Jan. 16, 1968 A. R. MARTIN 3,363,324

KILNS

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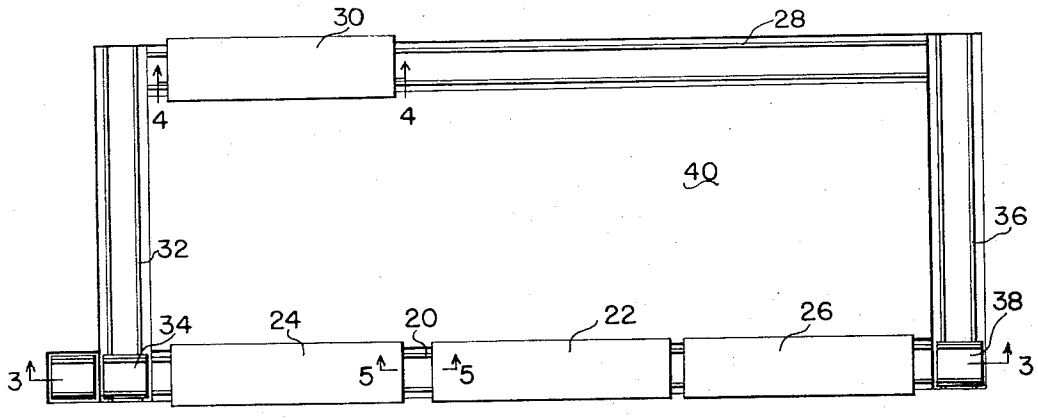
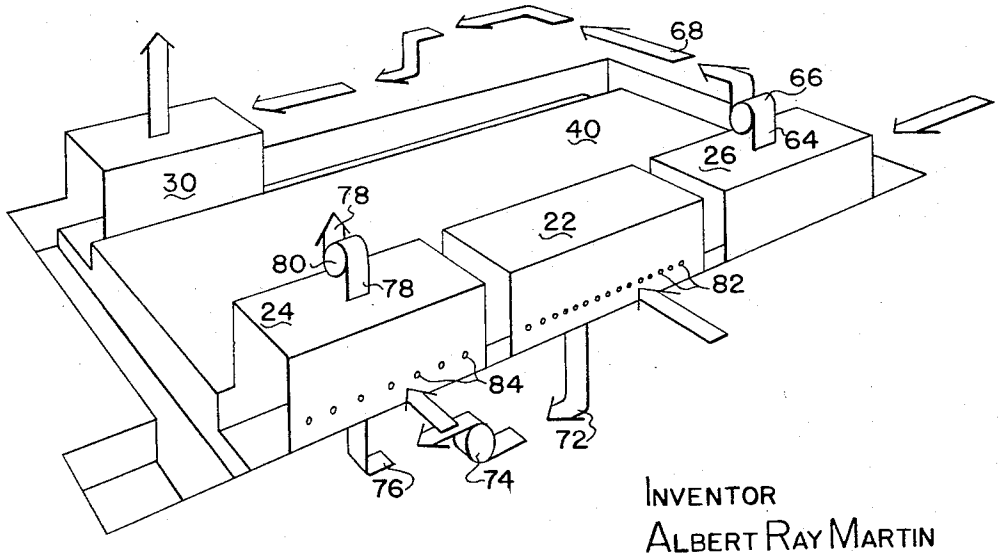


FIG. 1

FIG. 2



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FIG. 3

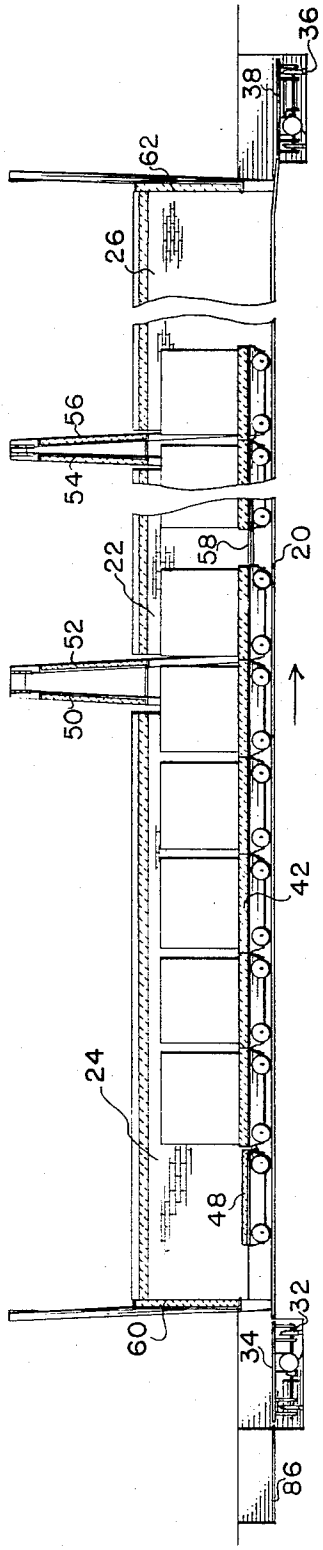
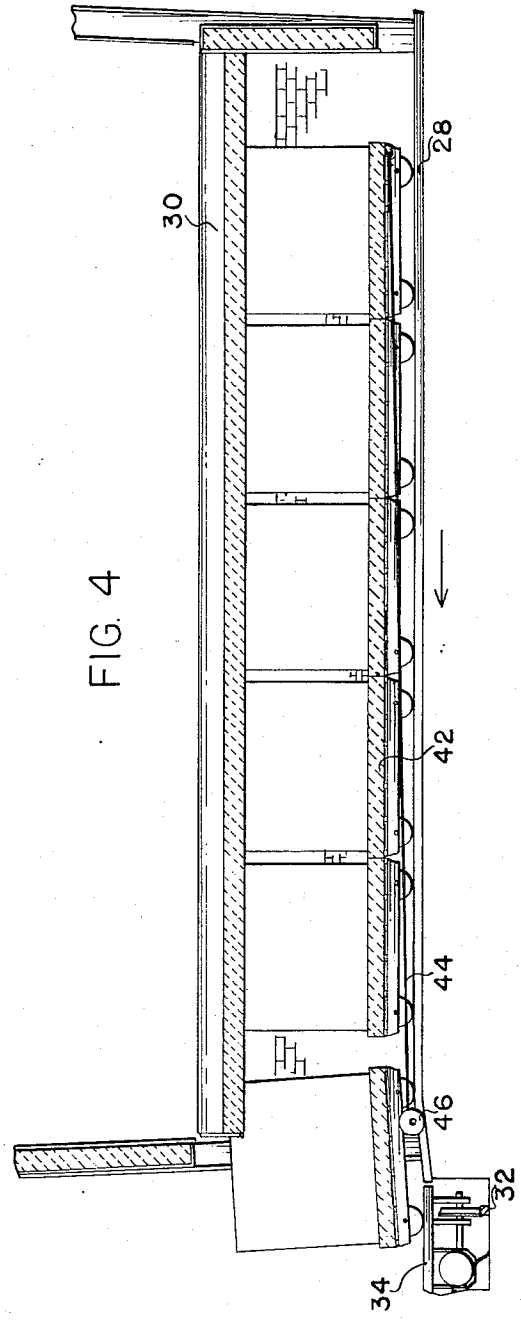


FIG. 4



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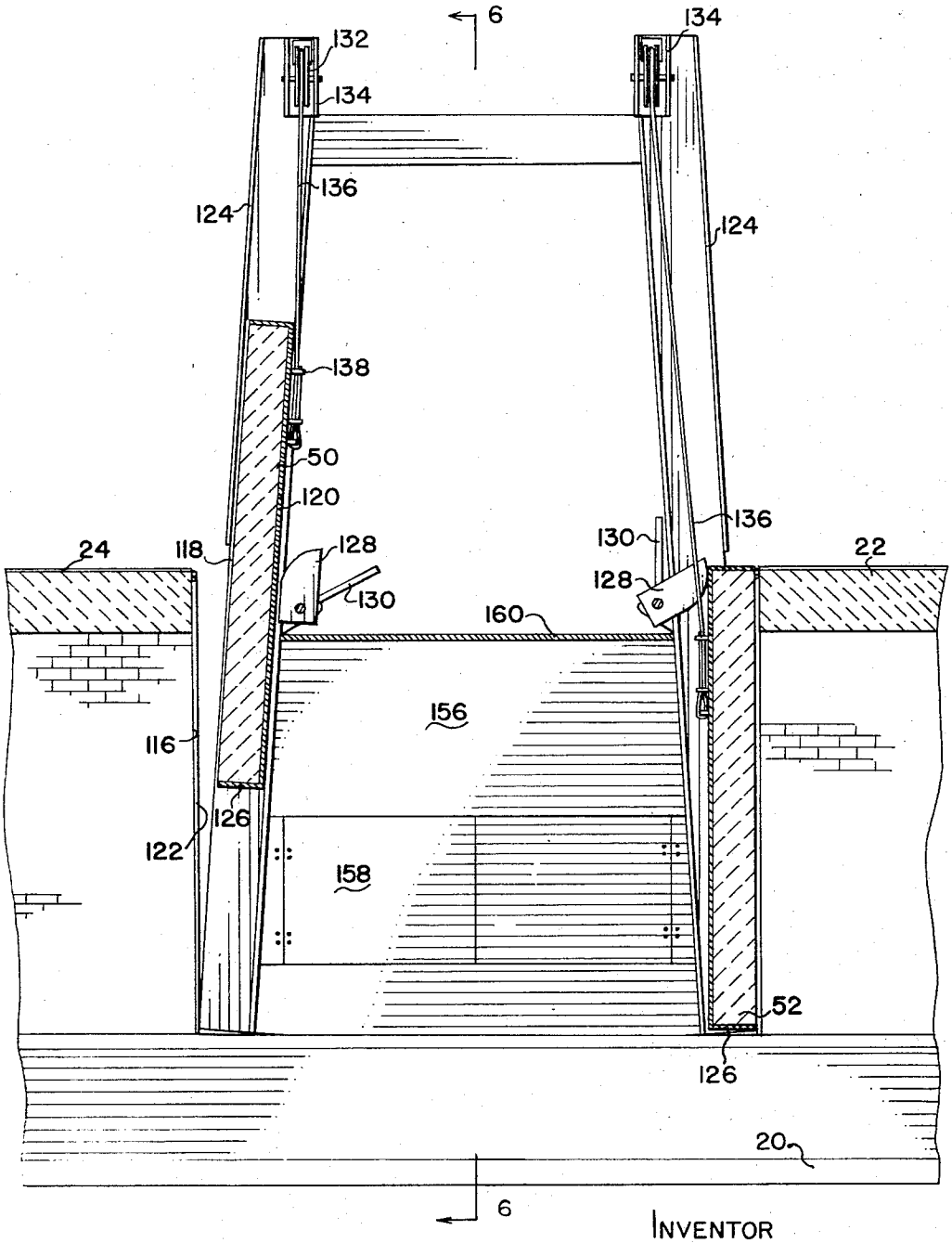


FIG. 5

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FIG. 6

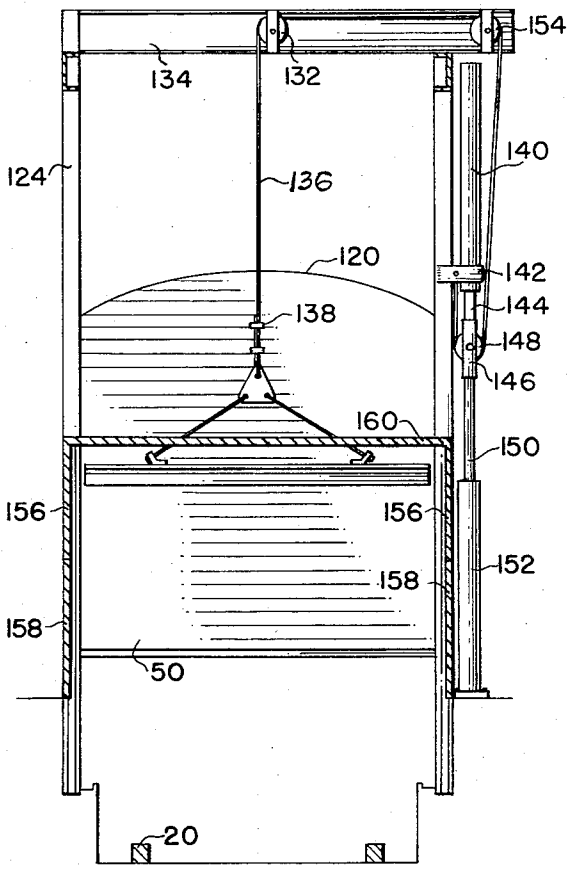


FIG. 7

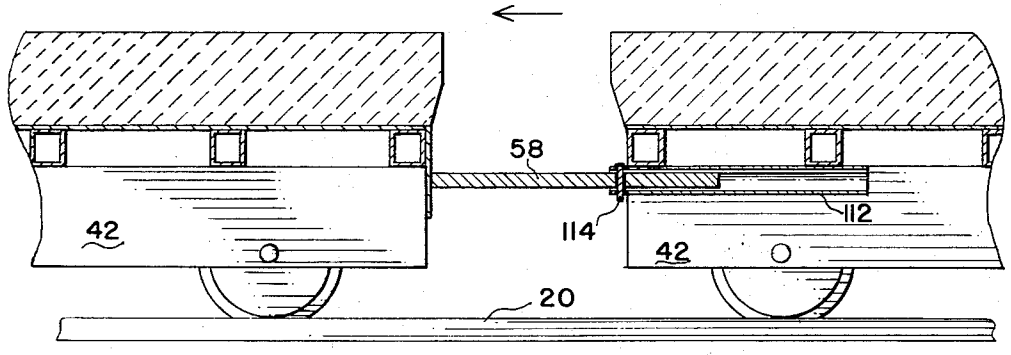
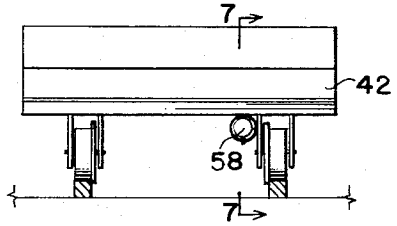


FIG. 8



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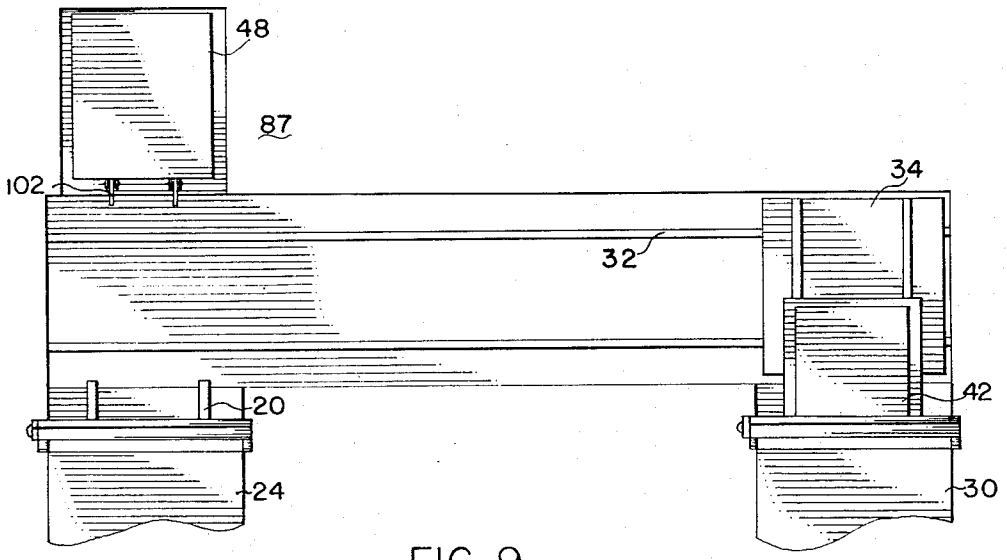
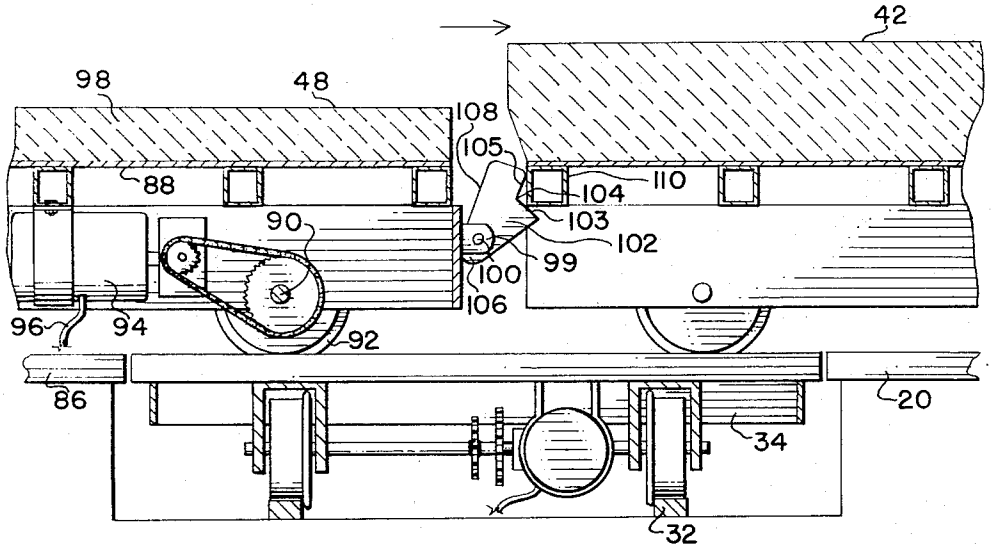


FIG. 9

FIG. 10



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13 Claims. (Cl. 34—22)

ABSTRACT OF THE DISCLOSURE

A zoned tunnel kiln for firing brick has three distinct sections sealed from the outside atmosphere and sealed from one another. Individual cars are moved into the preheat section until the preheat section is filled with six cars therein. All of the cars of the preheat section are moved into the firing section and all of the cars in the firing section are moved into the cooler. The cars after being cooled are moved on at a time from the cooler. During the time the cars are in the furnace, the furnace doors remain closed and cars are not added or removed during the firing time.

This invention relates to kilns and more particularly to a zoned tunnel kiln for brick. I have written an article about my invention which appeared in "Brick and Clay Record," vol. 147, No. 1, July 1965, at page 32, published in Chicago, Ill., by Cahners Publishing Company, Inc.

According to this invention, the ware is loaded upon cars and a stick of six cars is placed in a drier. Doors at both ends of the drier are closed and the ware dried therein. Thereafter, the cars are moved, one at a time, into a preheat section of the kiln. (Thereafter the drier may be refilled.) While the ware is in the preheat section, doors on both ends of that section are closed. Thereafter doors between the preheat section and the furnace section and between the furnace section and the cooling section, are opened. Then the cars within the furnace section are pushed into the cooling section by the cars being pushed from the preheat section into the furnace section. Thereafter all doors are again closed while the ware is fired. While the ware is being fired, other cars may be transferred from the drier to the preheat section. After the ware has cooled, still other cars may be moved, one at a time, from the cooling section so that the cooling section will be empty and ready to receive the stick of six cars from the furnace.

An object of my invention is to provide a kiln which is economical to operate.

Another object is to provide a kiln which is capable of high rates of production and can also be operated at extremely slow rates with little or no loss of efficiency.

Another object is to provide a kiln which is easily shut down without damage to ware or kiln and readily restarted.

A further object is to provide a kiln which is extremely flexible as to firing cycle, temperature, and ware loading.

A further object is to provide a kiln, the major sections of which do not fluctuate widely in temperature with each firing cycle.

A further object is to provide a kiln wherein each section of the kiln is completely isolated from each of the other sections by doors placed at each end of each section.

A further object is to provide a kiln adapted to operate on a wide range of fuel, such as oil, coal, or gas.

A further object is to provide an improved locomotive for moving sticks of kiln cars from one section to another.

A further object is to provide an improved door structure between sections to prevent loss of heat.

Still further objects are to achieve the above with structure that is sturdy, compact, durable, simple, safe, versatile, and reliable, yet inexpensive and easy to manufacture and operate.

Still further objects are to achieve the above with a method that is rapid, inexpensive, and does not require skilled people to adjust and operate.

The specific nature of the invention, as well as other objects, uses, and advantages thereof, will clearly appear from the following description and from the accompanying drawing, the different views of which are not necessarily to the same scale, in which:

FIG. 1 is a schematic plan view of a kiln according to this invention.

FIG. 2 is a schematic perspective representation of the kiln, particularly illustrating the air and heat flow.

FIG. 3 is a schematic sectional view of three sections of the kiln, with parts broken, taken on line 3—3 of FIG. 1.

FIG. 4 is a schematic sectional view of the drier, taken on line 4—4 of FIG. 1.

FIG. 5 is a sectional view showing the doors between the preheat and furnace sections of the kiln, taken on line 5—5 of FIG. 1.

FIG. 6 is a sectional view taken on line 6—6 of FIG. 5.

FIG. 7 is a sectional view showing two kiln cars with the pusher bar between them, taken substantially on line 7—7 of FIG. 8.

FIG. 8 is an end view of a kiln car with a pusher bar.

FIG. 9 is a partial plan view showing the transfer tracks and locomotive.

FIG. 10 is a sectional view showing the locomotive and one kiln car, each partially upon the transfer car.

Referring more particularly to FIG. 1, it may be seen that there are four zones or sections. Three of these are aligned with a straight railroad 20 extending the length thereof. The furnace or furnace section 22 is between the preheat section 24 and the cooler or cooling section 26.

Loading railroad 28 extends parallel and adjacent the railroad 20 and extends through the drier or drying section 30. Sunken transfer rails 32 with transfer car 34 connect the railroads 20 and 28 between the drier and preheat section. Likewise, sunken transfer rails 36 with transfer car 38 thereon connect the railroads 20 and 28 between the cooler 26 and loading area 40.

It will be understood by those skilled in the art that the railroads 20 and 28 are themselves about three feet below the surface of the working area 40 so that the top of the kiln cars 42 are level with the loading area.

Loaded kiln cars 42 are removad from the drier by attaching cable 44 to the rearmost car and reeling the cable upon winch 46 to move the kiln cars, one at a time, upon transfer car 34. (FIG. 4.) Approximately one-half the length of a kiln car from the end of the loading railroad 28 (at transfer car 34 end), the loading railroad 28 angles down slightly. Therefore, as the cars 42 are being moved from the drier and when they are

partially removed from the drier, they will roll by gravity onto transfer car **34** and it is unnecessary that the remainder of the cars within the stick be moved to the edge of the rail. Then the transfer car **34** is moved from its position in alignment with the railroad **28** to alignment with the railroad **20**. The kiln car is pushed by kiln locomotive **48** into the preheat section **24**. Thus, the cars **42** are removed, one at a time, from the drier **30** to the preheat section.

When the firing of the ware upon the stick of cars within the furnace **22** is completed, the door **50** on the exit of the preheat section **24** and the door **52** on the entrance of the furnace **22** and the door **54** on the exit of the furnace and the door **56** on the entrance of the cooler **26** are all opened. (FIG. 3.) Pusher bar **58** from the front car of the stick of cars within the preheat section **24** has already been extended so that it bears against the rear car of the stick of cars within the furnace **22**. Then the kiln locomotive **48** is moved across transfer car **34** to push the two sticks of cars into the next adjacent section, i.e., the stick of cars within the furnace **22** is pushed into the cooler **26** while the stick of cars within the preheat section **24** is pushed into the furnace **22**. Inasmuch as the kiln locomotive **48** is lower than the kiln cars **42**, it goes beneath the closed door **60** at the entrance of the preheat section. Also, inasmuch as the cooler **26** is empty before the transfer, the door **62** at the exit of the cooler is closed during the transfer. After the transfer is complete, the doors **50**, **52**, **54**, and **56** are again closed and the cycle repeated.

After the ware upon the cars **42** in the cooler **26** has been cooled to the desired temperature, the exit door **62** of the cooler is opened and the cars **42** are removed, one at a time, across transfer rail **36** to the loading area **40** where the finished ware is removed therefrom and the cars **42** again loaded with green ware to be moved into the drier **30**.

Ambient air in introduced from beneath the kiln cars **42** up to within the cooler **26**, through the hot ware, and into duct **64**. (FIG. 2.) A portion of the air comes beneath the exit door **62** of the cooler and a portion enters underneath entrance door **56** of the cooler. The air which is heated by the hot ware within the cooler **26** is moved by fan **66** and duct **68** into the drier **30**. From the drier, the air is exhausted.

The hot gases from the furnace **22** move through passageway **72** beneath the furnace to fan **74**, where the gases are further moved through passageway **76** into the preheat section **24** to preheat the ware to a desirable temperature. The exhause gas from the preheat section is moved through duct **78** and fan **80** to exhaust. Burners **82** along the side of the furnace **22** provide heat therefor. In continuous operation, the heat for the preheat section **24** is furnished by exhaust gas as described above. However, it will be understood that, when beginning a cycle, the preheat section may be fired by auxiliary burners **84**.

Describing the kiln locomotive **48** in greater detail, it is normally parked on rails **86** which are an extension of and aligned with the railroad **20**. (FIGS. 9 and 10.) As previously mentioned, the railroad **20** is below the level of the loading area **40** and also below the level at **87**. Therefore, a platform (not shown) extends over the rails **86** so that, in effect, the kiln locomotive **48** is kept in a crypt. The locomotive **48** has a horizontal metal frame or platform **88**. Two axles **90** are journaled for rotation beneath the frame. Flanged wheels **92** are attached to the axles so that the locomotive is adapted to run upon the rails **86** and the railroad **20**. Electric motor **94**, attached to the underside of the frame **88**, is drivingly connected to the wheels **92**. Power to the motor is supplied by electric cable **96**. Insulating bricks **98** are laid upon the top of the frame **88** to protect the locomotive from heat of the preheat section when in use. Two ears **99** are welded to the front of the frame **88**. Bar **100** is journaled within holes in the ears. The bar **100** is parallel to the axles **90**. Lift cams **102** are attached to the bar **100**. Each of the cams has a notch **104** therein which is above the bar **100**. The notch includes a shoulder **103** which angles downward from horizontal. The cams are mounted for pivoting with the bar **100**. Heel **106**, extending below the bar, prevents the cams from falling over forward. Backward travel is limited by head **108**.

In operation, when the cams **102** contact the kiln car **42** in front, the near vertical face **105** of the notch **104** contacts a vertical surface of frame member **110** of the kiln cars **42**. When the kiln locomotive pushes against the kiln car, this causes the lift cam **102** to pivot back slightly so that shoulder **103** underneath the frame member **110** will lift the rear of the kiln car slightly, placing additional weight upon the kiln locomotive. This increased weight upon the kiln locomotive increases the traction of the kiln locomotive so that it has sufficient traction to move two sticks of six kiln cars each. The height of the kiln locomotive **48** is quite low so that the kiln locomotive is capable of entering the preheat section **24** even when the entrance door **60** of the preheat section is closed.

The kiln cars **42** are substantially conventional, having a layer of insulating brick upon their top platform and having downward-turned flanges along their sides to form a sand seal with sand troughs along the edges of the furnace and preheat section, as is conventional. Their length is such that they form a heat seal along the top of the kiln cars **42** with the doors, as is known in the art.

Every sixth kiln car **42** (the leading kiln car of each stick of six kiln cars) is equipped with the pusher bar **58**. (FIGS. 7 and 8.) Horizontal tube **112** extends aligned with the direction of the travel of the kiln cars through the frame of the kiln car below the insulating brick. Pusher bar **58** is normally telescoped completely within the tube **112** so that it does not project therefrom. Before the stick of kiln cars **42** is pushed from the furnace **22**, the pusher bar **58** on the front car of the stick of kiln cars **42** within the preheat section **24** is extended and is locked in extended position by placing pin **114** through a diametrical hole in the pusher bar **58**. Therefore, the correct and proper spacing is maintained between the two sticks for the proper operation of the doors.

The spacing between the preheat section **24** and the furnace **22** is greater than the spacing between the furnace and the cooler **26**. The pusher bar **58** projects the proper distance to space the stick of cars for proper operation of the doors when the cars are stopped between the cooler section and furnace. However, inasmuch as the distance is greater between the furnace and preheat section, the bar does not contact the stick of cars within the furnace at the time it is first extended. Therefore, when the locomotive first begins pushing the stick of cars within the preheat section, it is pushing only six cars and has them in motion before it begins pushing the six cars within the furnace section. Stated otherwise, the locomotive **48** starts the cars with a "freight train" start.

Face **116** of each of the sections (preheat, furnace, and cooling) surrounding the openings therein are plane flat surfaces so that face **118** of the door may form a seal therewith. (FIG. 5.) The doors are constructed about metal frame **120** and the face **118** is covered with insulating brick. Asbestos roping **122**, surrounding the opening in the face **116**, cooperates with the face **118** of the door to form a good seal when the door is closed.

Each of the doors is mounted for vertical movement within tracks **124**. The tracks **124** angle away from the face **116** on their upper end. The frame **120** of the door, loosely slides within the tracks **124**. The bottom of the door will be held firmly against the bottom of the face **116** by the tracks **124**. The bottom edge **126** of the door is beveled so that the door tends to lean away from the face **116**. In the closed position, the top of the door is held against the face **116** by cams **128** mounted upon

cam arm **130** which is pivoted to suitable brackets attached to the tracks **124**. (Shown in FIG. 5 but not in FIG. 6 for clarity.) The cams **128** form means for pushing the top of the door against the opening.

Pulley **132** is attached to beam **134** extending across the top of the tracks **124**. (FIGS. 5 and 6.) Cable **136** is attached to the door and extends through guide **138** attached to the back side of the door. When the cams **128** are released, the top of the door moves away from the face **116** because of the beveled bottom **126**. When the cable **136** is pulled, the door, as it begins to slide upward, is not in contact with the face **116** of the section.

Hydraulic cylinder **140** is attached at its lower end to bracket **142** which is attached to the tracks **124**. (FIG. 6.) The bottom of rod **144** is attached to shell **146** of block **148**. The bottom of the shell is connected to guide rod **150** which is telescoped within guide tube **152**, which is attached to the tracks **124** below bracket **142**. Cable **136** is reeved from pulley **132** around pulley **154** at the top of tracks **124** through block **148** and is attached to bracket **142**. As the rod **144** is extended outward from cylinder **140** by hydraulic pressure, the cable over pulley **132** is moved upward, raising the door. Suitable source of hydraulic fluid under pressure and valve arrangements for operation are not shown inasmuch as they are conventional and well within the skill of ordinary mechanics. Thus, I have provided simple means for opening and closing the doors.

Due to the intense heat within the furnace **22**, when the furnace doors **52** or **54** are open, it is desired that large amounts of cool air not be permitted to enter the furnace, otherwise there would be damage to the furnace and to the ware. Therefore, the space between the furnace and the adjacent section is closed by heat shields **156**. (FIG. 5.) Heat shields, in the form of metal plates, extend within the space between the furnace **22** and the adjacent section from the top thereof to a point which is at least about halfway to the top of the kiln cars **42**. Access doors **158** readily may be provided below the heat shields **156** to gain access to the space between sections when the doors **50**, **52**, **54**, and **56** are closed. Spacing cover **160** extends from one heat shield **156** to the heat shield on the opposite side from proximate one door to proximate the other door. Although there is a considerable gap or space between the cover **160** and the door when the door is opened. If the doors **52** and **54** of the furnace are not opened when the entrance door **60** of the preheat section and the exit door **62** of the cooler are open, it may be seen that the furnace has very little communication to outside air and communication only with the air within the preheat section and the cooler.

It will be apparent that the embodiment shown is only exemplary and that various modifications can be made in construction, materials, and arrangement within the scope of the invention as defined in the appended claims.

I claim as my invention:

1. A kiln comprising in combination:
(a) an elongated preheat section,
(b) an elongated furnace section, and
(c) an elongated cooling section,
(d) said three sections aligned with the furnace between the others;
(e) a straight railroad extending through the kiln from the preheat section through the cooling section; and
(f) a separate door on each end of each section;
(ff) each door sealing the section to which it is attached.
(g) the furnace section forming means for firing clay ware,
(h) the preheat section forming means for preheating the ware before firing, and
(j) the cooling section forming means for cooling the fired ware after firing.

2. The invention as defined in claim **1** with the addition of:

(k) a drier means for drying the ware before preheating,
(m) a loading railroad extending through the drier, and
(n) transfer rails connecting the railroad and loading railroad so that kiln cars may be moved from the drier to the preheat section.

3. The invention as defined in claim **1** with the addition of:
(k) heat shields between each of the sections,
(m) said heat shields forming means for preventing excessive loss of heat from the furnace and preventing flow of cold air into the furnace.

4. The invention as defined in claim **1** with the addition of:
(k) a stick of kiln cars on the railroad in said furnace section with clay ware on the kiln cars,
(m) another stick of equal number of kiln cars on the railroad in said preheat section with clay ware on the kiln cars, and
(n) means for moving said stick of kiln cars from the preheat section into the furnace section simultaneously to moving said stick of kiln cars from the furnace section into the cooling section.

5. The invention as defined in claim **4** with the addition of:
(o) a pusher bar between said sticks of cars so that said sticks are properly spaced for the doors between the furnace and cooling sections.

6. The invention as defined in claim **5** wherein
(p) the space between the preheat and furnace sections is greater than the space between the furnace and cooling sections.

7. The invention as defined in claim **4** wherein
(o) said means for moving is a kiln locomotive operating on the railroad.

8. The invention as defined in claim **7** wherein
(p) said locomotive has lifting cam means on the front thereof for transferring weight of the pushed kiln cars onto the locomotive.

9. A part of a kiln comprising in combination:
(a) a furnace section
(b) forming means for firing clay ware;
(c) an adjacent section
(d) forming means for conditioning said ware;
(e) said furnace section and adjacent section spaced apart;
(f) an opening in each section,
(g) said openings aligned with each other,
(h) a railroad extending through the sections and through the aligned openings,
(j) kiln cars on the railroad,
(k) a door for each opening;
(kk) a brick face on the door of the furnace section,
(m) means for moving the doors up and down to open and close them,
(n) heat shields on either side of the doors extending from one section to the other, and
(o) a spacing cover extending from one heat shield to the other and extending from proximate one door to proximate the other door; so that a minimum of heat is lost from the sections when the doors are open.

10. The method of firing clay ware comprising loading green ware upon kiln cars, placing at least three ware-ladened kiln cars within a drier, blowing heated air over the ware in the drier until the ware is dry, removing the ware-ladened kiln cars from the drier and moving them into a preheater, thereafter closing the preheater and then blowing hot exhaust gases from a furnace upon the ware in the preheater, then opening one door of the preheater and two doors of a furnace, simultaneously moving all of the cars from the preheater into the furnace and all of the cars from the furnace into a cooler, there-

after closing the doors of the furnace and firing the ware within the furnace, blowing ambient air over the ware in the cooler to cool same and exhausting said heated air from the cooler into the drier, and moving the kiln cars, ladened with cooled ware, from the cooler to a loading area.

11. The invention as defined in claim **10** wherein the kiln cars are moved one at a time from the drier to the preheater and moved one at a time from the cooler to the loading area.

12. The invention as defined in claim **11** wherein the cars are moved from the preheater into the furnace by pushing them with a locomotive.

13. The invention as defined in claim **12** wherein, when the furnace doors are open, at least one door of each the preheater and the cooler are closed.

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