C. J. KIRK.

HEAT TREATING FURNACE AND METHOD.

APPLICATION FILED FEB. 10, 1920.

1,418,446.

Patented June 6, 1922.

2 SHEETS—SHEET 1.

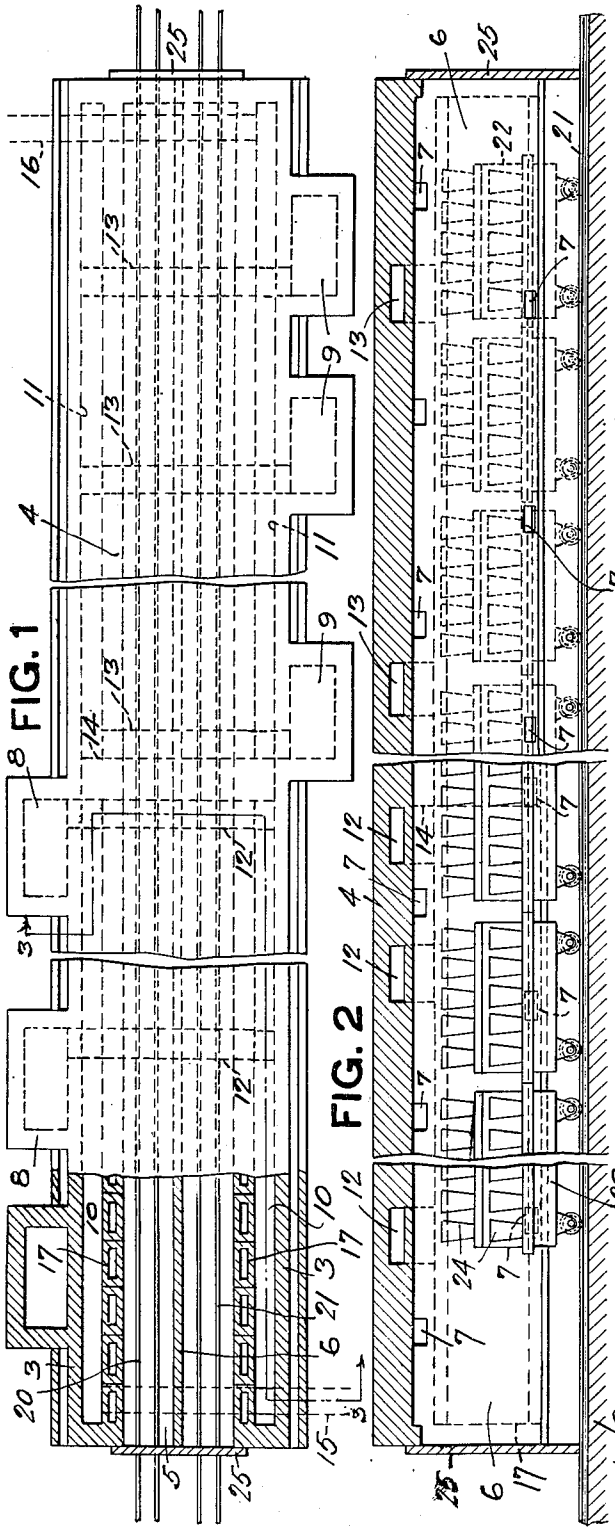

FIG. 1

FIG. 2

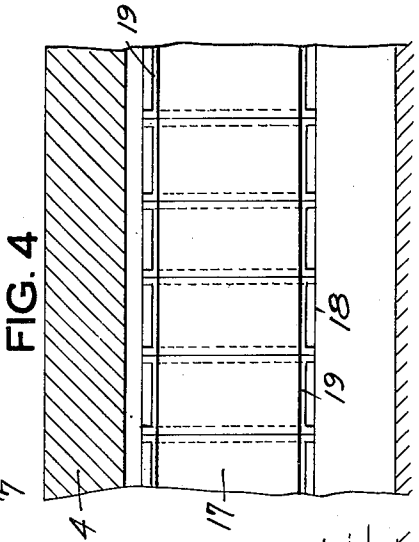

FIG. 4

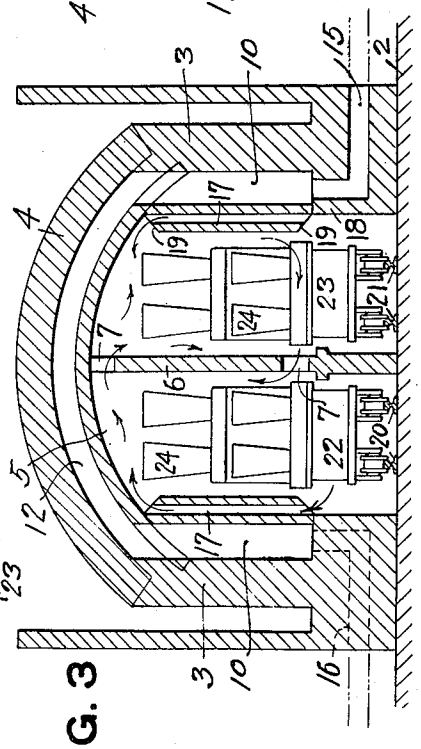

FIG. 3

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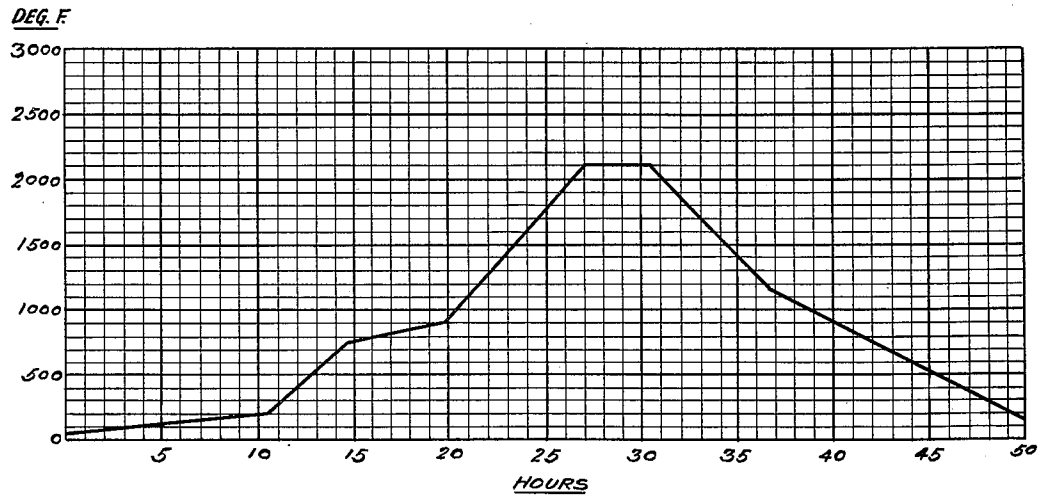
2 SHEETS—SHEET 2.

FIG. 5



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UNITED STATES PATENT OFFICE.

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HEAT-TREATING FURNACE AND METHOD.

1,418,446. Specification of Letters Patent. Patented June 6, 1922.

Application filed February 10, 1920. Serial No. 357,540.

To all whom it may concern:

Be it known that I, CHARLES J. KIRK, a citizen of the United States, and resident of New Castle, in the county of Lawrence and State of Pennsylvania, have invented a new and useful Improvement in Heat-Treating Furnaces and Methods; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to heat-treating furnaces, and it has special reference to tunnel kilns of the general type shown and described in my co-pending applications for Letters Patent Serial No. 280,131 filed March 1, 1919, and Serial No. 301,975 filed June 5, 1919.

One object of my present invention is to provide a method of firing earthenware and similar materials whereby the time required for treatment shall be accurately regulated and materially shortened.

Another object of my invention is to provide a heat-treating furnace of the character indicated, by means of which the heating of the material may be quickly and easily regulated, especially as to the several critical stages of firing when the temperature changes must take place slowly, and by means of which the heating of the ware between these critical stages may be materially accelerated.

The firing of sanitary earthenware and other articles molded from wet plastic materials requires considerable time and in the kilns which have heretofore been employed for this purpose, the ware often requires eighty (80) hours or more in passing through the kiln. This lenghty treatment is necessary because the temperature must be raised slowly and gradually during the period of "water-smoking" while the adhering moisture is being expelled and also during the several critical stages mentioned below. Heat-treating kilns have been designed to raise the temperature of the ware in the proper manner during the "water smoking" period and it has been necessary to continue the increase in temperature at the same rate after the water has been expelled, although there is no longer any need for such slow and gradual temperature rise except during the later stages when the combined moisture is expelled and when the ware is passed through the plastic stage. Since no provision has heretofore been made for varying the rate of temperature rise, it has ordinarily required fifty or sixty hours to bring the ware to the maximum firing temperature.

According to my present invention I shorten the time required for the heat treatment of earthen ware by providing the kiln with a series of separate and independently regulable fire boxes so that by suitably controlling the heat supply from such fire boxes the temperature of the ware may be gradually raised during the critical periods or danger zones and at the ends of these periods may be raised as rapidly as desired.

The tunnel kilns to which my invention relates are particularly, though not exclusively, of the muffle type, in which the objects to be heated are not exposed directly to hot products of combustion, but are subject to the indirect action of the heat, such kilns being therefore suitable for the firing of pottery of the annealing of metal. The furnace is divided into two compartments having tracks in each compartment, the cars on one track entering in the opposite direction from the cars on the other track. Provision is made for utilizing the heat emanating from the heated cars on one track, and from the objects carried thereby, for assisting in heating the objects on the cars entering the furnace from the opposite end on the other track. To this end, the partition wall between the two compartments is provided with a series of openings at the top and bottom to allow for the free circulation of convection currents, so that the hot air passing through one compartment to the other at the top will descend through the other compartment, and will return into the original compartment at the bottom, whereby a constant circulation is maintained and the time required for treatment, as well as the amount of fuel required, are greatly reduced.

My present invention has for its specific object the improvement of the heating means for furnaces of the description indicated above.

In the accompanying drawing, Fig. 1 is a plan view, with parts broken away and shown in section, of my improved furnace; Fig. 2 is a longitudinal sectional view, with parts broken away, of the structure shown in Fig. 1; Fig. 3 is an enlarged transverse sectional view of the same structure, the section being taken substantially on the line 3—3, Fig. 1; Fig. 4 is a longitudinal vertical

sectional view of a portion of one of the compartments of the furnace, showing the face of the inner wall thereof; and Fig. 5 is a diagram showing the manner in which my improved furnace shortens the time required for treating one class of earthenware.

In the drawing, the numeral 2 designates a suitable base or foundation upon which the furnace is erected. The furnace consists of side walls 3 and a top or crown 4, and is divided into two compartments by means of a partition wall 6 which also helps to strengthen and support the crown 4. The partition wall 6 is provided with openings 7 arranged at intervals at the top and adjacent to the bottom thereof, and these openings are preferably staggered with relation to each other.

In order to supply heat to the compartments of the furnace I provide two sets of separate combustion chambers or fire-boxes 8 and 9, the combustion chambers 8 being disposed at suitable intervals on one side of the center of the furnace and the combustion chambers 9 being disposed at the opposite side of the furnace, and on the opposite side of the center of the furnace and its opposite end, as clearly shown in Fig. 1. The fire boxes may be spaced and grouped as desired. I have shown three of the combustion chambers 8 and three of the combustion chambers 9, but the number of these combustion chambers may be increased as desired, and will be considerably more numerous in the case of long kilns. The combustion chambers may be arranged to consume gaseous or solid fuel, and they may be of any interior construction, such as is well known in this art.

Communicating with all the combustion chambers 8 are flues 10 arranged in the side walls of the furnace, and the flues 10 communicate with each other through the cross-flue 12 which passes through the top of the furnace chamber 5. Similarly, all of the combustion chambers 9 communicate with flues 11 arranged in the side walls of the furnace and the flues 11 communicate with each other through the cross-flue 13 similar to the cross-flue 12. As shown, the flues 10 and 11 do not communicate with each other, being separated by the wall 14. This is the arrangement which I prefer to employ, but if desired these flues may be made to communicate through the wall 14. The flues 10 and 11 are respectively provided with outlet flues 15 and 16.

The inner walls of the flues 10 and 11 are made up, as in my co-pending application Serial No. 301,975, of hollow tiles 17, these tiles being supported on a ledge 18 and being set close together to form tight joints with each other. The upper and lower ends of these tiles are open and communicate with the adjacent compartments of the heating chamber and the upper and lower ends of the tiles are preferably beveled as indicated at 19. These tiles form an insulating wall between the heating chambers and the flues 10 and 11 so that the heat from the flues is not directly conveyed from the wall to the objects to be treated, but is transmitted by convection currents circulating through the tiles. By this means, the contents of the heating chambers is protected from direct radiation of heat and, in addition, the wall itself is protected and its life prolonged.

Within the heating chamber are tracks 20 and 21 upon which cars 22 and 23 may travel, these cars being constructed of suitable refractory material in order to withstand the high heat to which they are subjected in passing through the furnace. The objects 24 to be heated are arranged upon the cars so as to allow the heat to circulate in and around them during their passage through the furnace.

The ends of the furnace are provided with suitable doors 25.

In the operation of the kiln, the ware mounted on the cars 22 is introduced into the furnace at one end and the ware mounted on the cars 23 is introduced on the opposite track and at the other end of the furnace.

Heated gases from the combustion chambers 8 and 9 pass respectively through the flues 10 and 11 and cross over through flues 12 and 13 to heat the opposite sides of the combustion chamber. As the ware passes through the heating chamber, it is progressively heated to a high temperature, and as the cars carrying the highly heated ware approach the discharge end, the heat given off by the cars and by the objects carried thereon will set up convection currents which ascend and pass through the openings 7 in the partition 6 into the other chamber where the convection currents encounter the relatively cold cars which are entering on the next track and in the opposite direction. These cold cars, and the cold objects which they carry, chill the air and it accordingly descends, passing through the bottom openings 7 in the partition wall and up through the heated cars on the opposite track. This circulation of convection currents takes place at both ends of the furnace and materially assists in bringing the incoming cars and the articles which they carry to proper temperature. At the same time, convection currents are set up through the hollow tiles 17, as described above.

As indicated above, I am able, on account of the provision of several combustion chambers distributed along each half of the furnace, to regulate accurately the rapidity with which the incoming ware is heated. Different kinds of material must, for the best results, be heated in different ways, and for different lengths of time. For example, in the case of sanitary porcelain there are four

distinct heating stages or danger zones where the heat must be changed gradually, while between these danger zones the temperature change may take place as rapidly as desired. The ware is first heated until it reaches 212° F., at which point the free moisture in the ware is evaporated with consequent generation of steam which has a volume some 1200 times greater than the volume of the original water. If this generation of steam occurs too suddenly, the sudden expansion sets up undue stresses in the ware which will produce cracks and other difficulties. It usually takes five to ten hours to pass this point safely, depending of course, upon the quantity of ware being fired and the weight and shape of the individual pieces.

The second danger zone is between 750° F. and 900° F. In this stage the water of crystallization contained in the ware begins to be liberated and the same precautions must be observed as in the first danger zone in order that rapid generation of steam may be prevented. The ware is therefore fired very slowly during this stage, but a rapid rate of increase of temperature may be employed between 212° F. and 700° F.

The third danger zone occurs where the less refractory ingredients of the ware begin to fuse and the whole mass becomes more or less soft and plastic. A sufficient time must be allowed during this stage so that the material will not sag by reason of its excessive softness, and yet the particles will fuse sufficiently to stick together. At this point, it is particularly necessary to maintain a uniform temperature. If the temperature becomes too high devitrification results, producing the so-called cheesy material. On the other hand, if the temperature drops below the proper fusing point, a non-uniform structure is produced, some parts being fused and other parts being only partially fused. The firing between the first and second danger zones may also be quite intensive.

Having passed the fusing stage the cooling stage is reached. The ware now begins to give off heat and its temperature falls. The cooling may be quite rapid until a dull red heat is reached, after which cooling should take place more gradually in order that the ware may be prevented from cracking.

Fig. 5 of the accompanying drawing shows a curve illustrating the heat treatment of porcelain according to the sequence of steps described above. In this diagram the ordinates represent degrees F. and the abscissas represent hours. It will be observed that the gradual and rapid stages of temperature increase are alternated at the points mentioned above, and that a material saving in time is produced if the curve is made very steep during the rapid heating stages. I accomplish this result according to my present invention by regulating the fires of the several combustion furnaces so that the ware is heated at just the required rate at every point in its travel through the firing chamber.

It is to be understood that the curve herein shown is merely illustrative and that by my present invention I am able, by regulating the fire boxes, to reproduce any heating curve that may be required.

I have found that sanitary earthenware may be fired in a thorough and satisfactory manner in forty-six to forty-eight hours as compared with eighty hours which is an ordinary figure when the ware is fired in the kilns heretofore employed.

While I have herein shown and described a preferred embodiment of my invention, it is to be understood that numerous changes in the construction and arrangement of parts may be made without departing from the scope of my invention, and I therefore desire that no limitations be imposed upon my invention, except such as are indicated in the appended claims.

What I claim is:

1. A method of firing earthenware that comprises subjecting the ware, while traversing a firing chamber, to heat from a plurality of separate and independently regulable heat sources creating well defined zones of heat.

2. The method of firing earthenware that comprises advancing the ware through an elongated firing chamber and subjecting the ware at successive points in its travel through the said chamber to heat from a plurality of separate and independently regulable heat sources.

3. The method that comprises advancing earthenware simultaneously in opposite directions through two elongated and adjacent firing chambers adapted for mutual interchange of heat and subjecting the ware in each chamber at successive points in its travel to heat from a plurality of separate and independently regulable heat sources.

4. The method that comprises advancing earthenware simultaneously in opposite directions through two elongated and adjacent firing chambers adapted for mutual interchange of heat and subjecting the ware in each chamber at successive points in its travel through the first half of its firing chamber to heat from a plurality of separate and independently regulable heat sources.

5. A heat treating furnace comprising a firing chamber, means for causing earthenware or the like to traverse the said chamber and a plurality of separately regulable combustion chambers that are severally adapted to communicate heat to the said chamber in well defined zones.

6. A heat treating furnace comprising an elongated heating compartment and a plurality of separately regulable combustion

chambers disposed adjacent to and adapted to heat the said compartment in well defined zones.

7. A heat treating furnace comprising two adjacent heating compartments, a plurality of separate combustion chambers adapted to heat one of the said compartments and disposed adjacent to one-half of the length of the said compartment, and a plurality of separate combustion chambers adapted to heat the other compartment and disposed adjacent to the other half of its length.

8. A continuous tunnel kiln of the muffle type comprising two adjacent heating compartments, and means for heating each of the two compartments from a plurality of separate sources giving well defined zones of heat.

9. A continuous tunnel kiln of the muffle type comprising two adjacent heating compartments, and means for heating each of the said compartments from a plurality of separate sources, all of the sources of heat for each compartment being disposed opposite to one-half of the length of the said compartment.

10. A continuous tunnel kiln of the muffle type comprising two adjacent heating compartments, and means for heating each of the said compartments from a plurality of separate sources, all of the sources of heat for each compartment being disposed opposite to one-half of the length of the said compartment, and the heat sources for the two compartments being distributed on opposite sides of the center of the kiln.

11. A heat treating furnace comprising a heating chamber, heating flues formed in the side walls of said furnace, a longitudinal partition wall dividing the said chamber into two compartments, the said partition having openings for establishing communication between the said compartments, and a plurality of sources of heat on each side of the said furnace, all of the said sources of heat at one side of the furnace being in communication with the said heating flues in the adjacent end of the said furnace.

In testimony whereof, I the said CHARLES J. KIRK, have hereunto set my hand.

CHARLES J. KIRK.

Witnesses:
MONT L. AILEY,
E. E. WHITTAKER.