

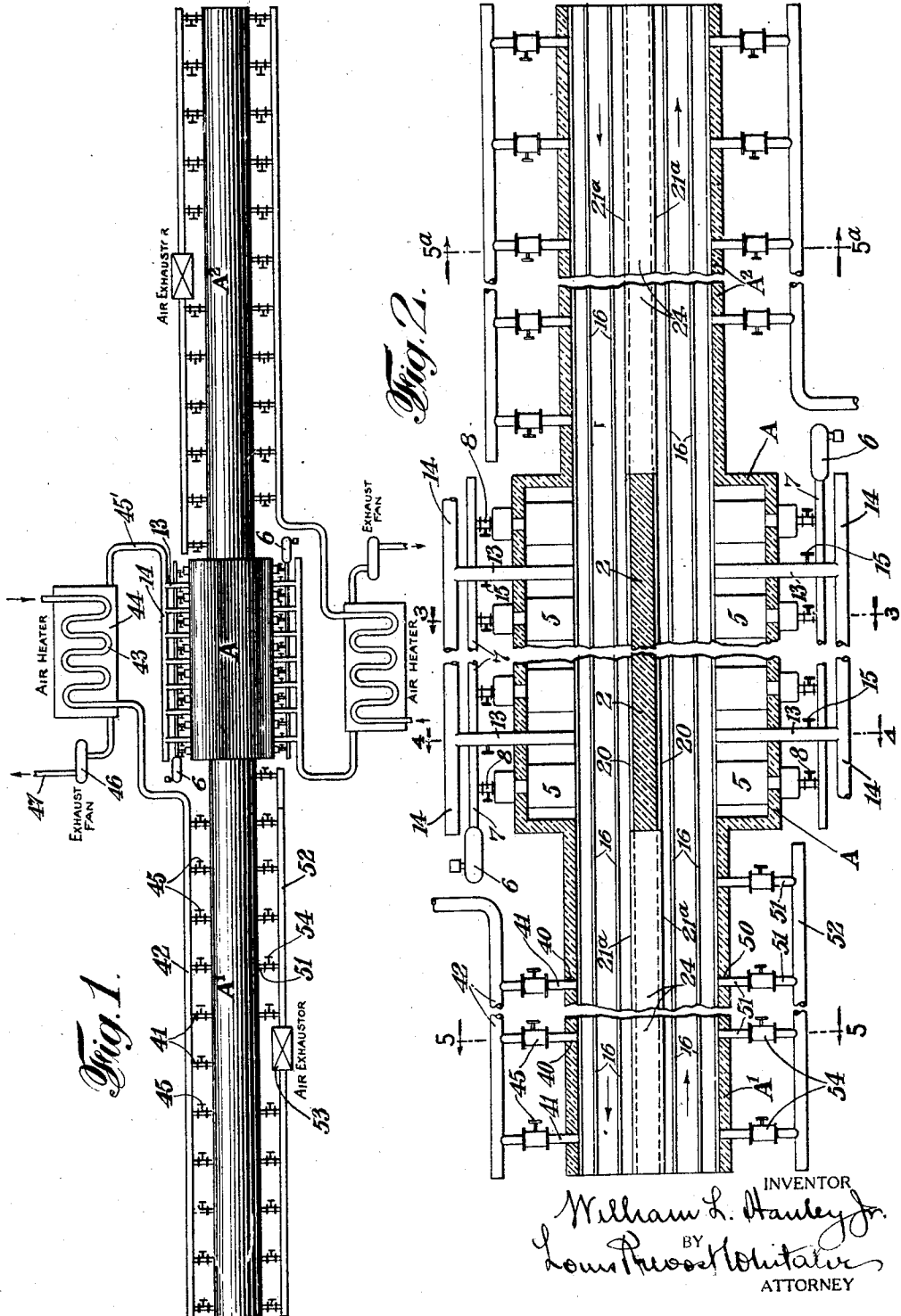
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W. L. HANLEY, JR

TUNNEL KILN

Original Filed Oct. 14, 1924 2 Sheets-Sheet 1



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Fig. 3.

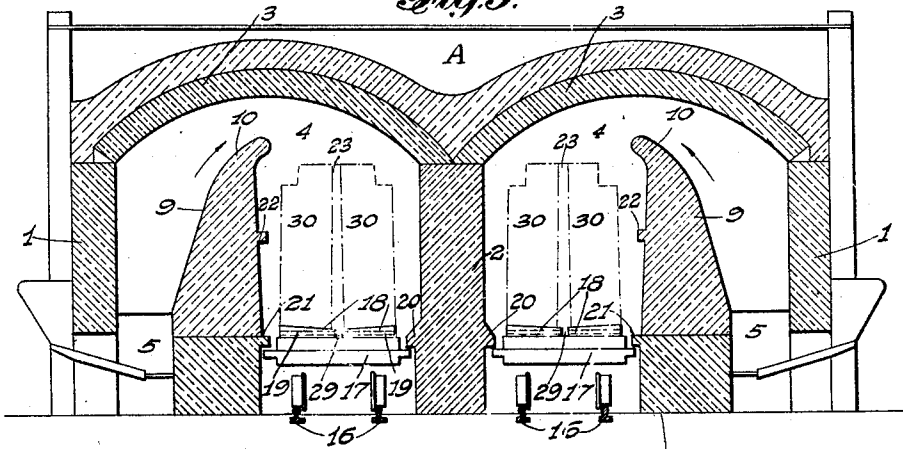


Fig. 4.

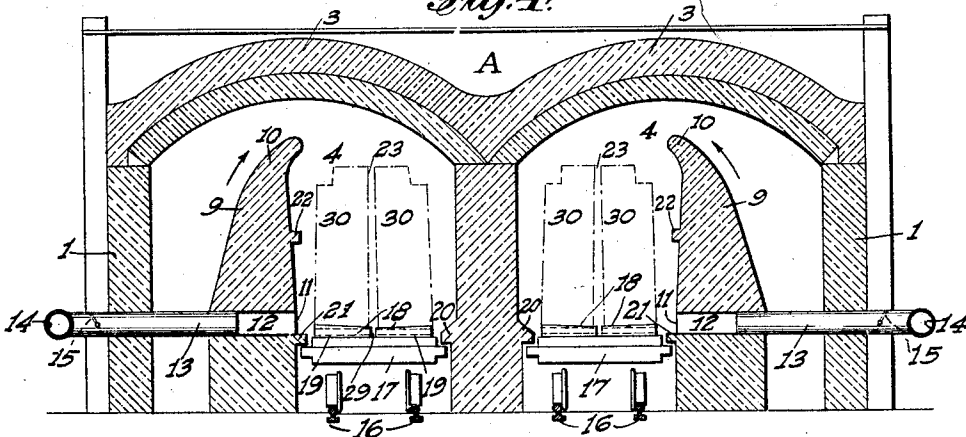
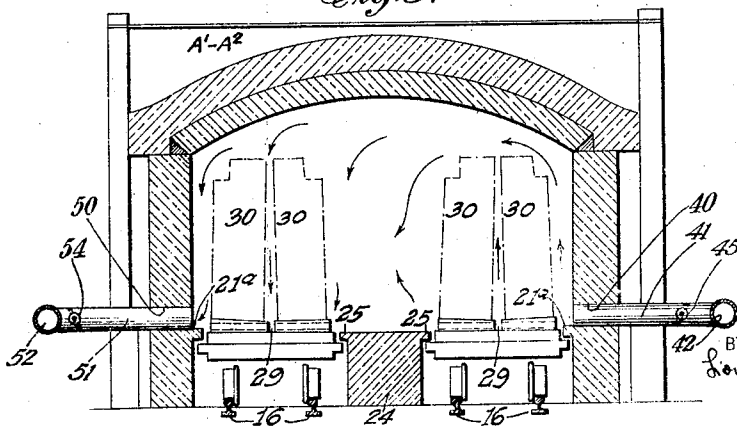


Fig. 5.



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TUNNEL KILN.

Application filed October 14, 1924, Serial No. 743,537. Renewed March 11, 1927.

My invention consists in the novel features hereinafter described, reference being had to the accompanying drawings, which show one form of tunnel kiln embodying my 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 tunnel kilns or ovens designed more particularly for firing coarse clay products, such as bricks, firebricks, tile, etc., although my invention is applicable to kilns for firing other classes of goods where found desirable and advantageous. In the operation of tunnel kilns, the goods which have been previously dried are moved progressively, either continuously or intermittently and usually are carried upon trucks or cars, the movement of the goods being effected in a direction longitudinally of the kiln and causing them to pass through zones of different temperatures so that the goods being in a green or unfired condition, when they enter the kiln, shall be completely fired and then cooled to substantially such a temperature that they may be handled at the time they reach the delivery end of the tunnel. Such kilns are divided longitudinally into a plurality of zones which may be described briefly as, first a preheating zone in which the goods are raised to somewhere near the temperature of firing, second the firing zone in which the goods are completely fired during their passage longitudinally thereof, and third the cooling zone in which the fired goods are gradually deprived of their excess heat and brought to a sufficiently low temperature to enable them to be handled. It has been customary in the construction and operation of these kilns to effect the combustion of the fuel within combustion flues or passages extending through the firing zone of the tunnel, in which the greatest amount of heat is radiated and the products of combustion are conducted through similar flues through the heating zone to the entrance end of the tunnel, for the purpose of preheating the goods. In the cooling zone at the other end of the tunnel, the fired goods are cooled by means of air drawn into the tunnel itself or through suitable flues provided in its walls or within the tunnel to abstract the excess

heat from the fired goods and this heated air is in some instances employed in the combustion flues, and in other instances is withdrawn for other purposes. The construction of this type of kiln is extremely expensive in its initial cost, and also in its upkeep and operation. It necessitates practically the use of gaseous fuel, and where this is not readily available, it necessitates the erection and upkeep and continuous operation of a producer gas plant, which is in itself extremely costly and requires a high degree of skill for its efficient operation. The kiln itself is expensive on account of the extensive flue construction, much of which is required to be of very high fire resisting material, and this flue construction is difficult to keep in repair. Repairs to the flue construction are also exceedingly expensive in that they necessitate the removal of the goods and the cooling of the entire kiln structure, to enable the workmen to enter and make the necessary repairs. Furthermore it is necessary to maintain and operate powerful air forcing apparatus to secure the circulation of the products of combustion through the flues in the firing zone and preheating zone, and additional and separate air forcing means for passing the cooling air through the cooling zone. All of these considerations have made it almost, if not quite, prohibitive to employ this type of kiln for the firing of coarse clay products, which on account of their extremely low sale price, must be handled continuously at the highest possible volume and at the lowest possible costs, both as to initial cost and upkeep and daily operating expenses. Efforts have been made to reduce the expense of these tunnel kilns, but they have usually been in the direction of reducing the initial costs in connection with the other items above mentioned. For example, it has been proposed to construct what may be termed "twin kilns" or double tunnel kilns, in which two exterior walls are employed, with a central wall, thus doubling the capacity at somewhat less than double the cost of construction. But the slight economy involved in disposing of one lateral wall, necessitates the greatly increased initial cost of the kiln in order to provide two tunnels. It has also been proposed to oper-

ate the cars in a twin tunnel kiln in opposite directions in the two tunnels, so that some of the heat from the fired goods might be radiated through the partition wall, from the cooling zone of one tunnel to the preheating zone of the adjacent tunnel. Such constructions, however, effected little, if any, decrease in the cost of the plant, and have also been objectionable on account of the lack of efficiency due to the difficulty experienced in transferring the heat through a partition wall from one tunnel to the other.

The object of my present invention is to provide a kiln having provision for the simultaneous treatment of goods carried therethrough on two lines of trucks or cars moving in opposite directions, the cars loaded with goods passing through a single tunnel at each end of the kiln structure, and through separate firing zones adjacent to the portion of the kiln located centrally thereof, longitudinally, the heat for the firing zone being furnished preferably by direct firing from a plurality of furnaces arranged on opposite sides of the centrally located firing zones, said furnaces being operated under conditions permitting their accurate control as to the temperature within all parts of the firing zones, the products of combustion being withdrawn, preferably by suction from the firing zones, and conducted away for the purpose of further use in preliminary drying rooms, and otherwise as hereinafter described, the fired goods on leaving the separated firing zones in opposite directions and passing through the end portions of the kiln on their way to the delivery end, transferring their heat to the green goods moving in the opposite direction within the same tunnel, either by direct radiation, or preferably by continuous circulation of air transversely of the tunnel and upon and through the heated and cooled goods therein, so as to cool the heated goods progressively, while progressively preheating the entering goods. The products of combustion withdrawn from the firing zone, are preferably used first to heat large quantities of air which is distributed to the end portions, or single tunnel sections of the kiln, and introduced thereunto through inlet ports located at a series of different points longitudinally of the respective tunnel sections, by pipes or passages, under the control of suitable valves or dampers by means of which the temperature of each of said end or single tunnel sections can be controlled with sufficient accuracy for all practical purposes, the said products of combustion being then carried to a separate drier or drying chamber to be there used for the preliminary drying of the green brick or other articles or I may introduce unheated air for the same purpose. My present invention also contemplates the provision in each of the

end or single tunnel sections of outlet ports controlled by dampers or valves, located at different points longitudinally of said tunnel sections and preferably on the opposite side of the tunnel from said inlet ports, the said outlet ports being connected by pipes or passages with a suitable means for creating suction, as a suction fan, or a chimney or stack for the purpose of withdrawing from the end tunnel sections, or any desired portions thereof, air, which has collected moisture and gases (water smoke) from the green clay products undergoing preheating therein.

This construction enables me to supply fresh dry unheated or heated air to the end tunnel sections at any desired point or points longitudinally thereof under the control of dampers to both regulate and control the temperature within the kiln at different portions longitudinally thereof and also to supply fresh air to compensate for that withdrawn through the outlet flues, while the air which becomes charged or admixed with moisture vapors, etc., generally characterized by the term "water smoke" is withdrawn at certain points longitudinally of the kiln sections under the control of the dampers, thus greatly facilitating the preheating of the green clay products and bringing them more rapidly and efficiently to the desired temperature and condition to enter the firing chamber and thus also facilitating the firing of the clay products in the firing chamber.

In this arrangement or construction, it will be observed that there is a very great decrease in the initial cost of construction, as the greater part of the kiln is composed merely of parallel exterior side walls, and a single crown or roof portion. Moreover direct firing, by which is meant that the products of combustion from the furnaces come directly into contact with the goods to be fired, results in great economy of fuel. The fuel most available at the point where the kiln is located can be utilized whether gas, oil, wood or coal, and its combustion can be readily regulated by means of suitable dampers and other controlling mechanism. It will also be seen that the products of combustion in the firing zones being positively withdrawn therefrom by suction, will not be carried lengthwise of the furnace into the end sections thereof, and this suction may be so regulated in connection with the air forcing means supplying air to the furnaces, as to withdraw only the products of combustion, or if desired to withdraw some of the air from the end portions of the kiln also, which would result in the admission of cool air at the extremities of the kiln.

It will also be noted that all longitudinal flue constructions through those portions of the kiln at opposite ends of the firing zones

are omitted, thus effecting a great saving in initial cost and upkeep, and in efficiency of operation.

Referring to the accompanying drawings,

Fig. 1 is a diagrammatic plan view of a tunnel kiln embodying my invention and showing one arrangement for supplying air to the end sections of the kiln under the control of suitable dampers, and for withdrawing moist air, etc., from the end sections of the kiln also under damper control.

Fig. 2 is an enlarged horizontal sectional view of the kiln, parts being broken away.

Fig. 3 is an enlarged vertical transverse sectional view taken through the firing zones on line 3—3 of Fig. 2.

Fig. 4 is a similar section on line 4—4 of Fig. 2.

Fig. 5 is an enlarged vertical transverse section through one or other of the end sections of the kiln, taken on lines 5—5, or 5^a—5^a of Fig. 2, looking in the direction of the arrows.

Referring to the 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 unitary cooling and preheating chamber, one of which is indicated at A¹, and the other of which is indicated at A². The duplex firing chamber is illustrated in section in Figs. 3 and 4. It comprises two exterior walls, 1, 1, a central partition wall, 2, and separate crowns, 3, 3, of any usual or preferred construction, forming two tunnels, 4—4, separated by the partition wall, 2, each of which constitutes a firing zone. At the outer side of the tunnels of each of the firing zones are located a plurality of furnaces, 5, for the combustion of any desired character of fuel, that is to say, gas, or oil, wood, coal, etc. The fuel may be supplied continuously in any desired or appropriate manner, according to its character, and I have not undertaken to illustrate the particular means for supplying the fuel, which may be a suitable stoking arrangement in the case of coal, operated either by hand or power, or suitable injector nozzles in the case of liquid or gaseous fuel. The necessary air for combustion will be supplied in any desired manner. I have illustrated in Figs. 1 and 2, a pair of air forcing devices, 6—6, for this purpose, connected by pipe, 7, with the various furnaces, under the control of valves or dampers, 8, so that the supply to each furnace may be regulated and adjusted.

In order to distribute the products of combustion from the furnaces as uniformly as possible through the goods and secure the even firing of the same, each firing zone is provided with a vertical deflecting wall, indicated at 9, which extends upwardly from the back walls of the furnaces, tapering to-

ward the top, and the upper portion is preferably curved or inclined inwardly towards the chamber occupied by the goods, as indicated at 10. The deflecting walls are each provided on their inner faces adjacent to the bottom of the contiguous goods space, with inlet ports, 11, at the inner ends of transverse passages, 12, extending through the wall and each communicating at the outer face of the wall with a pipe or passage, 13, so that the products of combustion from the goods space may be withdrawn through the transverse passages, 12, and pipes, 13, from the interior of the firing zone. In this instance I have shown the horizontal flues arranged between adjacent furnaces and extending from the firing chamber to the outside of the tunnel kiln where they are connected with a suitable suction device, such as, for example, a common exhaust flue, 14, which may be connected with an exhaust fan or other exhausting mechanism, by means of which the products of combustion are withdrawn from the interior of the firing zones and conducted elsewhere for further use. I prefer to provide each of the flues, 13, with a controlling damper, 15, which may be of any preferred or usual construction. I have simply indicated in the drawing an ordinary form of butterfly valve or damper, but a sliding valve, or any other type of damper may be conveniently used. By means of the dampers, 15, and the dampers, 8, it will be seen that the temperature within each of the firing zones can be readily regulated. Each of the exhaust flues or passages, 12, 13, will naturally withdraw the products of combustion from the adjacent furnaces on either side and by properly adjusting the several dampers in the different pipes, 13, the control of the firing zone throughout its length can be accurately secured, to maintain any desired heat curve. For example, I find it convenient to maintain a temperature of approximately 1400° F. at the entering end of each of the firing zones, and of approximately 1900° F. at the opposite end of each of the firing zones. These temperatures, however, can be readily varied as circumstances may require, by the means before described. It will be understood that each of the firing zones is provided with longitudinal rails, indicated at 16—16, extending therethrough for supporting the wheels of the trucks or cars, indicated diagrammatically at 17. The superstructure of these trucks is preferably built up of layers of fire resisting material supported upon the metallic frame-work of the truck, in a well known manner, and the upper layer of the fire resisting material, preferably consists of hollow slabs, indicated at 18, provided with horizontal passages, 19, therethrough, which are substantially in alignment with the passages, 12, in the lateral de-

deflecting walls, 9. The supporting slabs, 18—18, are also preferably separated along the longitudinal central portion of the truck, the object being to facilitate the circulation of the products of combustion downward through the goods and laterally through the passages, 19. In order to protect the metallic portions of the trucks as far as possible, as they pass through the firing zone, the central partition wall, 2, and the vertical deflecting walls, 9—9, are provided with inwardly extending projections, indicated at 20, and 21, respectively, which extend over the lateral portions of the trucks and tend to prevent the passage of products of combustion down around the wheels and supporting structure of the trucks.

I also prefer to provide the inner faces of the lateral deflecting walls, 9, with one or more horizontal, inwardly projecting ribs, 22, which project toward the goods carried by the trucks. These horizontal ribs are below the inwardly extending deflecting portion, 10, of the lateral deflecting walls, and cooperate therewith in causing the products of combustion to distribute themselves through the goods and prevent them from being drawn downwardly adjacent to the deflecting walls, 9. The goods are arranged on the trucks so as to provide a central passage downwardly between them indicated at 23, and if the goods are coarse clay products, such as bricks, tile, etc., they will be so arranged as to provide lateral passages, so that the products of combustion may become distributed throughout the stacks or piles of goods on the trucks after leaving the throat formed between the deflecting portion, 10, of the deflecting walls, and the top, 3, of the kiln portion, so that the products of combustion will pass substantially uniformly downwardly through and around the goods and across the bottom of the same through the passages, 19, through the ports, 11, and exit passages, 12, 13, to the outside of the kiln.

It will be noted that I prefer to arrange the firing zones for both lines of cars in alignment with each other, transversely, and located substantially centrally with respect to the entire length of the kiln structure. By this means the heat is concentrated and as the partition wall, 2, is subjected to heat from both sides, there is practically no loss of radiation through this partition wall, as any transfer of heat therethrough would be conserved within one firing zone or the other. At each end of this duplex firing zone, is provided a single tunnel structure preferably having only one crown or arch, and no central partition wall, as indicated in Fig. 5. These tunnel portions, A', A², connect with the central firing zone portions, A, and are provided with two sets of rails which are continuations of the rails extending through

the firing zones. The lateral walls are provided with inwardly extending projections, 21^a, similar to the projections, 21, in the firing zone, and between the sets of rails is located preferably a raised platform, 24, of brick or other fire resisting material, extending slightly above the lateral projections of the truck structure and provided on opposite sides with horizontal inwardly extending ribs or flanges, 25, to prevent the heated air from passing down around the wheels and metallic parts of the truck. The trucks are illustrated diagrammatically in the accompanying drawings, and their specific structure may be of any usual or preferred character. By reference to Fig. 5, which illustrates a section on the line 5—5 of Fig. 2, for example, it will be understood that in the portions, A'—A², of the kiln when in operation, there will be one line of trucks carrying goods which have been fired and are being moved toward the outer end, and another line of trucks on the other tracks moving in the opposite direction and carrying green or unfired goods to the firing zone. It will be noted at once that there will be an exchange of heat from the fired goods to the green goods as the fired goods are cooled and the green goods are preheated. It will also be seen that this exchange of heat will take place in such a manner that the fired goods will be gradually cooled and the green goods will be gradually heated. I prefer to make the end sections, A'—A², of the tunnel of such length that in handling any particular goods the fired goods will be sufficiently cooled to be handled by the time they are discharged from the kiln, and this will result in a very gradual heating of the green or unfired goods from the time they enter the kiln where they will have opposite them goods which have been very considerably cooled, until they reach the proximity of the firing zone, where they will have opposite them highly heated fired goods which have just left the firing zone, so that by the time the green or unfired goods reach the firing zone they have been brought nearly to the firing temperature. As these conditions will be somewhat modified by the exterior temperature of the air and other conditions, variations in the temperature at which the goods are delivered to the firing zone can be accommodated by proper regulation of the furnaces of the firing zone, as herein before described, and by the regulation of the temperature in the preheating and cooling zones as hereinafter described. For example, if the goods arrive at the firing zone at too low a temperature, the temperature of the firing zone at the initial end of the same can be increased by regulating the furnaces therefor so that by the time the goods reach the hottest portion of the firing zone they will be at the desired tem-

perature. In like manner, if it is found that the green goods reach the firing zone at a temperature very near the firing temperature, the heat of the furnaces in the firing zone can be slightly reduced to prevent excessive temperatures in the firing zone. It will be understood that in the transfer of heat from the fired goods to the green goods, this will be brought about by direct radiation and by convection air currents, the circulation of which is illustrated in the drawing by the arrows, in Fig. 5. The construction thus far described is substantially similar to that disclosed in my prior application for Letters Patent of the United States #666,880 filed October 6th, 1923.

As above stated, my present invention also contemplates the supplying of heated or unheated air to each of the end sections of the kiln at different points longitudinally thereof, under the control of suitable independently operable dampers in order that the temperature of each or any longitudinal portion of said end sections of the kiln may be directly controlled and regulated. I prefer to heat this air by means of the hot products of combustion withdrawn from the heating zones, by the use of a suitable heat exchanging apparatus, the particular construction of which forms no part of my present invention. Obviously the hot products of combustion from both sets of furnaces may be conducted to a single heat exchanging device for the purpose of heating air, which is conducted to both of the end sections of the kiln and introduced therein under the control of suitable dampers or valves, but I have found it convenient to take the products of combustion from each set of furnaces, on one side of the kiln structure, pass them through a suitable heat exchanging device, and conduct the heated air therefrom to one of the end sections of the kiln. While this duplicates the heat exchanging apparatus, the apparatus can be kept down to smaller limits of construction and the necessary amount of piping is reduced so that great efficiency is secured with economy of construction. As shown in Figs. 2 and 5 each of the end sections, A'-A², is provided along one side and preferably just above the horizontal rib, 21^a, with a plurality of inlet ports, indicated at 40, disposed at intervals longitudinally of the kiln, each of said inlet ports being connected by a short section of pipe, 41, with a longitudinal flue 42, which in this instance is connected with a heating coil, 43, of a heat exchanger or air heater, 44, of any usual or preferred construction, atmospheric air being admitted to the coil, 43, in any usual or well known way. Each of the inlet ports, 40, is independently controlled by a valve or damper, indicated at 45. I have shown the ordinary butterfly type of valve or

damper, but any other preferred form of damper may be employed for this purpose. Each of the heat exchanging devices, 44, is connected by a pipe, 45', with the common exhaust pipe, 14, for the set of furnaces on the adjacent side of the firing zones, and the heat exchange device, 44, is also provided with an exhaust fan or other suction device, indicated at 46, for withdrawing the products of combustion from the furnaces through the pipe, 14, pipe, 45, and the heat exchanger, 44. The products of combustion will give up the greater portion of their heat to the air passing through the coil, or passages, 43, of the heat exchanger and after leaving the heat exchanger the said products of combustion, while partly cooled, will still retain a considerable amount of heat and may be conducted by means of a pipe, 47, to a drying room, for example, in which green clay products are being dried preparatory to firing or may be otherwise disposed of or utilized as found most convenient. As illustrated in Figs. 1 and 2, I have duplicated the heat exchanger and its connections on opposite sides of the firing zone, each of said heat exchangers furnishing heated air to the inlet ports, 40, of one end section of the kiln, as shown, and this is my preferred construction, although as before stated, the heated air for the inlet ports, 40, of the said end sections may be supplied in any other desired manner, if preferred.

As illustrated in Figs. 1, 2 and 5, I have also shown each of the end sections, A'-A² of the kiln provided with a plurality of outlet ports, indicated at 50, connected by pipes or passages, 51, with a common eduction flue, pipe or passage, 52, leading to any suitable means for creating suction, which may consist of a suction fan or blower, or a vertical stack or chimney, for example. In Figs. 1 and 2 I have indicated the suction device, at 53, and have shown it connected to the common eduction flue, 52. I have shown two suction producing devices, 53, one for each end section of the kiln, and this is my preferred construction, although obviously the eduction port of both end sections could be connected with the same suction producing means if found convenient or desirable. Each of the outlet ports, 50, is controlled by a suitable damper, 54, said dampers being independently operable and being here shown as of the butterfly type, and located in the connecting pipes, 51, respectively, although they may be of other forms, located at any desired point for controlling the respective outlet ports, 50, as may be found most convenient. By means of these outlet ports the moist air, vapor and gases within the end sections of the kiln, and commonly referred to as "water smoke", may be withdrawn from the end sections throughout their entire length or throughout any longitudinal

portions thereof, as may be desired, under the control of the valves or dampers, 54. This prevents the accumulation within the end sections of moist air and vapors which might otherwise remain therein and delay the preheating of the advancing unfired clay products, on their way to the firing zones. I prefer to locate the outlet ports, 50, on the opposite side of each end section, A', A², from the inlet ports 40, and to arrange them slightly above the horizontal rib, 21^a, but I do not limit myself to the exact location of these inlet and outlet ports. By means of the independently controlled inlet ports and outlet ports in the end sections of the kiln, I am able to control very accurately the internal temperatures and the general condition of the air within the end sections of the kiln. For example, the products of combustion withdrawn from the firing chamber may be at a temperature of approximately 1600° F., and in passing through the heat exchanger will raise the temperature of the air delivered by pipe, 42, to approximately 1000° F. By means of the dampers, 45, this heated air can be admitted to a greater or less extent at all of the inlet ports or certain of them as preferred, and for example, I may maintain a certain portion of the end section at a temperature of approximately 500° F., and an intermediate portion at, say, 750° F., and a portion adjacent to the firing chamber, at, say, 1000° F., the extent of the different portions of the end section to be maintained at a particular temperature, being readily determined by the operation of the dampers, 45. In like manner, by means of the dampers, 54, the moist air vapor and gases within the end sections, is, for example, what is generally termed "water smoke", may be withdrawn from all portions of the end sections or from certain portions thereof, as may be found most desirable in preheating and preparing the unfired clay products on their way to the firing zone. The operation of these dampers will also have an effect in regulating the gradual cooling of the fired clay products on their way from the firing zone to the outer end of the end section, thus enabling the operation of the kiln to be very readily and accurately controlled to obtain the rapid and efficient and economical firing of the clay products.

It will also be seen that the greater portion of the kiln is of single tunnel construction, and as these portions of the furnaces are not subjected to as high heat as the firing zone, the construction thereof can be made cheaper and simpler and will be less liable to deterioration than where portions of the cooling zone are directly alongside of a firing zone for goods on another track.

My improved furnace is admirably adapted for the rapid and continuous firing of

coarse clay products, such as bricks, tile, etc., but it may also be employed for firing other classes of goods, if desired.

What we claim and desire to secure by Letters Patent is:—

1. In a tunnel kiln, the combination of a duplex firing chamber having two separate firing zones provided with heating means located on opposite sides of the duplex firing chamber, and a unitary tunnel section extending longitudinally from each end of the duplex firing chamber, provided with parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, means for introducing a gaseous heat modifying fluid into each of said end sections, at different points longitudinally thereof, independently operable means for controlling the introduction of said heating fluid at such points, and means for withdrawing the moist air vapor and gases from said end sections of the kiln.

2. In a tunnel kiln, the combination of a duplex firing chamber having two separate firing zones provided with heating means located on opposite sides of the duplex firing chamber, and a unitary tunnel section extending longitudinally from each end of the duplex firing chamber, provided with parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, each of said end sections of the kiln being provided with a plurality of inlet ports located at different points longitudinally thereof, means for supplying heat modifying gaseous fluid to said inlet ports, independently operable dampers for controlling said inlet ports, and means for withdrawing moist air, vapor and gases from said end sections of the kiln.

3. In a tunnel kiln, the combination of a duplex firing chamber having two separate firing zones provided with heating means located on opposite sides of the duplex firing chamber, and a unitary tunnel section extending longitudinally from each end of the duplex firing chamber, provided with parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, means for introducing a gaseous heat modifying fluid into each of said end sections, at different points longitudinally thereof, independently operable dampers for controlling the introduction of said heat-modifying fluid at such points, means located at different points longitudinally of said end sections for withdrawing moist air, vapor and gases, and independently operable dampers for controlling the with-

drawal of said air, vapor and gases at said points.

4. In a tunnel kiln, the combination of a duplex firing chamber having two separate firing zones provided with heating means located on opposite sides of the duplex firing chamber, and a unitary tunnel section extending longitudinally from each end of the duplex firing chamber, provided with parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, each of said end sections of the kiln being provided with a plurality of inlet ports located at different points longitudinally thereof, means for supplying heated gaseous fluid to said inlet ports, independently operable dampers for controlling said inlet ports, each of said end sections being also provided with a series of outlet ports located at different points longitudinally thereof, means connected with said outlet ports for withdrawing the moist air, vapor and gases, and independently operable dampers for controlling said outlet ports.

5. In a tunnel kiln, the combination of a duplex firing chamber having two firing zones separated by a vertical longitudinal partition 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 unitary tunnel section extending longitudinally from each end of the duplex firing chamber provided with parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, air heating means receiving the products of combustion withdrawn from said firing zone, and means for conducting the air heated by said air heating means to and delivering it into said unitary tunnel sections.

6. In a tunnel kiln, the combination of a duplex firing chamber having two firing zones separated by a vertical longitudinal partition 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 unitary tunnel section extending longitudinally from each end of the duplex firing chamber provided with parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, air heating means receiving the products of combustion withdrawn from the fir-

ing zone, means for conducting the air heated by said air heating means to and discharging it into said unitary tunnel sections at different points longitudinally thereof, and independently operable dampers for controlling the admission of heated air to said unitary tunnel sections at said points.

7. In a tunnel kiln, the combination of a duplex firing chamber having two firing zones separated by a vertical longitudinal partition 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 unitary tunnel section extending longitudinally from each end of the duplex firing chamber provided with parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, said unitary tunnel sections being each provided with a plurality of inlet ports at different points longitudinally thereof, a damper for controlling each of said inlet ports, air heating means provided with passages communicating with the firing chambers for receiving the products of combustion withdrawn therefrom, and with independent air passages communicating with said ports.

8. In a tunnel kiln, the combination of a duplex firing chamber having two firing zones separated by a vertical longitudinal partition 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 unitary tunnel section extending longitudinally from each end of the duplex firing chamber provided with parallel goods conveying means movable in opposite direction, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, each of said unitary tunnel sections being provided with a plurality of inlet ports at different points longitudinally thereof, an air heating device on each side of the duplex firing chamber, each provided with passages communicating with the adjacent firing zone, and with air passages communicating with the inlet ports of one of said unitary tunnel sections, and independently operable dampers for controlling said inlet ports.

9. In a tunnel kiln, the combination of a duplex firing chamber having two firing zones separated by a vertical longitudinal partition 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 zones, means for withdrawing the products of combustion from each firing zone, a unitary tunnel section extending longitudinally from each end of the duplex firing chamber provided with parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, each of said unitary tunnel sections being provided with a plurality of inlet ports, and a plurality of outlet ports located at different points longitudinally thereof, independently operable dampers for said inlet and outlet ports, air heating means provided with passages communicating with the firing zones, and independent air passages connected with said inlet ports and air withdrawing means connected with said outlet ports.

10. In a tunnel kiln, the combination of a duplex firing chamber having two firing zones separated by a vertical longitudinal partition 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 zones, means for withdrawing the products of combustion from each firing zone, a unitary tunnel section extending longitudinally from each end of the duplex firing chamber provided with parallel goods conveying means movable in opposite directions, each of which passes through one of the firing zones, each of said end sections forming a combined cooling and preheating zone, each of said unitary tunnel sections being provided with a plurality of inlet ports, and a plurality of outlet ports located at different points longitudinally thereof, independently operable dampers for said ports, an air heating device on each side of the duplex firing chamber having passages communicating with the adjacent firing zone, and independent air passages communicating with the inlet ports of one of said unitary tunnel sections, and an air withdrawing device for each of said unitary tunnel sections connected with the outlet ports thereof.

11. In a tunnel kiln, the combination of a duplex firing chamber having two separate firing zones arranged side by side and provided each with a row of furnaces located adjacent to its exterior wall and discharging into the adjacent firing zone, an eduction flue adjacent to each of said furnaces and communicating with the adjacent firing zone for withdrawing the products of combustion therefrom, independently operable dampers for said eduction flues, a unitary tunnel section extending longitudinally from each end of the duplex firing chamber, said kiln being provided with two parallel lines

of tracks extending longitudinally there-through for two oppositely moving trains of cars, each line of tracks passing through one of the firing zones, and each of said unitary tunnel sections, each of said unitary tunnel sections being provided with a plurality of inlet ports arranged at different points longitudinally thereof, air heating means having passages communicating with said eduction flues, and independent air passages communicating with said inlet ports, and independently operable dampers for said inlet ports.

12. In a tunnel kiln, the combination of a duplex firing chamber having two separate firing zones arranged side by side and provided each with a row of furnaces located adjacent to its exterior wall and discharging into the adjacent firing zone, an eduction flue adjacent to each of said furnaces and communicating with the adjacent firing zone for withdrawing the products of combustion therefrom, independently operable dampers for said eduction flues, a unitary tunnel section extending longitudinally from each end of the duplex firing chamber, said kiln being provided with two parallel lines of tracks extending longitudinally there-through for two oppositely moving trains of cars, each line of tracks passing through one of the firing zones and each of said unitary tunnel sections, each of said unitary tunnel sections being provided with a plurality of inlet ports arranged at different points longitudinally thereof, air heating means having passages communicating with said eduction flues, and independent air passages communicating with said inlet ports, independently operable dampers for said inlet ports, and means for withdrawing moist air, vapors and gases from said unitary tunnel sections.

13. In a tunnel kiln, the combination of a duplex firing chamber having two separate firing zones arranged side by side and provided each with a row of furnaces located adjacent to its exterior wall and discharging into the adjacent firing zone, an eduction flue adjacent to each of said furnaces and communicating with the adjacent firing zone for withdrawing the products of combustion therefrom, independently operable dampers for said eduction flues, a unitary tunnel section extending longitudinally from each end of the duplex firing chamber, said kiln being provided with two parallel lines of tracks extending longitudinally therethrough for two oppositely moving trains of cars, each line of tracks passing through one of the firing zones and each of said unitary tunnel sections, each of said unitary tunnel sections being provided with a plurality of inlet ports arranged at different points longitudinally thereof, air heating means having passages communicating with said eduction

tion flues, and independent air passages communicating with said inlet ports, independently operable dampers for said inlet ports, each of said unitary tunnel sections being

5 also provided with a plurality of outlet ports located at different points longitudinally thereof, independently operable dampers for said outlet ports, and air withdrawing means operatively connected with said outlet ports.

10 14. In a tunnel kiln, the combination of a duplex firing chamber having two separate firing zones, a row of furnaces located on opposite sides of said chamber, the furnaces of each row communicating with the adjacent

15 firing zone, an eduction flue adjacent to each row of furnaces, connecting flues from each of said eduction flues communicating with the adjacent firing zone at different points longitudinally thereof for withdrawing the

20 products of combustion therefrom, independently operable dampers for said connecting flues, a unitary tunnel section extending longitudinally from each end of the duplex firing chamber, and provided with inlet and outlet ports located at different

25 points longitudinally thereof, independently operable dampers for said inlet and outlet ports, said kiln being provided with two parallel lines of tracks extending longitudinally

30 therethrough for two oppositely moving trains of cars, each line of tracks passing through one of the firing zones, and each of said unitary tunnel sections, air heating means located on opposite sides of the duplex firing chamber, each provided with passages connected with the adjacent eduction flue, and independent air passages connected

35 with the inlet ports of one of said unitary tunnel sections, and air withdrawing means connected with the outlet ports of each of said unitary tunnel sections.

15. In a tunnel kiln, the combination with a centrally located duplex firing chamber, furnaces communicating with the interior of

45 the firing chamber, means for withdrawing the products of combustion from the firing chamber, a unitary combined preheating and cooling portion located at each end of the firing chamber, and parallel goods conveying means movable in opposite directions

50 through the kiln, of means for introducing a gaseous heat modifying fluid into each of said end sections at different points longitudinally thereof, means for independently

55 controlling the introduction of said fluid at such points to facilitate the water-smoking and oxidation of the goods, and means for withdrawing the moist air vapors and gases from said end sections of the kiln.

60 16. In a tunnel kiln, the combination with a centrally located duplex firing chamber, furnaces discharging their products of combustion directly into said firing chamber, means for withdrawing the products of combustion from said firing chamber, a unitary

combined preheating and cooling portion located at each end of the firing chamber, and parallel goods conveying means movable in opposite directions through the kiln, of means for introducing a gaseous heat

70 modifying fluid into each of said end sections, for facilitating the water-smoking and oxidation of the goods, means for withdrawing the moist air vapors and gases from said end sections of the kiln at different points

75 longitudinally thereof, and means for independently controlling the withdrawal of said air, vapors and gases at such points.

17. In a tunnel kiln, the combination with a centrally located duplex firing chamber, furnaces therefor discharging their products of combustion directly into the firing chamber, means for withdrawing the said products of combustion from said firing chamber, a unitary combined preheating and cooling portion

85 located at each end of the firing chamber, and parallel goods conveying means movable in opposite directions through the kiln, of means for introducing a gaseous heat modifying fluid into each of said end sections, means for independently controlling the introduction of said fluid at such points to facilitate the water-smoking and oxidation of the goods, means for withdrawing the moist air vapors and gases from said end

90 sections of the kiln at different points longitudinally thereof, and means for independently controlling the withdrawal of said air, vapors and gases at such points.

18. In a tunnel kiln, the combination of a firing chamber provided with heating means and a unitary tunnel section extending longitudinally from each end of the firing chamber, provided with parallel goods conveying means movable in opposite directions and extending through the firing chamber, each of said end sections forming a combined cooling and preheating zone, means for introducing a gaseous heat modifying fluid

100 into each of said end sections at different points longitudinally thereof, independently operable means for controlling the introduction of said heating fluid at such points, and means for withdrawing the moist air, vapor and gases from said end section of the kiln.

19. In a tunnel kiln, the combination of a firing chamber provided with heating means and a unitary tunnel section extending longitudinally from each end of the firing chamber, provided with parallel goods conveying means movable in opposite directions and extending through the firing chamber, each of said end sections forming a combined cooling and preheating zone, means for introducing a gaseous heat modifying fluid

120 into each of said end sections at different points longitudinally thereof, means for withdrawing the moist air, vapor and gases from said end sections of the kiln at different points longitudinally thereof, and inde-

130

pendently operable means for controlling the withdrawal of said heating fluid at such points.

20. In a tunnel kiln, the combination of a firing chamber provided with heating means and a unitary tunnel section extending longitudinally from each end of the firing chamber, provided with parallel goods conveying means movable in opposite directions and extending through the firing chamber, each of said end sections forming a combined cooling and preheating zone, means for introducing a gaseous heat modifying fluid into each of said end sections at different points longitudinally thereof, independently operable means for controlling the introduction of said heating fluid at such points, means for withdrawing the moist air, vapor and gases from said end sections of the kiln, and independently operable means for controlling the withdrawal of said air, vapor and gases at such points.

21. In a tunnel kiln, the combination of a firing chamber provided with heating means and a unitary tunnel section extending longitudinally from each end of the firing chamber, provided with parallel goods conveying means movable in opposite directions and extending through the firing chamber, each of said end sections forming a combined cooling and preheating zone, air heating means receiving the products of combustion withdrawn from the firing chamber, and means for conducting the air heated by said air heating means to and delivering it into said unitary tunnel sections.

22. In a tunnel kiln, the combination of a firing chamber provided with heating means

and a unitary tunnel section extending longitudinally from each end of the firing chamber, provided with parallel goods conveying means movable in opposite directions and extending through the firing chamber, each of said end sections forming a combined cooling and preheating zone, said unitary tunnel sections being each provided with a plurality of inlet ports at different points longitudinally thereof, a damper for controlling each of said inlet ports, air heating means provided with passages communicating with the firing chamber for receiving the products of combustion withdrawn therefrom, and being provided with independent air passages communicating with said ports.

23. In a tunnel kiln, the combination of a firing chamber provided with heating means and a unitary tunnel section extending longitudinally from each end of the firing chamber, provided with parallel goods conveying means movable in opposite directions and extending through the firing chamber, each of said end sections forming a combined cooling and preheating zone, each of said unitary sections being provided with a plurality of inlet ports and a plurality of outlet ports located at different points longitudinally thereof, independently operable dampers for said inlet ports, air heating means provided with passages communicating with the firing chamber, and provided with independent air passages connected with said inlet ports, and air withdrawing means connected with said outlet ports.

In testimony whereof I affix my signature.

WILLIAM LEE HANLEY, JR.