the firing zone. In addition, impurities in the brick such as sulphur and carbonaceous matter are oxidized and eliminated. The bricks then enter the firing zone where they are vitrified. Subsequently they are cooled to room temperature before passing out of the kiln.

In order to facilitate the drying, the oxidation, and the firing processes, the walls of the kiln are provided with openings through which large quantities of air may enter the chamber. A loaded kiln will actually remove tons of moisture during the drying process for which reason great quantities of air are required. The device of the present invention, however, does not require the use of auxiliary facilities for moving the air such as outside fans, ventilators, or exhaust stacks. Instead, the chamber has an open top for venting purposes. The combined air and hot gases rise upwardly between the rollers at substantially right angles to the path of travel of the brick as they descend on the rollers.

Although the bricks descend on the conveyor rollers by gravity, some of the rollers at spaced intervals are driven to increase the rate of descent of the bricks and provide a spacing between the bricks. In that manner, the bricks cannot back-up and then create an avalanche.

Moreover, the rollers are separately mounted on the exterior of the kiln walls for a two-fold purpose. In the first place, the rollers may be separately replaced from time to time by removal of a manually operated spring-loading device which holds the rollers in alignment within roller-receiving openings in the walls. In addition, the exterior mounting of the rollers avoids unnecessary heating of the mounting means.

Accordingly, a continuous kiln is provided with means for controlling the descent of bricks from the upper inlet end to the lower outlet end and thereby provide a final product having a consistently hard, dense construction. Although the rollers support the bricks, they also allow the hot gases from the firing zone to rise upwardly through the chamber between and around the rollers and thereby heat the bricks to increasing temperatures as they descend.

In the foregoing description certain terms have been used for brevity, clearness and understanding, but no unnecessary limitations have been implied therefrom as such words are used for descriptive purposes and are intended to be broadly construed.

Moreover, the embodiment of the improved construction illustrated and described herein is by way of example and the scope of the present invention is not limited to the exact construction shown.

Having now described the invention, construction, operation and use of a preferred embodiment thereof and the advantageous, new and useful results obtained thereby, the new and useful continuous kiln and reasonable mechanical equivalents thereof obvious to those skilled in the art are set forth in the appended claims.

What is claimed is:

1. A continuous kiln for burning bricks including a vertical annular chamber; spiral conveyor means mounted in the chamber for carrying bricks from the upper end to the lower end of the chamber; the chamber having an upper preheating zone, an intermediate firing zone, and a lower cooling zone; means for heating the firing zone, and air inlet port means for admitting air into the chamber and including spaced apertures distributed around the chamber and adjacent the conveyor means.

2. A continuous kiln for burning bricks including concentric walls forming a vertical annular chamber; a spiral conveyor mounted in the chamber and having an upper brick-inlet end and a lower brick-outlet end; the chamber having an upper preheating zone, an intermediate firing zone, and a lower cooling zone; means for heating the intermediate zone; and inlet means in the chamber walls and coextensive with at least a portion of the conveyor for admitting air into the chamber.

3. The kiln construction of claim **2** in which the conveyor includes a plurality of spaced gas-passage means for permitting gases to rise to the upper end of the chamber.

4. A continuous kiln for burning bricks including concentric walls forming a vertical chamber, conveyor means mounted in the chamber for carrying bricks from the upper end to the lower end of the chamber, the conveyor means including a plurality of spaced brick-supporting rollers, the rollers forming a spiral path within the chamber, means for heating bricks and coextensive with a portion of the spiral path, and means for controlling the speed of movement of bricks on the conveyor and including a plurality of driven rollers at spaced intervals throughout the spiral path of the conveyor.

5. A continuous kiln for burning bricks including concentric walls forming a vertical annular chamber, the upper end of the chamber being open, conveyor means mounted in the chamber for carrying bricks from the upper end to the lower end of the chamber, the conveyor means including a plurality of spaced brick-supporting rollers, the rollers forming a spiral path within the chamber, said spiral path having vertically spaced flights, means for heating bricks and coextensive with a portion of the spiral path, and means for controlling the speed of movement of bricks on the conveyor and including a plurality of driven rollers at spaced intervals throughout the spiral path of the conveyor.

6. A continuous kiln for burning bricks including concentric walls forming a vertical annular firing chamber, conveyor means mounted in the chamber for carrying bricks from the upper end to the lower end of the chamber, the conveyor means including a plurality of spaced brick-supporting rollers, the rollers forming a spiral path within the chamber, said spiral path having vertically spaced flights, means for heating the bricks and coextensive with a portion of the spiral path, means for controlling the speed of movement of the bricks on the conveyor and including a plurality of driven rollers at spaced intervals throughout the spiral path of the conveyor, the driven rollers being vertically aligned in adjacent flights, and means for operating the driven rollers including a continuous chain extending over and between the ends of the rollers.

7. A continuous kiln for burning the bricks including

inner and outer walls forming a vertical annular chamber, conveyor means mounted in the chamber for carrying bricks from the upper end to the lower end of the chamber, the conveyor means including a plurality of spaced brick-supporting rollers, the rollers forming a spiral path within the chamber, the inner and outer walls having roller-receiving openings communicating between the chamber and the exterior of the walls, each roller having end portions extending through the openings in the walls, means for mounting each end of each roller on the outer surface of the inner and outer walls, means for heating bricks and coextensive with a portion of the spiral path, and means for controlling the speed of movement of bricks on the conveyor and including a plurality of driven rollers at spaced intervals throughout the spiral path of the conveyor.

8. The kiln construction of claim 7 in which the size of the roller-receiving openings in the inner and outer walls is greater than the diameter of the rollers, and in which an air inlet space exists between the end portion of each roller and the periphery of the corresponding roller-receiving opening.

9. The kiln construction of claim 7 in which the spiral path of the rollers includes vertically spaced flights, in which each spaced driven roller in one flight is in vertical alignment with driven rollers in other flights, and means for driving the vertically aligned rollers including a continuous chain extending over and between said rollers.

10. A continuous kiln for burning bricks including inner and outer walls forming a vertical annular chamber having an upper open end, conveyor means mounted in the chamber for conveying bricks from the upper end to

the lower end of the chamber, a brick outlet opening in one of the walls communicating with the lower end of the conveyor means, the conveyor means including a plurality of spaced brick-supporting rollers arranged in a spiral path, the rollers forming a plurality of vertically spaced spiral flights, the chamber having an upper preheating zone for preliminarily drying bricks, an intermediate zone for oxidizing impurities in bricks, and a firing zone for bricks, the walls including openings aligned with each roller, each end portion of each roller extending through the openings in the walls and providing a clearance space with the periphery of the openings, means for mounting each of each roller on the exterior of each wall, the conveyor including a plurality of driven rollers disposed at spaced intervals throughout the spiral path, each driven roller in one flight being vertically aligned with a driven roller in the other flights, each roller being mounted on an axle, the axles on one wall of the kiln having a sprocket gear mounted thereon, and means for driving the driven rollers including a continuous chain extending over and around the sprockets of the several aligned driven rollers.

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