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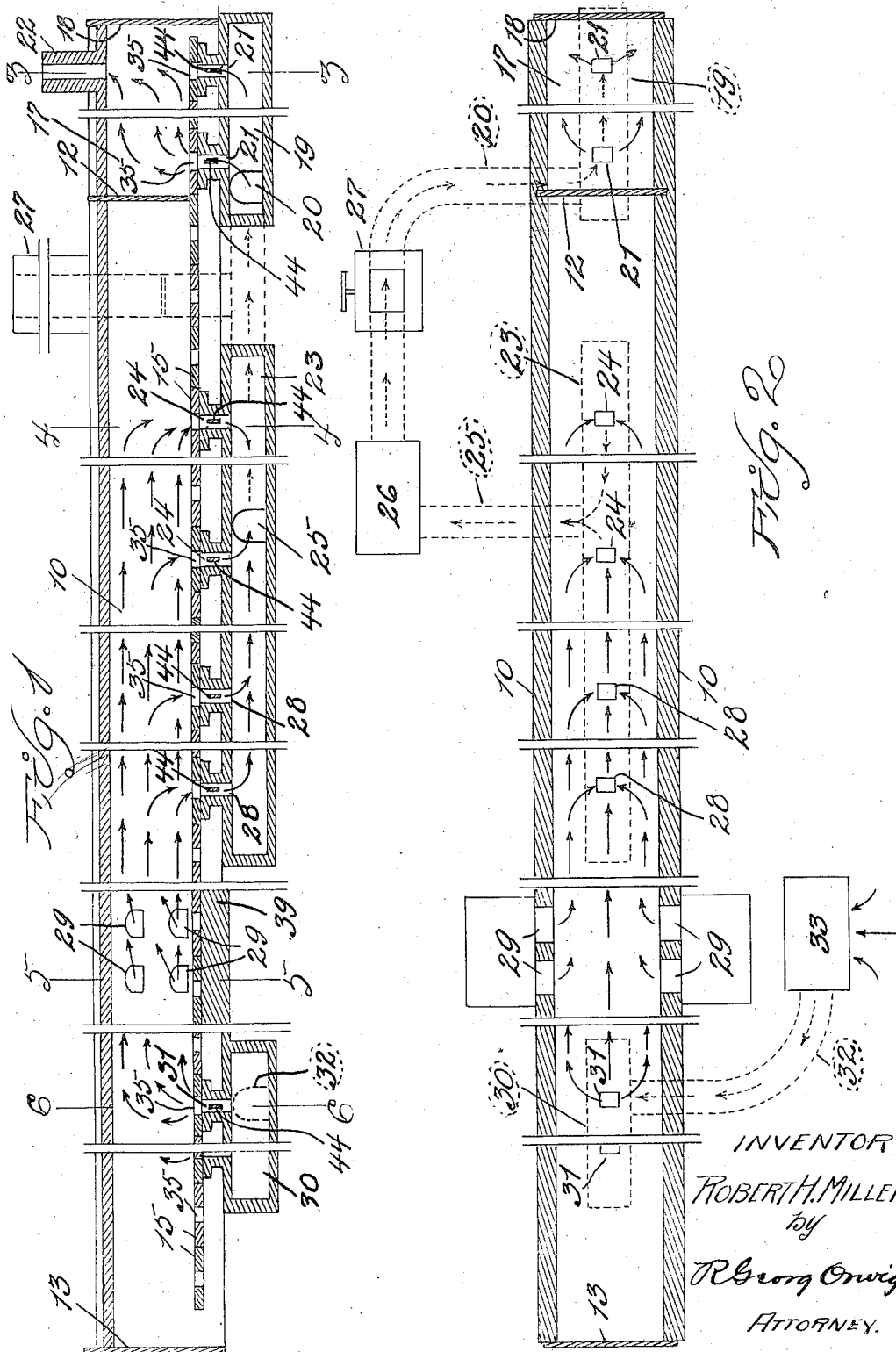
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R. H. MILLER

TUNNEL KILN

Filed April 15, 1922

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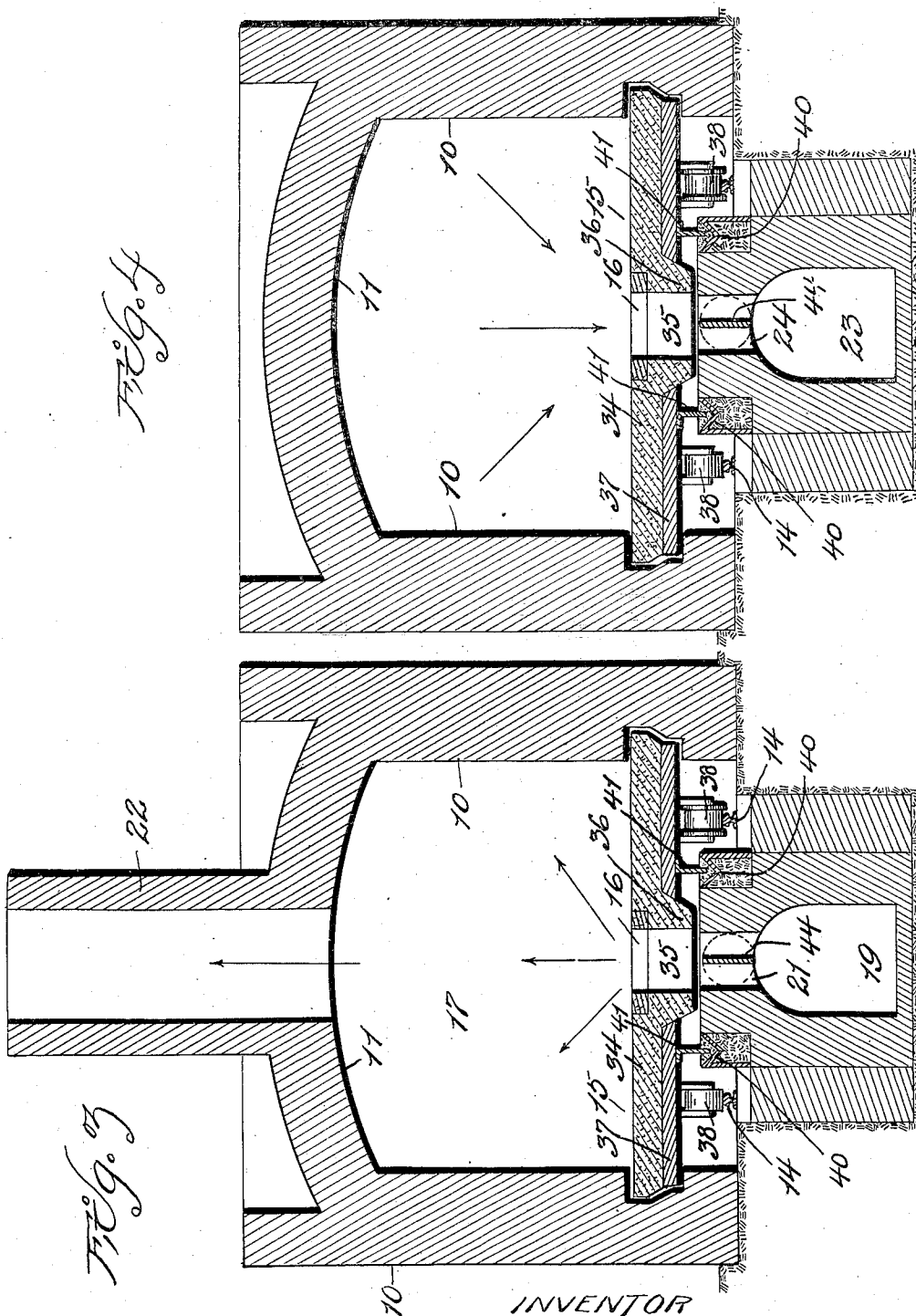
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TUNNEL KILN

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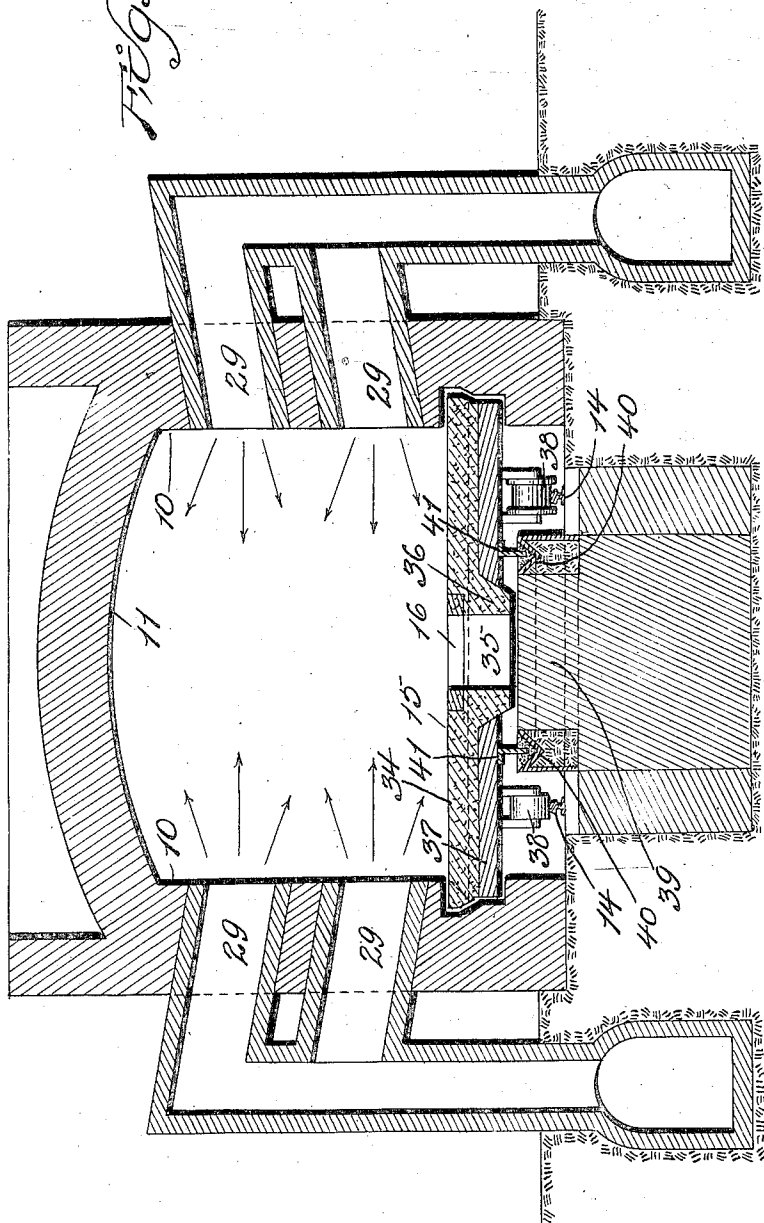
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TUNNEL KILN

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5 Sheets-Sheet 3



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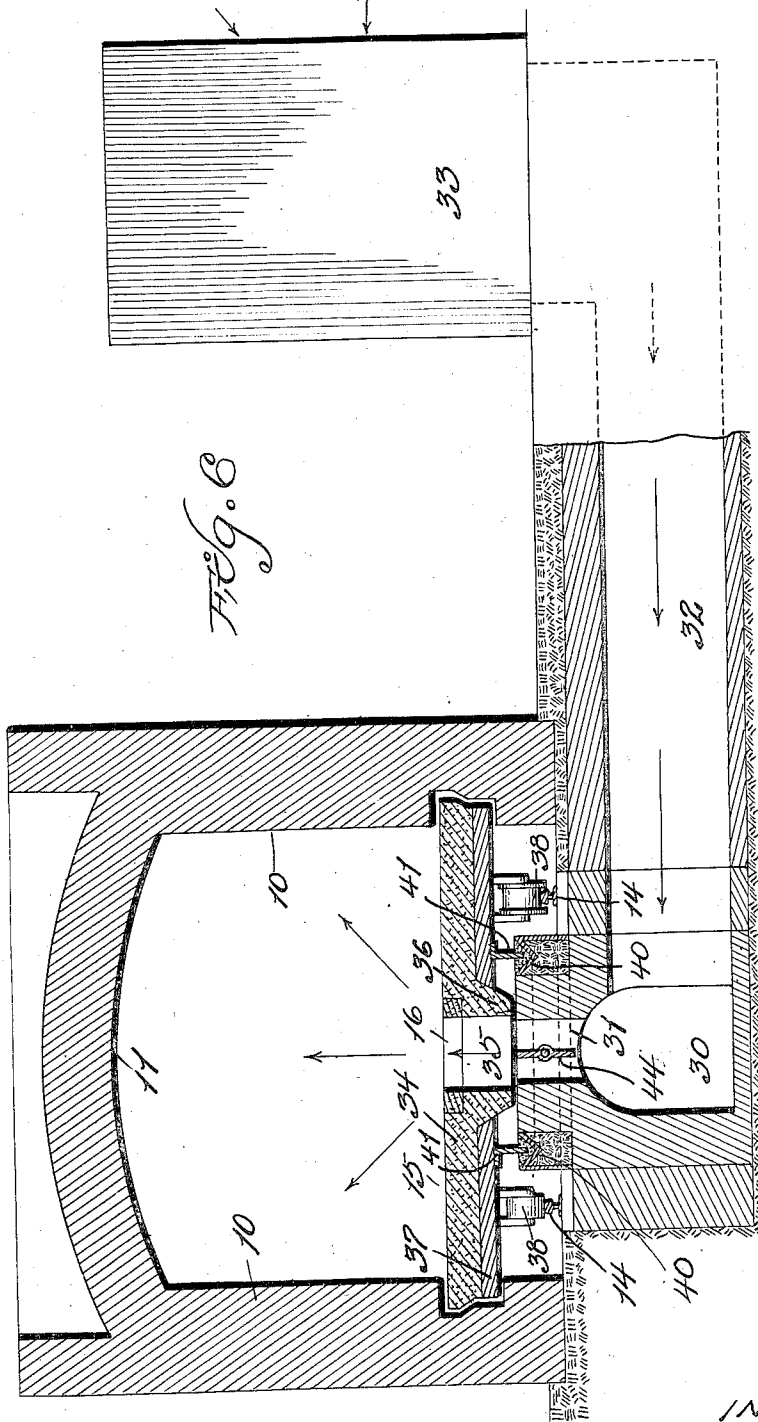
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TUNNEL KILN

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5 Sheets-Sheet 4



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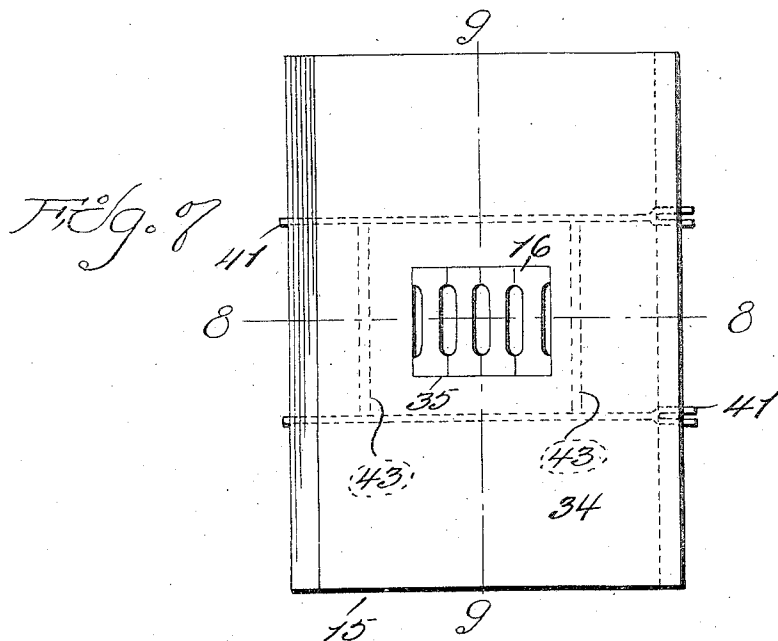
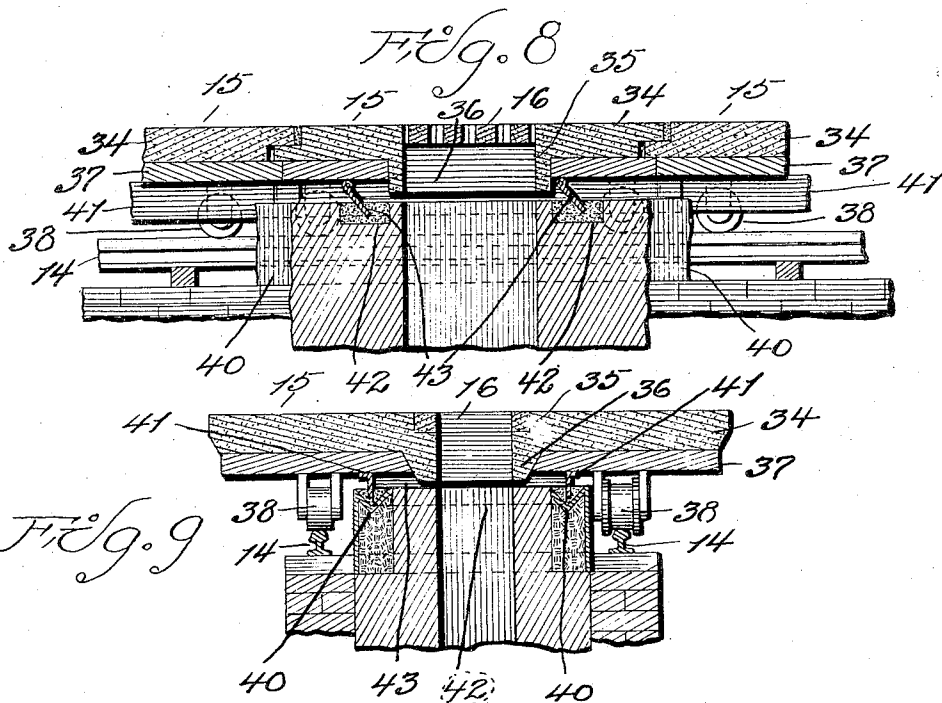
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TUNNEL KILN

Filed April 15, 1922

5 Sheets-Sheet 5



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Patented Jan. 29, 1924.

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UNITED STATES PATENT OFFICE.

ROBERT H. MILLER, OF ST. LOUIS, MISSOURI.

TUNNEL KILN.

Application filed April 15, 1922. Serial No. 552,843.

To all whom it may concern:

Be it known that I, ROBERT H. MILLER, a citizen of the United States, residing at St. Louis, State of Missouri, have invented certain new and useful Improvements in Tunnel Kilns, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to improvements in tunnel kilns and more particularly to railroad tunnel kilns for burning and annealing products, such as bricks, in which the operation is continuous.

There are now three distinct types of tunnel kilns, namely, the muffle type, the open type and the composite muffle and open type.

In the muffle type the combustion takes place in an enclosed chamber; the heat is confined in the muffle; the combustion gases lead to exhaust through a series of muffles, and the burning and preparing done by radiation alone.

In the open type the combustion takes place in the ware and the gases are led to the exhaust through the ware.

In the composite muffle and open type the combustion takes place in the ware and the gases immediately led into a recuperator and thence to exhaust.

In all such types, the kilns operate on what is known in practice, as the up-draft principle, in which the combustion gases are conducted in a substantially horizontal plane, or course, to openings, usually in the side walls, near the entrance end of the kiln.

Naturally, in all such kilns the combustion gases have a tendency to rise to the top, or arch, and to move in paths of least resistance, along the top of the kilns with the result that the "preparing" of the ware is "advanced" along the "top" and the "upper sides" and the "centers" and "bottoms" improperly prepared, or "retarded."

Numerous expedients have been resorted to in efforts to control the flow of combustion gases to force the heat to the "center" and "lower sides" of the ware, such as "back-pressure devices," which, so far have resulted in producing unsatisfactory conditions in the "preparing zone" and operated to effect non-uniform performance of the kilns generally.

In such of the present kilns, where attempts to recover the heat from the material in

the cooling zone are made the currents of air, usually by means of a pressure blower, are forced to travel in a path distinct from the path of the material, toward the discharge end of the kiln under the conveyor and thence back through the kiln in the path of the material. Obviously, and for the same reason as recited in connection with the "preparing" zone, the tendency is for the cool currents to follow along the bottom of the ware, thereby causing the upper ware to lose its heat in a slower manner than the lower ware.

At present, all kilns, having conveyors for the movement of the ware through the kiln, employ conveyors, such as cars or trucks, having solid, imperforate bottoms, or beds, hence the circulation of currents, whether in the preparing, treating, or cooling zone must of necessity be around the sides and top of the material and in a path paralleling the trend of the kiln.

In substantiation of the contention that the present kilns are operating at an efficiency widely separated from maximum it is pointed out that the product of all kilns is now subjected to "grading," and, that such grading includes seldom less than three distinct conditions of material. These conditions are created by inability to properly control and distribute the currents in the preparatory stages of burning.

The primary object of my invention is to provide an apparatus comprising a ware conveying means, and a confining means surrounding the path of travel of the conveying means, adapted to effect a substantially uniform condition of treating medium throughout said confining means, whereby all of a quantity of material conveyed through said confining means will be uniformly subjected to said treating medium.

A further object of my invention is to provide an apparatus comprising an open work conveyor, a confining means surrounding the path of travel of the conveyor and means for controlling the movement of a treating medium in paths out of parallel with the trend of the confining means whereby material carried on the open work conveyor will be subjected to currents of such treating medium whose trends are angular to the path of the conveyor, to the end that such material is uniformly treated.

A further object of my invention is to provide a kiln of the tunnel type in which an open work conveyor forms the bottom of the treating chamber and in which means is provided for the movement of the treating medium vertically as well as longitudinally through the material carried upon the open work conveyor, whereby the flow of treating medium may be held in selected planes of travel and moved either upwardly or downwardly as well as longitudinally through the conveyor and material carried by the conveyor.

With the above mentioned, and other, objects, as will be revealed, in view, my improvements consist in the novel construction, arrangement and combination of parts as will be fully, clearly and concisely described, definitely pointed out in my claims and illustrated by the accompanying drawings, (5 sheets) in which—

Figure 1 is a longitudinal sectional elevation of a kiln constructed in accordance with my invention, and in which arrows indicate the course of treating medium.

Fig. 2 is a sectional plan view of the kiln illustrated in Fig. 1.

Fig. 3 is an enlarged transverse sectional elevation, taken on the line indicated 3—3 of Fig. 1 showing the drying chamber or zone.

Fig. 4 is an enlarged transverse sectional elevation, taken on the line indicated 4—4 of Fig. 1, showing the preparing zone.

Fig. 5 is an enlarged transverse sectional elevation, taken on the line indicated 5—5 of Fig. 1 showing the burning zone.

Fig. 6 is an enlarged transverse sectional elevation, taken on the line indicated 6—6 of Fig. 1, showing the cooling zone.

Fig. 7 is a plan view of one of the cars, showing its open-work bottom.

Fig. 8 is a longitudinal sectional elevation of the car taken on the line indicated 8—8 of Fig. 7, and Fig. 9 is a transverse sectional elevation of the car taken on the line indicated 9—9 of Fig. 7.

In the form of apparatus illustrated the kiln proper comprises opposed parallel side walls 10 which are spanned by an arch, or top 11, which together form a tunnel through which material to be treated is moved. At each end of the kiln proper, entrance and discharge ends, there is provided a closure, such as the doors 12 and 13, which may be of the ordinary sliding variety, whose specific construction forms no part of my invention.

On the ground, or floor of the tunnel, paralleling the side walls are the rails 14 for the support of ware carrying cars 15, whose beds, having open work, or grills 16 form the bottom of the kiln proper or treating zones, and upon which the treated material is moved through the kiln.

By preference, and as shown, the tunnel length includes a drying chamber 17, in communication with the kiln proper through the recited entrance door 12 and which is provided with a receiving door 18.

Paralleling and preferably coextensive in length with the drying chamber 17 is a conduit 19, having an inlet 20, for the drying medium, preferably a plurality of mouths, 21, opening directly into the chamber through the open-work, or grill, of the ware conveyor, or cars 15.

By preference, the inlet 20 resides adjacent the discharge end of the drying chamber, the recited mouths 21 are relatively spatially related and disposed with relation to the length of the drying chamber as to establish and maintain a graded temperature lengthwise of the drying chamber, and the drying chamber is provided with an outlet, preferably in the form of a stack such as 22, leading from the chamber, preferably through the top or arch 11, adjacent the receiving end of the drying chamber.

The portion of the tunnel length next the receiving end, at the door 12, hereinafter referred to as the preparing zone, is provided with a conduit 23, (similar to the described conduit 19) which extends parallel with the preparing zone and is in communication with a portion of the length thereof through mouths 24, similar to the recited mouths 21 and which conduit is provided with an outlet 25.

For economy, I prefer that the outlet 25 of the preparing zone be in communication with the inlet 20 of the drying chamber, as indicated in Figs. 1 and 2, and for the control of the flow of medium in the preparing zone and between the preparing zone and drying chamber I provide a blower, or other inducer as at 26, and a damper controlled stack as at 27.

That portion of the tunnel length next the preparing zone and hereinafter referred to as the treating and burning zone is provided with an outlet in the form of spatially related mouths 28, which communicate with the recited conduit 23, which conduit is extended beyond the preparing zone to include the mouths 28, or outlet of the treating zone, and adjacent the discharge end of the treating zone, preferably through the side walls of the kiln as shown are the burner openings 29, for the discharge of fuel into the treating zone. Through the openings 29 the combustible is released, and, coming in contact with the heated air, from the cooling ware, forms the complete combustion.

Following the treating zone, the remaining tunnel length, hereinafter referred to as the cooling zone is provided with a conduit 30 similar to the recited conduits 19 and 23, having an outlet, in the form of spatially

related mouths 31 and an inlet 32, which by preference is equipped with an inducer such as a blast fan, or blower, 33.

In the immediate foregoing description the kiln is related to the direction of travel of the ware, that is from right to left in Figs. 1 and 2, and for clarity it is here pointed out that Figs. 1 and 2 show only related fragments of the tunnel length. For example, the drying zone may be of a length to include eleven of the ware carriers, cars 15, each of whose lengths may be, for example, six feet, the preparing and treating zones each of a length to include fifteen of the cars, and the cooling zone of a length to include eleven of the cars.

Each of the cars 15 comprises a bed or bottom 34, constructed of refractory or heat resisting material, as best shown in Figs. 7, 8 and 9, having an opening 35 approximately centrally disposed in which is supported the recited open work or grill 16 and surrounding which opening is the dependent lip or flange 36. The bed is supported on a frame 37 comprising a wheeled support 38 for travel on the recited rails 14.

For the protection of the running gears of the cars, the metallic frames 37 and wheels 38, against exposure to the excessive heat of the treating zone (see Fig. 5), I have provided a dead wall section 39, which forms a continuation of the conduits 23 and 30, whose upper surface approximates the plane of the depending flanges 36 of the cars, and augmenting this expedient I have provided parallel troughs 40, containing substance such as sand arranged for traverse by depending blades 41 carried by the cars, so that circulation is prevented by either the heat from the treating chamber reaching the running gears through the openings in the cars, or air being drawn from underneath the cars into the treating chamber.

In addition to such troughs and blades and to prevent travel of air or gases lengthwise of the kiln beneath the car beds or kiln bottom I have provided the lateral sealing troughs such as 42 (see Fig. 8) which are preferably in communication with the longitudinal troughs and coact with cross blades 43, pivotally carried by each car to fall by gravity into the troughs 42.

To seal the joints between the car ends I form the ends of the beds as rabbets which form grooves, extending laterally or crosswise of the tunnel bottom, in which I place sand, or its equivalent, and thus prevent communication from the tunnel proper to the air space surrounding the tracks and running gear, as best shown in Fig. 8.

Augmenting the control of treating medium as by the relative disposal and arrangement of the various inlets and outlets, such as the mouths 24 and 28 I provide dampers such as 44 at each mouth whereby

each mouth may be active or inactive as desired. And further control, especially in relation to obtaining uniform treatment at the burning zone, is provided by arranging the burner openings 29 at varying altitudes, whereby the material in its movement relative to the burning zone will be subjected to heat issuing from sources occupying positions affording direct, intimate treatment or burning of the load or bung throughout its height.

According to the present methods the drying step is distinct from the remaining steps and in all kilns distinct apparatus including the conveyor, or cars, is employed, which means that the material after having been dried must be reset or transferred from the conveyor of the drier to the conveyor of the kiln proper.

In the provision of a conveyor, or car, having an open work bottom, and in the construction of the drier, with relation to its inlet for heated currents, identically like the construction of the kiln proper obviously the same cars may be employed in both the drier and the kiln, hence the handling of material is minimized.

By reason of the placement of the drier in direct ware communication with the kiln proper, or preparing chamber, or zone, the ware is constantly maintained in a controlled temperature or condition, and such controlled temperature or condition may be made substantially similar between the discharge end of the drier and the receiving end of the preparing zone so that the ware need not be subjected to too rapid changes in treating conditions.

By reason of the utilization of the treating medium from the preparing zone to effect the drying, an ideal condition in the drier is obtained for the reason that such medium, is laden with considerable moisture which in the presence of heat causes a humidity which effects more rapid and uniform drying of the ware, and practically eliminates "checking" or face cracks due to too rapid surface drying.

The operation of a kiln constructed in accordance with my invention for the making of brick is as follows:

The cars 15, are loaded, or set, in the yard at the press, with raw material in "open stacks" or bungs, and rolled directly into the drier, where due to the control, including the dampered stack, and dampered inlets the treating currents may be conditioned as desired and their courses directed in the drier as desired and by reason of the inlets being beneath the material the treating currents are caused to be moved vertically as well as longitudinally through the material, instead of only along the top and upper sides as in the present kilns.

Assuming all of the various zones to con-

tain cars laden or set, as recited, the drier in communication with the kiln proper through outlet 25 and inlet 20, the burners at openings 29 active, cooler inlet 32 active and the various dampers at the various mouths set as desired, and assuming further that such an operating condition may be continuous and the cars intermittently introduced to be moved through and discharged from the various zones:

Obviously upon the introduction of a car into the drier, or the entrance end of the kiln a car will be moved out of the discharge end of the cooler. The movement of the train of cars is thus unitary in which the openings 35 in the car bottoms are "step by step" related to and brought to register progressively with the mouths 21 of the drying zone; mouths 24 of the preparing zone; mouths 28 of the burning zone and mouths 31 of the cooling zone.

Obviously further, the materials in the preparing zone, by reason of the arrangement of the outlets 24 will be caused to travel in a heated current of substantially uniform temperature throughout the height of the kiln and by reason of the open bottom cars such currents will be caused to be moved through the material both vertically and horizontally hence the "centers" reached and properly prepared, which action is not accomplished, or is possible, in the present kilns by reason of the employment of solid bottom conveyors, or cars.

In the treating, or burning, zone by reason of the described arrangement of burner openings and the arrangement of the outlets or mouths 28 the currents may be controlled and directed to travel in selective planes for uniformity of temperature throughout the height of the kiln for the whole length of the treating zone and by reason of the open stacked material and the open bottomed cars the heated air "forced" through the "centers" of the material.

In the cooling zone by reason of the described construction the cooling medium, atmospheric air acts to uniformly cool the material.

I claim:

1. In an apparatus of the class described, a confining means, a conveyor arranged for movement through the confining means, and means for directing a treating medium to travel lengthwise through said confining means and vertically through said conveyor.

2. In an apparatus of the class described, a confining means, an open bottom conveyor arranged for movement through the confining means, and means for directing a treating medium to travel lengthwise through said confining means and vertically through said open bottomed conveyor.

3. In an apparatus of the class described, a confining means, a conveyor arranged for

movement through the confining means, and means comprising spatially related mouths for directing a treating medium to travel longitudinally of the confining means and vertically through said conveyor.

4. In an apparatus of the class described, a confining means, a conveyor arranged for movement through the confining means, and means, comprising controllable inlets and outlets spatially related along the trend of the confining means for directing a treating medium to traverse the confining means in selective planes.

5. In an apparatus of the class described, a confining means, an open bottom conveyor arranged for movement through the confining means, and means comprising controllable inlets and outlets spatially related along the trend of the confining means for directing a treating medium to traverse the confining means in selective planes and to direct such medium to be moved vertically through the open bottom conveyor.

6. In an apparatus of the class described, a confining means, comprising a movable bottom, forming a ware conveyor, means for introducing a treating medium in the confining means for travel in the trend of the confining means, and an outlet comprising a plurality of spatially related mouths for controlling the plane of movement of the treating medium through said confining means.

7. In an apparatus of the class described, a confining means comprising a movable bottom, forming a ware conveyor, having openings therethrough at intervals, means for introducing a treating medium into the confining means for travel in the trend of the confining means, and an outlet comprising a plurality of mouths spatially related and arranged for register with the recited openings in the ware conveyor whereby the flow of currents of the treating medium may be directed in its travel to flow lengthwise through the ware as well as vertically therethrough.

8. In an apparatus of the class described, a confining means, comprising a movable bottom forming a ware conveyor, having openings at intervals, means for introducing a treating medium into the confining means for travel in the general trend thereof, and an outlet comprising a plurality of controllable mouths arranged for registration with the recited openings in said movable bottom whereby currents of said treating medium may be caused to moved in selective planes in the trend of the confining means and caused to moved vertically through the said openings and mouths.

9. In an apparatus of the class described, a confining means, comprising a bottom forming a ware conveyor, having openings therethrough at intervals, means for intro-

ducing treating medium into the confining means for travel in the general trend thereof, means for dividing the confining means to form distinct compartments, means comprising spatially related mouths for communication with the recited openings in said bottom for controlling the movement of the treating medium through said distinct compartments.

10. In an apparatus of the class described, a tunnel, movable closures at the entrance and discharge ends of the tunnel, a movable closure intermediate the entrance and discharge ends to divide the tunnel into distinct compartments, means common to said compartments for the conveyance of ware therethrough, means for introducing a treating medium into one of said compartments and means for controlling the movement of said treating medium causing it to travel through all of said compartments in selective planes.

11. In an apparatus of the class described, a tunnel, ware conveying means arranged for movement through the tunnel, means intercepting the path of the ware to divide the tunnel length into distinct drying and treating zones, means for introducing combustion gases into the treating zone, means for conducting currents from the treating zone to the drying zone and means for introducing into the tunnel length atmospheric air for the creation of a cooling zone in advance of and in direct communication with the treating zone, whereby ware carried upon said conveying means will be subjected to drying, preparing, burning and cooling treatments without handling and without exposure to other than controlled temperatures and conditions.

12. In an apparatus of the class described, a tunnel, a ware conveying means having openings at intervals forming the bottom proper of the tunnel, means for introducing combustion gases into the tunnel above said bottom, an outlet for said combustion gases comprising a plurality of spatially related mouths beneath said bottom for communication with the recited openings in said bottom, whereby a preparing and burning zone is established, means for establishing communication between said outlet and a distinct inlet comprising a similarly arranged plurality of mouths whereby a drying zone is established in advance of the preparing and burning zone and an inlet comprising a third distinct plurality of mouths following the burning zone whereby a cooling zone is established whereby ware in its travel through the tunnel will be subjected to currents of treating mediums both longitudinally and vertically therethrough.

13. In an apparatus of the class described, having a drying zone, a preparing and burning zone and a cooling zone, a confining

means common to all of said zones, a bottom common to all of said zones, in the form of a ware conveying means, and which bottom is provided with openings at intervals in its length, an inlet to said cooling zone comprising a plurality of spatially related mouths beneath said bottom and in communication with the zone through the openings in said bottom whereby the burned ware carried upon said conveying means will be subjected to currents of cool air through the center of the masses of ware as well as along their sides and tops, said cooling zone being in direct, open communication with the burning zone, an inlet, to said burning zone, for combustion gases, with which the currents from the cooling zone mingle for travel toward the entrance ends and whose natural path is along the top of the confining means, an outlet for said preparing and burning zone comprising a plurality of spatially related mouths beneath said bottom and in communication with the preparing and burning zone through the recited openings in said bottom, an inlet to said drying zone comprising a plurality of spatially related mouths beneath said bottom and in communication with the drying zone through the openings in said bottom, means for establishing and controlling communication between the outlet of the preparing zone and the inlet of the drying zone, an outlet for the drying zone and movable closures at the receiving ends of the drying and preparing zones and at the discharge end of the cooling zone.

14. In a kiln, a tunnel, a track-way on the floor of said kiln, a ware conveyor in the form of cars, having metallic frames and wheeled supports, and beds of refractory material, said beds forming the bottom proper of the kiln, means for directing currents of treating medium to move in a controlled course through the tunnel and vertically through openings in said tunnel bottom and means for preventing exposure of said track-way, said metallic frames and wheeled supports of the conveyor cars to said treating medium and to prevent air being drawn from under said bottom to the tunnel proper.

15. In a tunnel kiln, a ware conveyor, comprising cars having wheeled supports, and whose beds form the bottom of the tunnel, there being openings in said beds, inlets and outlets for treating medium comprising mouths located beneath and for communication with the openings in said car beds, sand containing sealing troughs surrounding said mouths, and blades carried by the cars for coaction with said sand troughs for sealing around said openings and mouths.

16. In a tunnel kiln, a ware conveyor forming the bottom of the tunnel and pro-

vided at longitudinal intervals with openings extending vertically therethrough, inlets and outlets for treating medium comprising mouths located beneath and for
5 communication with the openings in the ware conveyor, and means for sealing about said openings and mouths comprising ele-

ments resident at said mouths and elements carried by the conveyor for coaction therewith.

In testimony whereof I hereunto affix my signature.

ROBERT H. MILLER.