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W. L. HANLEY, JR

TWIN TUNNEL KILN

Original Filed Oct. 8, 1925 2 Sheets-Sheet 1

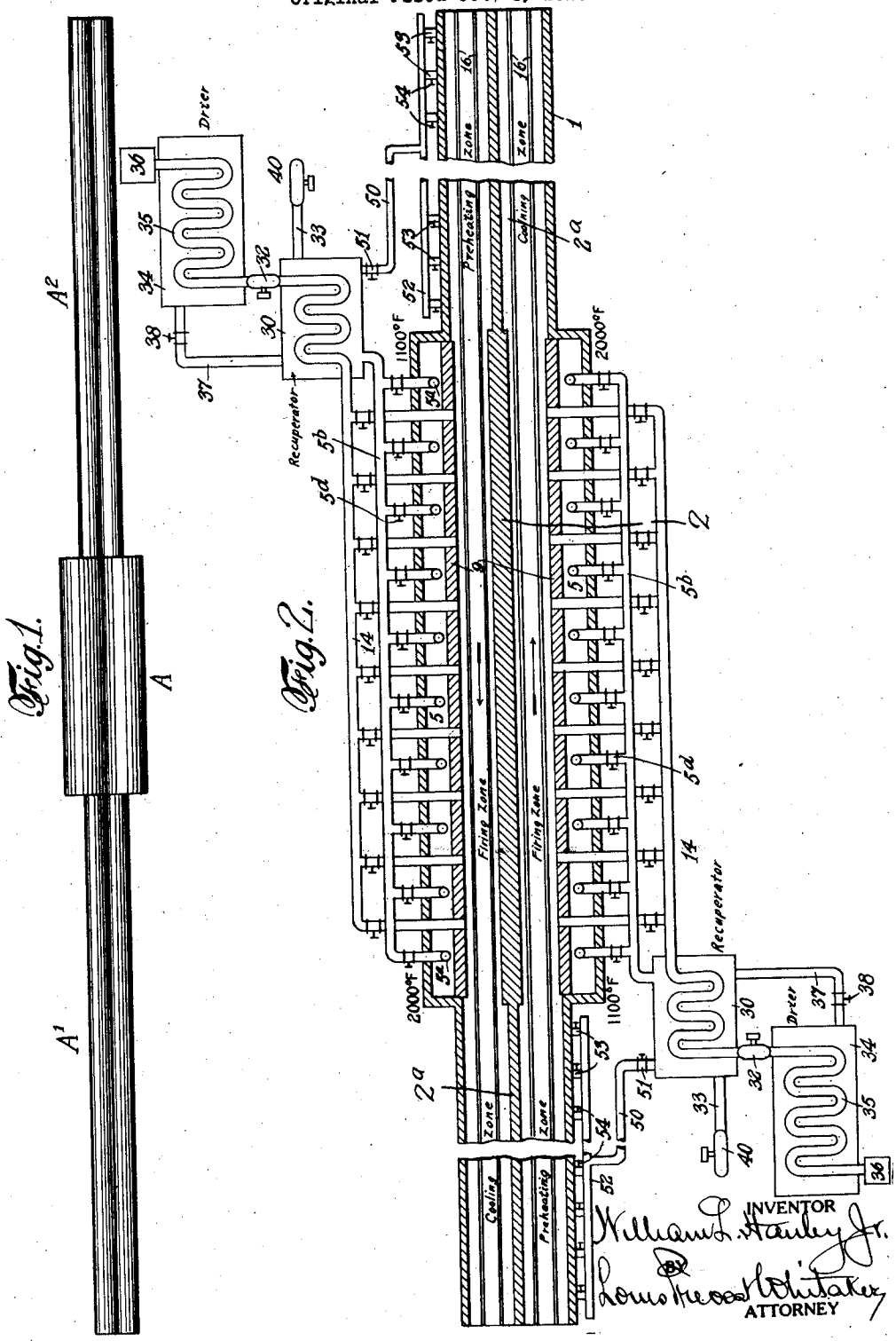

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Fig. 3.

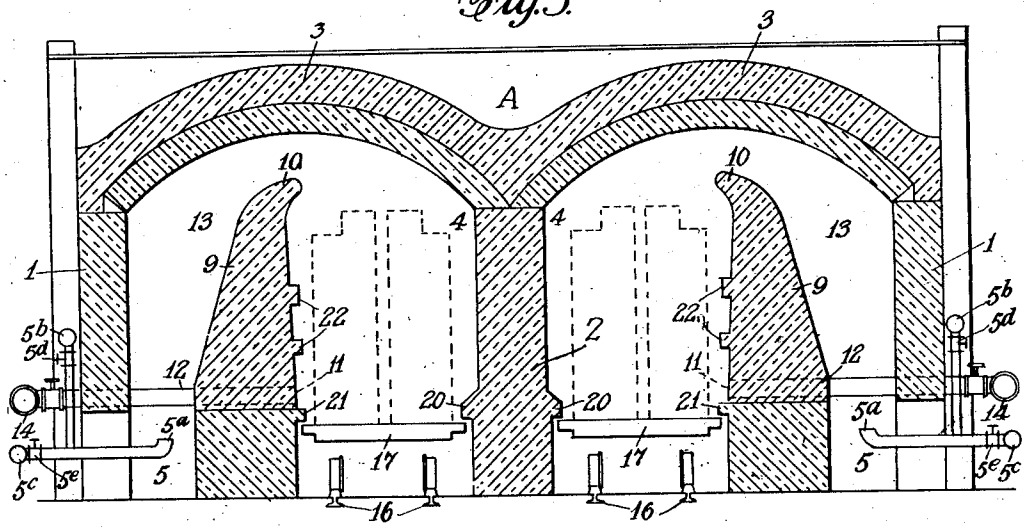
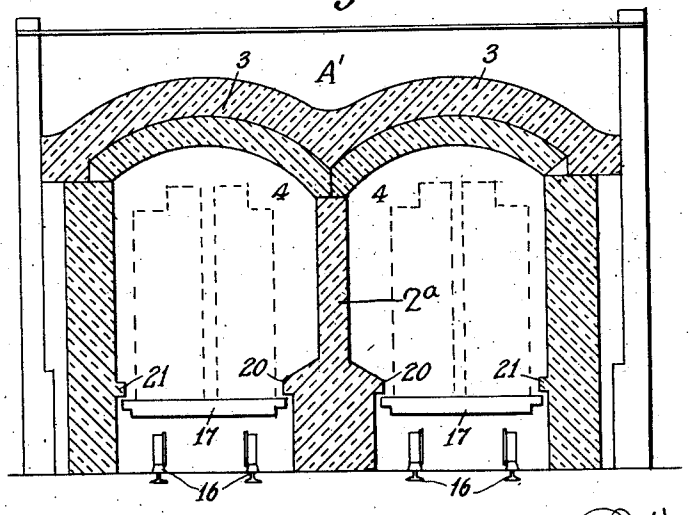


Fig. 4.



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UNITED STATES PATENT OFFICE.

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TWIN-TUNNEL KILN.

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My invention consists in the novel features hereinafter described, reference being had to the accompanying drawings which illustrate one embodiment of the invention, selected by me for purposes of illustration, and the said invention is fully disclosed in the following description and claims.

My invention relates to twin tunnel kilns or ovens designed more particularly for firing coarse clay products such as bricks, fire brick, tile, etc., although the invention is applicable to kilns for firing other classes of goods.

The object of my invention is to provide a twin tunnel kiln having goods conveying means extending on two parallel tracks and moving in opposite directions, in such a manner as to provide a simple and comparatively inexpensive structure which can be cheaply built and kept in repair and workable condition at slight expense, and which will be highly efficient in firing the brick and also in handling an extremely large quantity and giving a very high output. In carrying my invention into effect. I construct a twin tunnel kiln as a duplex structure throughout its entire length, that is to say, comprising two side walls and a centrally and longitudinally located impervious wall or partition extending throughout the entire length of the kiln and producing two parallel tunnels separated by the said central wall at all points. The central portion of the kiln forms a duplex firing chamber provided with two firing zones, each heated by an independent series of furnaces arranged along the outer side of the firing zone, and discharging their products of combustion over a baffle wall into the firing zone directly upon the goods to be fired, the said furnaces being provided with means for independently controlling them so as to regulate the temperature of different portions of each firing zone and to gradually increase the temperature from the entering end of the firing zone to the discharging end thereof, in accordance with a pre-determined rising heat curve, it being understood that the heat curve in one firing zone will be the opposite of that in the other firing zone, which is accomplished by means of the independent regualtion of the furnaces and the complete separation of the two zones by the central impervious wall. The end portions of the kiln at each end of the firing chamber constitute duplex pre-heating and cooling chambers, each comprising throughout its length two separated tunnels, in one of which cars of fired brick leaving the firing zone in alignment therewith, are moving toward the end of the kiln and giving up the heat of said fired brick gradually and progressively to the central partition wall of the tunnel, while in the other tunnel, arranged alongside, cars of dried brick or other products are moving in the opposite direction from the end of the tunnel toward the firing zone in alignment therewith, and are being gradually preheated, water-smoked and oxidized. The central partition wall is preferably made thinner, through the preheating and cooling zones, than through the firing chamber, to facilitate radiation.

As the two tunnel sections of each duplex pre-heating and cooling chamber of the kiln are completely separated from each other, the heat of the fired brick passes through the central partition wall by radiation into the pre-heating tunnel on the other side thereof, and I construct the duplex pre-heating and cooling chambers of the kiln of such length that the products in the pre-heating zone of each of these duplex end sections will be raised to approximately the temperature at the inlet end of the aligned firing zones of the duplex firing chamber in traversing the distance from the end of the kiln to the firing zones.

It is of the utmost importance that the products of combustion from each of the firing zones be kept out of the corresponding or aligned pre-heating zones, for the reason that the presence of such products of combustion in the pre-heating zone interferes with the proper oxidation of the clay products, as they contain no free oxygen and they also produce scumming or staining during the water smoking of the brick. I therefore provide each firing zone of the duplex firing chamber with means for withdrawing therefrom all of the products of combustion discharged into the firing zone by its furnaces, and I preferably provide a pipe or passage adjacent to each of said furnaces, for withdrawing the products of combustion thereof and preferably located at the base of a deflecting wall, between the inlet passages from the furnaces, and the adjacent goods space, over the top of which bridge wall the products of combustion enter said goods space, each of said pipes or passages

being provided with a regulating valve or damper so that the regulation of these discharge pipes assists in the regulation of the heat in the different portions of each firing zone and the maintenance of the desired curve. By means of these dampers, I may also withdraw not only the products of combustion, but some of the air from the aligned end portions of the kiln, causing them to be replaced by fresh air and insuring that the pre-heating shall proceed in the presence of fresh air containing the required amount of oxygen. The products of combustion withdrawn from the several furnaces of each firing zone are preferably conducted through a recuperator and caused to heat quantities of fresh air which is conducted to the driers in which the clay products are dried preparatory to firing or burning, thus conserving the heat of the products of combustion, while eliminating them from the respective firing zones.

Referring to the accompanying drawings, which illustrate diagrammatically a kiln embodying my present invention,

Fig. 1 represents a diagrammatic top plan view of my improved twin tunnel kiln.

Fig. 2 represents a horizontal section of the kiln drawn to a larger scale, parts being broken away.

Fig. 3 represents a vertical transverse section, drawn to a larger scale through the duplex firing chamber.

Fig. 4 is a similar sectional view taken through one of the duplex pre-heating and cooling end sections of the kiln.

Referring to the kiln illustrated in the accompanying drawings, A, represents the duplex firing chamber of my improved kiln, which is located centrally with respect to the length of the kiln and is provided at each end with a duplex cooling and pre-heating chamber, one of which is indicated at A^1, and the other at A^2. The entire tunnel is constructed as a duplex structure comprising lateral walls, 1, 1, a central impervious partition wall, 2^a, 2, 2^a, and separate crowns or roofs, 3, 3, of any usual or preferred construction, forming two tunnels 4, 4, throughout the entire length of the kiln. Each tunnel is provided with a track, the rails of which are indicated at 16, 16, for a line of tunnel cars, 17, diagrammatically illustrated in Fig. 3 and Fig. 4, extending the entire length of the kiln on each set of tracks, said cars being moved in the respective tunnels in opposite directions, as indicated by the arrows in Fig. 2. Each tunnel will therefore comprise a pre-heating zone within one of the end sections of the kiln, a central firing zone within the duplex firing chamber, A, and a cooling zone within the other end section of the tunnel kiln, the arrangement of these respective zones being the reverse in one tunnel of the arrangement in the other. The central partition is preferably made thinner where it extends between the cooling and pre-heating zones at each end of the kiln, as indicated at 2^a, 2^a, to facilitate radiation, and these portions are termed radiating portions of the partition, while the central portion, 2, interposed between the firing zones, is termed the substantially non-radiating portion.

Fig. 3 represents a transverse sectional view through the firing chamber, showing the two firing zones and the heating furnaces therefor. At the outer side of the tunnel of each firing zone, is located a plurality of furnaces, 5, for the combustion of any desired character of fuel, gas, oil, wood, coal, etc., which may be supplied in any appropriate manner, and provided in any usual manner with the necessary air to insure the proper combustion of the fuel. In the present instance I have shown a heating nozzle indicated at 5^a, and supplied with air and gas from an air pipe, 5^b, and gas pipe, 5^c, under the control of suitable regulating valves, indicated respectively at 5^d and 5^e, so that the combustion in each furnace can be regulated to effect the regulation of the temperature in the corresponding portions of the adjacent firing zones. The furnaces are located on opposite sides of the firing chamber, exterior to the adjacent firing zones. Within each of the firing zones I locate a vertical deflecting wall, or baffle wall, indicated at 9, between the furnace and adjacent goods space, the said wall extending upwardly from the back walls of the furnaces and tapering toward the top, the upper portion being preferably curved or inclined inwardly toward the goods space, as indicated at 10. Each of the deflecting walls, 9, is provided on its inner face at approximately the level of the upper face of the tunnel cars, with an eduction port, 11, adjacent to each of the furnaces, or in other words located between adjacent furnaces, said eduction ports each forming part of an eduction passage indicated at 12, extending to the outside of the firing chamber and communicating with an eduction pipe or header, 14, so that the products of combustion of each furnace may be withdrawn from the firing zone after they have imparted their highest heat to the goods on the cars within the adjacent firing zone. The inner face of each of the baffle walls is provided with one or more longitudinal ribs, indicated at 22, at different elevations above the trucks or cars, for the purpose of preventing the products of combustion from taking a short cut to the eduction ports, 11, and assisting in forcing them to pass down through the goods on the cars. The products of combustion will pass upwardly through the passages indicated at 13, and will be discharged downwardly from

the roof or crown of each firing zone, upon, through and around the goods, descending to the lower portion of the goods space and passing out through the eduction ports and passages to the eduction pipe or header, 14. The baffle walls, 9, and the central wall, 2, are provided respectively with projecting flanges, 21 and 20, as usual, extending above the lateral portions of the tunnel cars to protect the cars from the injurious effects of the high temperature within the firing zones, and these flanges are continued also through the duplex end sections of the kiln, as indicated in Fig. 4. The eduction passages are thus located below the portions of the deflecting wall which lie between the inlet passage, 13, for the products of combustion and the adjacent goods space, into which said passage, 13, discharges over the top of said deflecting wall.

The eduction pipes, 14, are each shown connected to a recuperator, 30, so that they pass through the same for the purpose of heating air which is passing through the recuperator out of immediate contact with the products of combustion. In this instance, I have shown the recuperator as consisting of a receptacle containing a heating coil connected with the adjacent pipe, 14, and to a suction fan, 32, so as to withdraw the products of combustion from the adjacent furnaces and pass them through the recuperator which is supplied with fresh air through a pipe indicated at 33. The air from the recuperator is heated and is delivered into the adjacent air pipe, 5^b, for supplying air to the furnaces for combustion. The products of combustion, after giving up a very considerable portion of their heat, are preferably carried to a drier, 34, and passed through heating coils, 35, or passages therein, for heating the air within the drier and by radiation and convection utilizing the heat of the spent gases in drying the products before they are taken to the kiln to be fired. From the drier heat coils or passages, 35, the products of combustion pass to a stack, 36. Some of the air heated by the recuperator may also be taken to the drier and admitted thereto directly in contact with the brick by means of a pipe, 37, for example, under the control of a suitable valve, 38, if desired, and the air supplied to the recuperator will be furnished by a fan or blower, indicated at 40.

In some instances the air, or portions of the air, heated by the products of combustion, may be conducted from the recuperator to one or both of the preheating zones to aid in preheating the product. In Fig. 1, for example, I have shown the recuperators, 30, each connected by a pipe, 50, provided with a valve or damper, 51, to a header, 52, connected by branch pipes, 53, with the adjacent preheating zone, each branch pipe being provided with an independent damper, 54, so that the admission of heated air may be regulated in a graduated, or any other preferred manner.

In Fig. 2 I have shown the above described arrangement duplicated at opposite sides of the firing chamber, and this is my preferred construction, although it is obvious that a single recuperator could be made of sufficient size to handle the products of combustion from both sets of furnaces and supply heated air to both sets of burners and to the desired number of driers by making the necessary pipe connections.

In the operation of my improved kiln, I prefer to so regulate the furnaces of each firing zone that the temperature adjacent to the entering end thereof will be approximately from 900° F. to 1400° F. In the drawing, Fig. 2, I have noted, for example, the temperature at 1100° F. at the entering end of each firing zone. The temperature within each firing zone will be gradually increased according to a predetermined heat curve by regulating the several furnaces to a temperature of approximately 1800° F. to 2100° F. at the discharge end of the firing zone. In Fig. 2 I have indicated at the discharge end of each firing zone, by way of example, a temperature of 2000° F. It will thus be seen that the highest temperature in one firing zone is opposite the lowest temperature in the other firing zone and by means of the central longitudinal wall, 2, which effects a complete separation of the two firing zones of the duplex firing chamber, A, and by the regulation of the furnaces of each firing zone, by means of the valve controlling the admission of air and fuel and the withdrawal of the products of combustion, the desired heat curve in each firing zone can be maintained very accurately.

It will also be noted that the separate tunnels, 4, 4, of each of the end sections, A^1, and A^2, are separated from each other throughout their length by the central impervious wall, 2, which becomes highly heated from the fired brick passing through, on one side of the wall, the duplex end section, from the firing chamber, transmitting this heat to the entering product on the cars in the other tunnel, the temperature of which is gradually raised, as before stated, to the temperature at the entering end of the adjacent firing zone, by the time it reaches the firing zone. It will be understood that each set of tracks, 16, carries a line of cars extending throughout the entire length of the tunnel, the said cars being moved in opposite directions in the separate tunnels, either continuously or intermittently, a car of green brick being inserted in the pre-heating zone of each tunnel, 4, as a car of fired and cooled

brick is removed from said tunnel at the opposite end thereof. The trains of tunnel cars may be advanced in any usual or desired manner.

In constructing my improved tunnel kiln the duplex end portions can be constructed of any ordinary brick and will be of very cheap and at the same time durable construction. The firing chamber will involve the use of a considerable quantity of refractory material, as fire brick, but as there are no longitudinal flues within the walls or roof, the construction is comparatively inexpensive and the construction of the entire kiln is so simple that it is a comparatively easy matter to keep the kiln in repair at all times, and it may be used for very extensive periods without any repairs. This is an important item, as twin tunnel kilns are necessarily very expensive in their initial cost and in order to operate them economically, it is necessary to obtain not only a large, but a continuous, output. It will also be noted that great economy in fuel is obtained in my improved kiln, in addition to securing the other technical effects desired. By the discharge of the products of combustion into the firing chamber, the highest efficiency in the firing operation can be obtained and by withdrawing the products of combustion, the preheating, water-smoking and oxidation of the products will be performed in clean air, free from products of combustion. The heat in the products of combustion withdrawn from the furnaces is utilized and conserved by employing it to heat air in the recuperator for supplying the furnaces and also the drier, or driers, and the residual heat of the products of combustion, after leaving the recuperator, is further conserved and applied to the heating of the air within the drier or driers, so that comparatively little of the heat of the products of combustion is wasted, and the kiln can thus be operated continuously and at high efficiency.

It is also to be noted that I withdraw the hot products of combustion from the firing zone and conduct them directly to the recuperator, so that the air passed through the recuperator is heated to a much higher temperature than is possible where the gases are conducted through muffles or heating passages where they give up the larger portion of their heat and are then conducted to recuperating means to utilize the comparatively low temperature residual heat which may remain in them. The air in such cases is not raised to a sufficiently high temperature for efficient preheating, or for securing the highest efficiency of the burners. By my construction the air is heated to a temperature very nearly as high as that existing in the firing zone itself, and this highly heated air may be employed efficiently for preheating purposes, for example, and will also be highly efficient in promoting combustion in the furnaces.

What I claim and desire to secure by Letters Patent is:

1. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertical longitudinal impervious wall and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, means for withdrawing the products of combustion from each firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a pre-heating chamber communicating with the inlet end of one firing zone and a cooling chamber communicating with the discharge end of the other firing zone, said pre-heating and cooling chambers being separated by an impervious wall forming a continuation of the longitudinal wall between the firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the pre-heating and cooling chambers at the opposite ends thereof.

2. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertical longitudinal impervious wall and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, means for withdrawing the products of combustion from each firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a pre-heating chamber communicating with the inlet end of one firing zone and a cooling chamber communicating with the discharge end of the other firing zone, said pre-heating and cooling chambers being separated by an impervious wall forming a continuation of the longitudinal wall between the firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the pre-heating and cooling chambers at the opposite ends thereof, each of said furnaces being provided with heat regulating means whereby the furnaces for one of the firing zones can be regulated to provide a rising heat curve in one direction longitudinally thereof, and the furnaces for the other firing zone can be regulated to provide a rising heat curve extending longitudinally thereof, in the opposite direction.

3. In a twin tunnel kiln, the combination of a duplex firing chamber having two firing zones separated by a vertical longitudinal impervious wall, and provided with rows of furnaces located on opposite sides

of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, means for independently regulating each of said furnaces to control the heat thereof, an eduction passage adjacent to each of said furnaces of each row, for withdrawing the products of combustion from the interior of the adjacent firing zone, independent regulating means for each of said eduction passages, a duplex section extending longitudinally from each end of the duplex firing chamber, and each comprising a pre-heating chamber communicating with the inlet end of one firing zone, and a cooling chamber communicating with the outlet end of the other firing zone, the pre-heating and cooling zones of each of said duplex end sections being separated by an impervious centrally located longitudinal partition wall, forming a continuation of the partition wall between the firing zones.

4. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertical longitudinal impervious wall and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a pre-heating chamber communicating with the inlet end of one firing zone, and a cooling chamber communicating with the discharge end of the other firing zone, said pre-heating and cooling chambers being separated by an impervious wall forming a continuation of the longitudinal wall between the firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the pre-heating and cooling chambers at the opposite ends thereof, recuperating means provided with air passages for heating air, air connections from said recuperating means to a point of use, and means for withdrawing the products from each firing zone and conducting them directly to said recuperating means.

5. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertical longitudinal impervious wall and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a preheating chamber communicating with the inlet end of one firing zone and a cooling chamber communicating with the discharge end of the other firing zone, said pre-heating and cooling chambers being separated by an impervious wall forming a continuation of the longitudinal wall between the firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the pre-heating and cooling chambers at the opposite ends thereof, recuperating means provided with air passages for heating fresh air, air connections from said recuperating means to a point of use, and means located adjacent to each furnace for withdrawing the products of combustion from the firing zone adjacent thereto, and conducting them directly to said recuperative means.

6. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertical longitudinal impervious wall and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a pre-heating chamber communicating with the inlet end of one firing zone, and a cooling chamber communicating with the discharge end of the other firing zone, said pre-heating and cooling chambers being separated by an impervious wall forming a continuation of the longitudinal wall between the firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the pre-heating and cooling chambers at the opposite ends thereof, recuperating means provided with air passages for heating air, air connections from said recuperating means to each preheating chamber, and means for withdrawing the products of combustion from each firing zone and conducting them directly to the recuperating means.

7. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertical longitudinal impervious wall and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a pre-heating chamber communicating with the inlet end of one firing zone, and a cooling chamber communicating with the discharge end of the other firing zone, said pre-heating and cooling chambers being separated by an impervious wall forming a continuation of the longitudinal wall between the firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the pre-heating and cooling chambers at the opposite ends thereof, recuperating means

provided with air passages for heating air, air connections from the said recuperating means to each preheating chamber, communicating therewith at different points longitudinally thereof, means for independently controlling the admission of air heated by the recuperating means at said different points, and means for withdrawing the products of combustion from each firing zone and delivering them directly to said recuperating means.

8. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertical longitudinal impervious wall and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a pre-heating chamber communicating with the inlet end of one firing zone, and a cooling chamber communicating with the discharge end of the other firing zone, said pre-heating and cooling chambers being separated by an impervious wall forming a continuation of the longitudinal wall between the firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the pre-heating and cooling chambers at the opposite ends thereof, recuperating means provided with air passages for heating air, air connections from said recuperating means to each preheating chamber including branch pipes discharging into said chambers at different points longitudinally thereof, independent controlling means for said branch pipes, and means for withdrawing the products of combustion from each firing zone located adjacent to each of said furnaces and for conducting said products of combustion directly to said recuperating means.

9. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertically, longitudinal, impervious wall, and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, a baffle wall interposed between each row of furnaces and the adjacent firing zone, means for withdrawing the products of combustion from each firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a preheating chamber communicating with the inlet end of one firing zone, and a cooling chamber communicating with the discharge end of the other firing zone, said preheating and cooling chambers being separated by an impervious wall in alignment with and forming a continuation of the longitudinal wall between firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the preheating and cooling chambers at the opposite ends thereof.

10. In a twin tunnel kiln, the combination of a duplex firing chamber having two firing zones arranged side by side and separated by a vertical, longitudinal, impervious, and substantially non-radiating wall, two rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, a baffle wall interposed between each row of furnaces and the adjacent firing zone, means adjacent to each of the furnaces of each row for withdrawing the products of combustion therefrom, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a preheating chamber in alignment and communication with the inlet end of one firing zone, and a cooling chamber in alignment and communication with the discharge end of the other firing zone, said preheating and cooling chambers at each end of the kiln being separated by an impervious radiating wall of less thickness than the wall between the firing zones and parallel goods conveying means, movable in opposite directions, each of which passes through one of said firing zones and the preheating and cooling chambers at the opposite ends thereof.

11. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertical, longitudinal, impervious wall, and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, a baffle wall interposed between each row of furnaces and the adjacent firing zone, and providing an inlet passage on one side of said baffle wall and over the top, for the products of combustion from the row of furnaces to the adjacent firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a preheating chamber communicating with the inlet end of one firing zone, and a cooling chamber communicating with the discharge end of the other firing zone, said preheating and cooling chambers being separated by an impervious wall in alignment with and forming a continuation of the longitudinal wall between firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the preheating and cooling chambers at the opposite ends thereof, recuperating means provided with air

passages, and eduction passages extending from each firing zone, transversely to the exterior of the kiln, below the portions of the baffle wall lying between each firing zone and the inlet passage from the adjacent furnaces, said eduction passages being directly connected to the recuperating means.

12. In a twin tunnel kiln, the combination of a duplex firing chamber, having two firing zones separated by a vertical, longitudinal, impervious wall, and provided with rows of furnaces located on opposite sides of the duplex firing chamber, the furnaces of each row communicating directly with the adjacent firing zone, a baffle wall interposed between each row of furnaces and the adjacent firing zone, and providing an inlet passage on one side of said baffle wall and over the top, for the products of combustion from the row of furnaces to the adjacent firing zone, a duplex tunnel section extending longitudinally from each end of the duplex firing chamber, each comprising a preheating chamber communicating with the inlet end of the firing zone, and a cooling chamber communicating with the discharge end of the other firing zone, said preheating and cooling chambers being separated by an impervious wall in alignment with and forming a continuation of the longitudinal wall between firing zones, and parallel goods conveying means movable in opposite directions, each of which passes through one of said firing zones and the preheating and cooling chambers at the opposite ends thereof, recuperating means provided with air passages, eduction passages extending from each firing zone, transversely to the exterior of the kiln, below the portions of the baffle wall lying between each firing zone and the inlet passage from the adjacent furnaces, said eduction passages being directly connected to the recuperating means, means for conducting heated air from the recuperating means to the preheating chambers and distributing it thereto at different points longitudinally thereof, and independently controlled dampers for independently regulating the admission of heated air to the preheating chambers at such different points.

13. In a twin tunnel kiln, the combination with a firing chamber provided with furnaces communicating therewith, of a duplex tunnel section extending longitudinally from each end of the firing chamber, each comprising a preheating chamber and a cooling chamber communicating with the firing chamber, said preheating and cooling chambers being separated by an impervious wall, parallel goods conveying means movable in opposite directions, each of which passes through the firing chamber and the preheating and cooling chambers at the opposite ends thereof, recuperating means provided with air passages for heating air, air connections from said recuperating means to a point of use, and means for withdrawing the products of combustion from the firing chamber and conducting them to said recuperating means.

14. In a twin tunnel kiln, the combination with a firing chamber provided with furnaces communicating therewith, of a duplex tunnel section extending longitudinally from each end of the firing chamber, each comprising a preheating chamber and a cooling chamber communicating with the firing chamber, said preheating and cooling chambers being separated by an impervious wall, parallel goods conveying means movable in opposite directions, each of which passes through the firing chamber and the preheating and cooling chambers at the opposite ends thereof, recuperating means provided with air passages for heating air, air connections from said recuperating means to a point of use, and means located adjacent to each furnace for withdrawing the products of combustion from the firing chamber adjacent thereto and conducting them to said recuperator.

15. In a twin tunnel kiln, the combination with a firing chamber provided with furnaces communicating therewith, of a duplex tunnel section extending longitudinally from each end of the firing chamber, each comprising a preheating chamber and a cooling chamber communicating with the firing chamber, said preheating and cooling chambers being separated by an impervious wall, parallel goods conveying means movable in opposite directions, each of which passes through the firing chamber and the preheating and cooling chambers at the opposite ends thereof, recuperating means provided with air passages for heating air, air connections from said recuperating means to each preheating chamber, and means for withdrawing the products of combustion from the firing chamber and conducting them to the preheating means.

16. In a twin tunnel kiln, the combination with a firing chamber provided with furnaces communicating therewith, of a duplex tunnel section extending longitudinally from each end of the firing chamber, each comprising a preheating chamber and a cooling chamber communicating with the firing chamber, said preheating and cooling chambers being separated by an impervious wall, parallel goods conveying means movable in opposite directions, each of which passes through the firing chamber and the preheating and cooling chambers at the opposite ends thereof, recuperating means provided with air passages for heating air, air connections from said recuperating means to each preheating chamber communicating therewith at different points longitudinally

thereof, means for independently controlling the admission of air heated by the recuperating means, at said different points, and means for withdrawing the products of combustion from the firing chamber and delivering them to said recuperating means.

17. In a twin tunnel kiln, the combination with a firing chamber provided with rows of furnaces located on opposite sides thereof and communicating directly with the interior of the firing chamber adjacent thereto, a baffle wall interposed between each row of furnaces and the adjacent firing zone, and providing an inlet passage on one side of said baffle wall and over the top thereof for the products of combustion from the adjacent row of furnaces, a duplex tunnel section extending longitudinally from each end of the firing chamber, each comprising a preheating chamber and a cooling chamber, said preheating and cooling chambers being separated by an impervious wall, and parallel goods conveying means movable in opposite directions, each of which passes through the firing chamber and the preheating and cooling chambers at the opposite ends thereof, of recuperating means provided with air passes, and eduction passages extending from the firing chamber transversely to the exterior of the kiln below the portions of the baffle walls lying between the adjacent goods space and the inlet passage from the adjacent furnaces, said eduction passages being connected to the recuperating means.

18. In a twin tunnel kiln, the combination with a firing chamber provided with rows of furnaces located on opposite sides thereof and communicating directly with the interior of the firing chamber adjacent thereto, a baffle wall interposed between each row of furnaces and the adjacent firing zone, and providing an inlet passage on one side of said baffle wall and over the top thereof for the products of combustion from the adjacent row of furnaces, a duplex tunnel section extending longitudinally from each end of the firing chamber, each comprising a preheating chamber and a cooling chamber, said preheating and cooling chambers being separated by an impervious wall, and parallel goods conveying means movable in opposite directions, each of which passes through the firing chamber and the preheating and cooling chambers at the opposite ends thereof, of recuperating means provided with air passages, and eduction passages extending from the firing chamber transversely to the exterior of the kiln below the portions of the baffle walls lying between the adjacent goods space and the inlet passage from the adjacent furnaces, said eduction passages being connected to the recuperating means, means for conducting heated air from the recuperating means to the preheating chambers and distributing it thereto at different points longitudinally thereof, and independently controlled means for independently regulating the admission of heated air to the preheating chambers at such different points.

In testimony whereof I affix my signature.

WILLIAM L. HANLEY, JR.