W. G. DE STEIGNER.

CONTINUOUS KILN.

APPLICATION FILED JUNE 2, 1920.

1,407,192.

Patented Feb. 21, 1922.

2 SHEETS—SHEET 1.

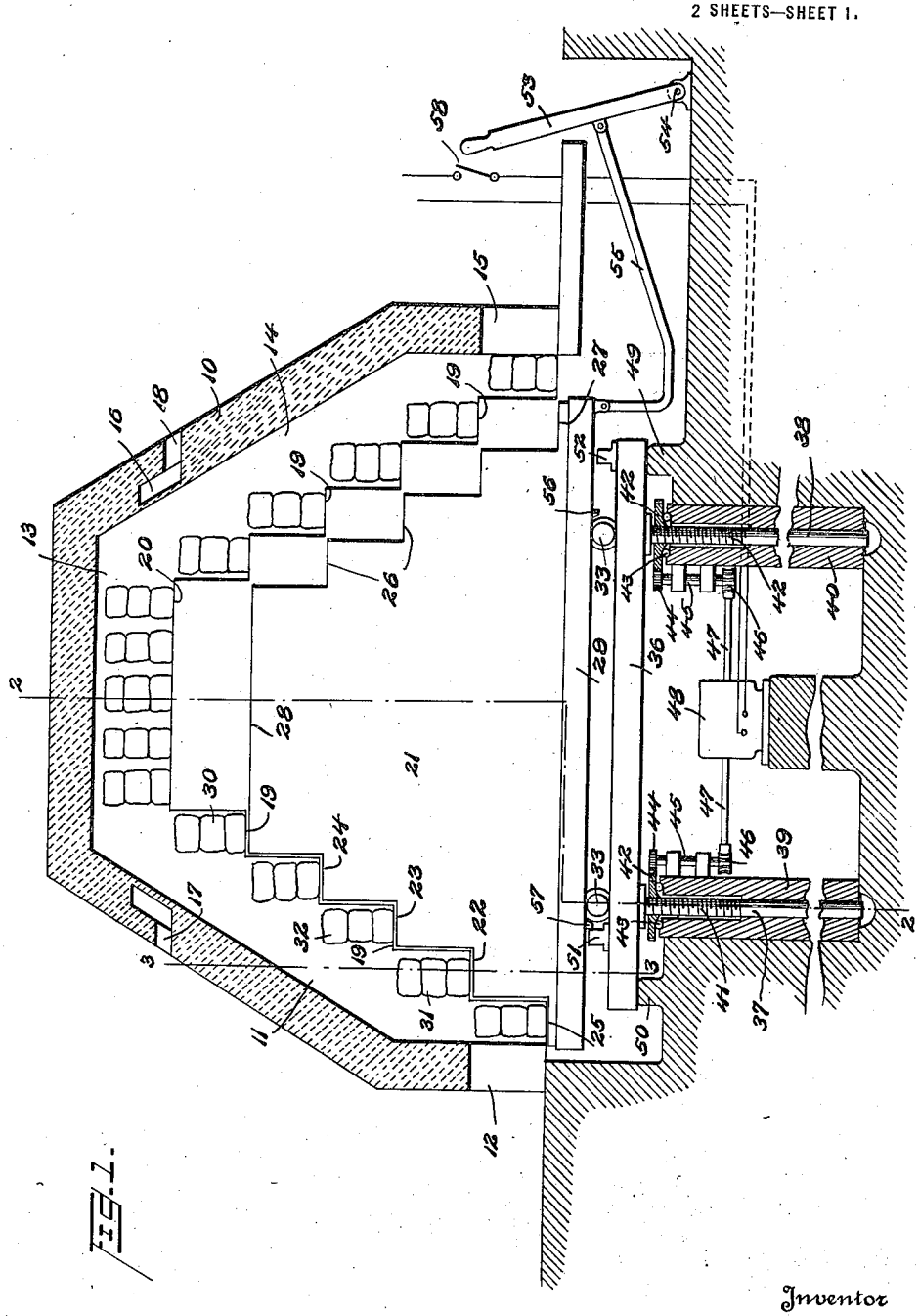


FIG. 1.

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FIG. 2.

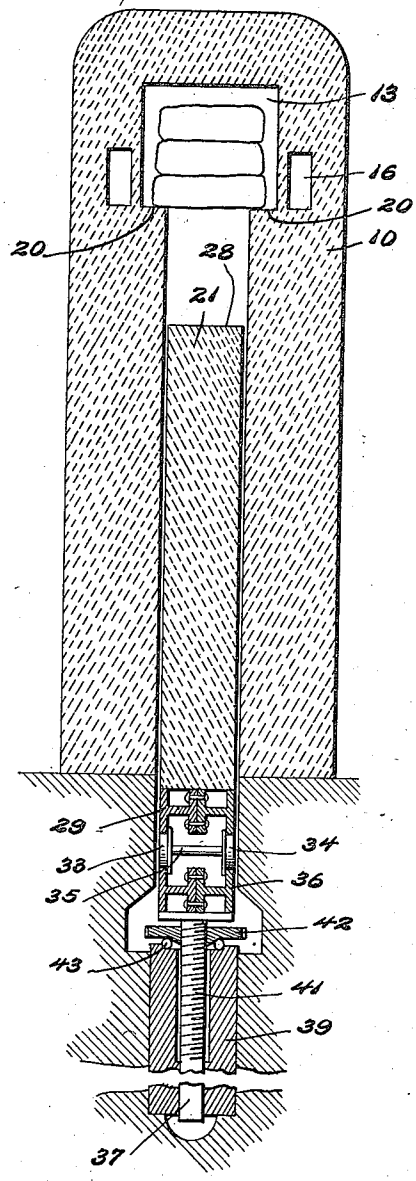
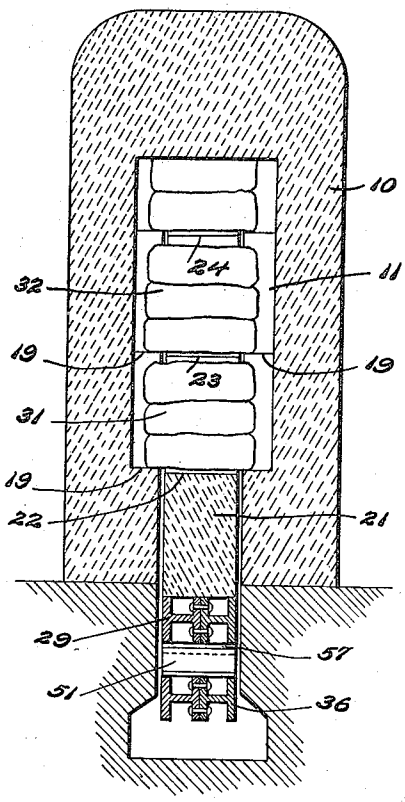


FIG. 3.



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UNITED STATES PATENT OFFICE.

WALTER G. DE STEIGNER, OF SAN DIEGO, CALIFORNIA.

CONTINUOUS KILN.

1,407,192. Specification of Letters Patent. Patented Feb. 21, 1922.

Application filed June 2, 1920. Serial No. 385,964.

To all whom it may concern:

Be it known that I, WALTER G. DE STEIGNER, a citizen of the United States, and residing at San Diego, San Diego County, State of California, have invented certain new and useful Improvements in Continuous Kilns, of which the following is a specification.

This invention relates to a kiln for baking clay products, and particularly to that type of kiln known as the continuous kiln, in which the wares to be baked pass into, through and out of the kiln without interruption of the firing process. It constitutes an improvement on and embodies many of the novel features broadly covered in my prior application, Serial No. 68,565, filed December 24, 1915, and which was allowed March 26, 1919. As stated in my prior application it has been found very difficult to secure satisfactory results in firing the ware or clay products as a continuous process by any previously known means or system and while the continuous system has many obvious advantages over the intermittent system and if it can be used with proper facility and satisfactory results, the difficulties encountered have interfered with the successful commercial use of the continuous system heretofore. The present invention is designed to avoid those difficulties heretofore encountered and to provide means for easily handling the articles to be treated and for easily passing them through the heating zone in succession with easily regulated timing while at the same time providing a very simple and effective means for regulating and maintaining the proper temperature in the succeeding zones through which the articles are passed to secure the best results and uniformity in the product. My invention enables me to accurately secure that gradual heating of the ware to the point of maturity followed by gradually cooling down to normal temperature which is the ideal sought to be obtained in practice and which it has heretofore been found so difficult to secure in a continuous system. As set forth in my earlier application, I secure the proper temperature in the succeeding portions of the kiln or muffle through which the articles are passed by so forming and elongating the passageway, muffle or chamber through which the articles pass, that it is at a higher level at all points between its inlet end and its outlet end than at those ends so that its bottom wall is above the inlet and outlet practically throughout its length, and is highest along its center portion where the heat is applied. The result of this is to practically trap the hot air and gases in the upper central portion while it is gradually and progressively cooler down the symmetrical inlet and outlet portions and thus the articles as they pass through the kiln are gradually heated and after reaching maturity in the hottest part at the top central portion, are gradually cooled as they descend to the outlet. While I have shown one specific novel form of kiln or structural arrangement by which this operation may be brought about and in which the passageway has straight sides and inclined ends, it will be understood that the particular form of mechanism may be varied within wide limits so long as it includes those fundamental features of construction broadly stated in some of the following claims producing the operation and that the terms used therein are therefore not intended to have a narrow or limited construction. My invention furthermore includes novel means for passing the articles to be treated through the passageway and successive zones of heat. It is easily operated from a single point by unitary mechanism. The articles or carriers containing the articles to be heated are placed one at a time on a movable support at the entrance end of the passageway or muffle and then by means controlled by the operator standing by the kiln at the end of the muffle, that article is moved upward one step in the muffle and each article ahead of it in the series is moved forward one step towards the outlet and if the muffle is at that time full the last article or carrier in the series is discharged in finished condition at the other end of the muffle. The articles being treated are not connected to or in contact with each other in their travel through the kiln nor are they connected to the supporting and carrying means but merely rest thereon by gravity. It is not necessary that the articles being treated shall be in containers or carriers, but it is only necessary that the lower supporting surface of the article or carrier shall be of such size and shape as to be engaged and held up by the supporting means and carrying means hereinafter described, and that the articles

shall not be too large to pass through the passageway. As above indicated a single cycle of movement of the conveying means causes all of the articles to move forward separately one step and maintains them in proper order and sequence without disarrangement. The conveying mechanism furthermore can be easily and quickly operated with absolute certainty at the moment desired and is so simple in construction that the chances of getting out of order are reduced to a minimum. In its specific form the means for moving the articles includes a single central longitudinally extending member or vane in the bottom of the elongated muffle which is movable vertically and horizontally in moving the articles. Other novel features of the invention will be apparent from the following description and the accompanying claims.

In the drawings:

Figure 1 is a section through a kiln longitudinally of the modification embodying my invention;

Figure 2 is a vertical section on the line 2—2 of Figure 1;

Figure 3 is a vertical section on the line 3—3.

In the particular form of kiln shown in the drawings for the purpose of illustration the main body 10 of the kiln is of course made of refractory material with the side portions parallel and the ends inclined or tapered as shown. Within the outer wall there is a muffle, passageway or system of connecting shafts for the articles to be heated having an inclined portion 11 extending forwardly at an angle from the inlet end 12 to a top horizontal portion 13 and a downwardly extending portion 14 leading to the outlet 15 at the other end of the kiln. The portions 11 and 14 are preferably inclined towards each other at corresponding angles. It will be observed that in this construction all portions of the muffle between its inlet and outlet ends are above the inlet and outlet and in the form shown heat is applied to the kiln at the upper portion by means of a surrounding chamber 16 opposite the upper central portion 13 of the muffle and it will be understood that combustion may be produced in this chamber by means of a hydrocarbon burner, for instance, at the inlet end 17 and the products of combustion after passing around the kiln through the chamber or passageway 16 may escape at 18 to any suitable stack or conveyor. It should be noted in this connection, however, that while I have shown means for heating the central upper portion of the muffle separate from and not in communication with the muffle, my invention is not in any sense limited to this particular method of heating since the essential point is merely that the heat shall be applied to that portion of the muffle along the center which is elevated above the inlet and the outlet. The passageways 11, 13 and 14 are entirely closed at their tops and sides but there is a bottom opening extending along all of these portions of the muffle in line and that opening has parallel sides from one end to the other and is of less width than the muffle chamber itself and is centrally arranged. The bottom wall of the muffle or passageway at the sides of the central longitudinal bottom opening are formed in the upwardly extending portion 11 and in the downwardly extending portion 14 in the form of ledges 19 at the sides in step formation, while the bottom along the central portion 13 of the muffle is in the form of horizontal ledges 20 at the sides serving as supports for the articles or packages being treated. It will be observed by reference to Figure 1 that in the particular form shown there are four steps formed by the ledges in the upwardly inclined portion 11 and in the downwardly inclined portion 14 aside from the horizontal top ledge 20. These ledges where in step formation in the portions 11 and 14 are to support the articles to be treated and as will be seen they have straight sided vertical connections and are of such width as determined upon in reference to the particular type of article to be treated. Each step is made of such size as to properly receive and support a single article or carrier but it will be understood that there are always a number of articles or carriers side by side but separated on the ledges 20 in the upper middle portion 13.

Within the central longitudinal bottom opening in the muffle I place a member or vane 21 which is movable vertically and horizontally and which is composed of refractory fire-proof material forming in reality the bottom wall at the center of the muffle. This central member or vane has its upper surface at the ends inclined at substantially the same angle as the portions 11 and 14 of the muffle and these inclined end portions are made in step formation including steps 22, 23 and 24 and a bottom step 25 on the inlet side next to the portion 11. These steps are of corresponding depth, width and arrangement in vertical section as the steps in the main body of the kiln formed by the side ledges in the portion 11. A similar step arrangement is formed on the other end of the member 21 to match the steps formed in the side walls of the portion 14 by the ledges heretofore mentioned. In other words, the step formation of the outlet side of the member 21 includes the steps 26 above the bottom support 27 corresponding exactly to those heretofore mentioned on the inlet side. The upper end 28 of the member 21 is horizontal but it will be noted it is longer than the horizontal ledges 20 in the main body of the kiln by the length of one step.

The central member or vane 21 is mounted on a suitable support 29 which may be in the form of steel I beams and this support, together with the central member or vane 21 is movable longitudinally of the muffle and vertically and means are provided for giving it both motions. In normal position the steps 22, 23 and 24 on the inlet side and the corresponding steps in the outlet side are slightly below the corresponding ledge steps on the sides of the muffle and the top 28 is slightly more than the height of one step below the ledges 20 along the top of the muffle. In normal position furthermore the member 21 is in the position shown in Figure 1 with its bottom support 25 ready to receive the article inserted in the inlet opening 12 and its succeeding steps directly underneath the corresponding steps formed by the side ledges on the bottom of the portion 11 and thus directly underneath any articles resting on those ledges with the exception of the top article 30 resting on the top step formed by the ledges and the top 28 of the member 21 is directly beneath this article. It will be observed from Figure 1 that at this time the steps 26 and 27 are slightly more than one step below the articles directly above them carried by the ledge steps in the downwardly extending portion 14 of the muffle, and the top 28 is slightly more than one step below the articles carried by the horizontal ledges 20. A vertical movement of the member 21 therefore for a distance slightly more than the height of a step will engage and lift all of the articles on the side ledges in the portion 11 a distance slightly greater than the height of one step and during the very last part of this upward movement all of these articles on the horizontal ledges 20, and on the ledge steps in the downwardly extending portion 14, will be engaged and slightly lifted from their seats. If then the member 21 is moved a distance equal to the width of a single step to the right in Figure 1 it will during that movement carry all of the articles on the steps on both sides and along the top entirely disconnected from the kiln proper or the supporting ledges of the kiln. The result of this will be, for instance, to carry the article 31 from its fixed supporting ledge up to the position of article 32 and will at the same time move the successive articles in the horizontal portion 13 one step to the right and will move the articles on the ledges of the downwardly extending portion 14 over to a position above the next lower step in the series. If the member 21 is then lowered slightly more than the height of a step all of the articles of the inlet portion 11 are deposited on the ledge steps one step in advance of where they had been and those articles on the horizontal portion are moved forward one step and those on the ledges in the portion 14 are moved downward one step leaving the last article on the bottom ledge 27 finished and ready for removal.

According to my invention the central member, vane, or carrier 21 may be given its vertical and horizontal movement by any suitable means and my invention in its broader aspects is not limited to any particular structural arrangement for operating it, but in the drawings I have shown a structure which may be used for this purpose. As above stated the member 21 of refractory material may be mounted on the steel I-beams 29 to rigidly support it and these I-beams may be mounted on rollers or flanged wheels 33 and 34 connected by a shaft 35 travelling along the edges of the beams as tracks. These rollers may also travel on the edges of supporting I-beams 36 mounted on and secured to the upper ends of the steel posts or supports 37, 38 and it will of course be understood that these steel supports 36 are immediately below and parallel to the I-beams 29. The posts 37 and 38 move vertically in and are securely held by the steel casings 39, 40, and are screw threaded at 41 on their upper portions to engage screw threads on the enlarged circular nuts 42 which nuts are supported by the ball bearings 43, resting on the tops of the casings 39, 40. These nuts 42 may be turned on the posts 37 and 38 in order to elevate the support 36 and their outer edges are made to form gear teeth which engage corresponding gear teeth 44 on the vertical shaft 45 which in turn has on its lower end a gear 46 engaging a worm gear on the end of the shaft 47 driven from a motor 48. I have described the connection from the motor to one of the posts but it will be understood as seen by reference to Figure 1 that there is a similar connection to the other post and that both operate simultaneously and to the same extent when the motor is energized to raise or lower the member 21 and its supporting mechanism. The motor 48 may be an electrical motor or a motor of any kind. It will, of course, be understood that the turning of the nuts 42 will raise the posts 37 and 38 and the platform 36 on which the central vane or member 21 and its supporting member 29 are mounted so as to raise the central support. Stops 49, 50 may be arranged under the ends of the I-beam supporting member 36 so as to limit the downward movement of the parts and it will of course be understood that the motor is reversible so as to turn the nuts 42 in either direction to raise or lower the member 21 and that it may be provided with any suitable automatic means for stopping its operation when the member 21 reaches the desired limit of its movement up and down. Such mechanism will of course be understood by those skilled in the art and a specific description is not

necessary. Fixed stops 51 and 52 may be placed on the vertically movable supporting part 36 so as to limit the longitudinal movement of the supporting beams 29 and the member 21 carried by them. For this purpose there are downwardly projecting lugs 56, 57 secured to the I-beams 29 of the support in the longitudinal path of the projections 51, 52, properly positioned so as to bring the support to a stop in exactly the right position for receiving an article at the inlet end or for discharging an article at the outlet. Longitudinal movement may be imparted to the supporting I-beams 29 and the member 21 by any suitable means and in Figure 1 I have shown a hand lever 53 pivoted at 54 connected by a suitable link connection 55 to the I-beams 29 so as to permit hand operation in moving the member 21 horizontally. In case of the use of an electric motor 48 the operator may of course control the action of the motor from his position at the outlet end 15 of the kiln by simply operating a switch 58.

For convenience of illustration the articles shown in the drawings as being on the ledges, such as 30, 31, and 32, are represented as what are known as saggers, such as are used in the manufacture of glazed tile, but it will be understood practically any form of container may be used and passed through the device so long as it lies within certain simple limits as to size, not being longer than the steps of the muffle or higher than the length of a step and having sufficient breadth to rest on the two side ledges formed at the bottom of the muffle. In fact wares or any articles within proper size limits of suitable character may be treated in this device without placing them in a carrier or container. While I have shown my central vane or member conveying the articles up one incline along the level top and down another incline by step movement, it will of course be understood that in its broader aspect this means of conveying the articles through the flue of a continuous type of kiln, is not limited to any particular from or shape of muffle or passageway through which the articles are passed and in which they are heated since the broad principles are applicable to many types of kiln. It will further be noted that the vertical and horizontal movements of my conveyor may take place successively or simultaneously and may be regulated and controlled to suit the particular purpose.

It is believed that the operation of the device will be understood from the structure above described. Assuming however that the kiln is filled with ware as it will be in the continuous use, the central carrying vane or member 21 is moved to the position shown in Figure 1 with the stops 51, 57 in contact and the lower ledge or step 25 in position to receive a new article through the inlet opening 12. The motor 48 is then started and through the drive connection turns the nuts 42 so as to elevate the supporting beams 36 together with the beams 29 and the vane 21 and this upward movement is continued until the central carrying member 21 has been raised slightly more than the height of the step as heretofore described thus lifting all articles on those steps on the left-hand side of Figure 1 a distance slightly more than the height of a step, and then lifting all of the other articles in the kiln from their seats. It will of course be understood that this is accomplished by reason of the fact that the member 21 extends under the central portions of each article as illustrated in Figure 3 and when it is raised it naturally raises the article with it from the seat on the side flanges of the kiln member. At the upper limit of the movement just described the motor is preferably stopped automatically and then the operator by a pull on the hand lever 53 may move the carrier 29 travelling on the supporting freely moving wheels 33 and 34 to the right, as shown in Figure 1, until the stop 56 comes in contact with the projections 52. This moves each and every article in the kiln one step to the right in Figure 1 while they are held up entirely out of contact with anything except the carrying member 21. The motor is then started in the reverse direction to lower the supporting platform 36 and the central vane 21 and this lowering motion is continued until the member 21 reaches the same level as that before it was raised and this may be fixed by the supporting stops 49, 50. The result of this is to deposit each of the articles on the ascending side of the next succeeding step and to transfer those articles on the horizontal top portion a distance to the right equal to the width of one step and to transfer each of the articles on the descending side one step forward although the last article in the series is placed in position to be removed through the exit opening 15. It will be noted that in this cycle of operations all of the articles are picked up and moved forward one step toward the exit through the heating muffle and that this is done smoothly and without jar or shock. The articles being treated may be fed to the kiln at the entrance side 12 and removed from it at the outlet side 15 by hand or by the use of any suitable means such as trucks. The cycle of operations just described on introducing one new article is of course repeated at suitable intervals allowing proper timing for the necessary heating and thus the kiln in reality acts continuously, one article following another through it at proper intervals.

While the heating chamber may be described as having open ends because of the permanent inlet 12 at one end and the per-

manent outlet 15 at the other end formed in the wall of the furnace, it is to be understood that those open ends may be temporarily closed by a door or other movable closure during operation when no article is being inserted or removed so as to conserve heat.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. The combination in a continuous kiln having a substantially horizontal middle portion and downwardly directed end portions, of means for moving a series of mechanically unconnected and separated articles to be treated by intermittent successive steps up one end portion across the middle portion and down the other end portion, and means for independently supporting said separated articles during the interval between stepped movements.

2. The combination in a continuous kiln having a substantially horizontal middle portion and downwardly directed end portions, fixed supports in said end portions and across said middle portion of the kiln for a series of separated mechanically unconnected articles to be treated so formed and arranged in said end portions as to support the articles therein in vertically stepped relation slightly greater than the height of the articles, and movable means for lifting the articles from their supports and transferring them to the next supports in the series.

3. In a kiln of the continuous type adapted to receive articles to be treated, means for supporting the articles therein motionless in series separated vertically and horizontally from and unconnected with each other, and means for moving said articles vertically and horizontally in said kiln to successive positions on said supporting means.

4. In a kiln of the continuous type adapted to receive articles to be treated at one end and discharge them at the other end, means constituting a fixed part of said kiln for supporting the articles therein in series separated vertically and horizontally from and unconnected with each other, and means constituting a movable part of said kiln for intermittently lifting said articles and moving them vertically and horizontally step by step from the inlet to the outlet.

5. A continuous kiln comprising a system of shafts forming a continuous passageway for wares, the central portion of said system being raised above the end portions, means for heating said central portion, and means for moving a series of unconnected articles to be treated through said system in succession so constructed as to maintain the surfaces of said articles in the same angular relation to horizontal planes throughout their passage through the kiln.

6. In a kiln of the continuous type having an elongated heating chamber open at its ends with its center portion elevated above said ends, means for supporting a series of articles separate from and independent of each other within said chamber, and means for lifting said articles and moving them forward through said chamber step by step.

7. In a kiln of the continuous type having an elongated heating chamber in shaft form through which a series of separate articles to be treated may pass, its midway portion including its bottom wall being materially elevated above its entrance and outlet, of movable means extending along the bottom of said chamber, and means for moving said longitudinally extending means vertically and horizontally to move said articles.

8. In a kiln of the continuous type having an elongated heating chamber open at its ends with its center portion including its bottom wall materially elevated above said ends, stationary means for supporting a series of articles separate from and independent of each other within said chamber from end to end at different elevations, and means along the bottom of said chamber movable vertically to engage and lift said articles and movable longitudinally to carry them forward along the chamber.

9. In a kiln of the continuous type having an elongated heating chamber open at its ends with its center portion including its bottom wall materially elevated above said ends, stationary means constituting part of the fixed structure within said chamber furnishing a series of horizontal supporting sections at different elevations along the bottom to receive in succession and support a series of separate articles to be treated, and means operating from below to transport said articles from those supporting sections on which they rest to the next in the series.

10. In a kiln of the continuous type having an elongated heating chamber open at its ends with its center portion elevated above said ends, stationary means including supporting sections in stepped relation throughout the length of said chamber to receive and support separately a series of separate articles, and means for moving said articles successively step by step from the supporting sections on which they rest to the next in the series through the chamber.

11. In a kiln of the continuous type having an elongated heating chamber open at its ends with its center portion elevated above said ends, stationary means including supporting sections in stepped relation throughout the length of said chamber to receive and support separately a series of separate articles, and means for simultaneously moving all of said articles forward through the chamber step by step on the successive supporting sections.

12. The combination in a continuous kiln having a substantially horizontal middle portion and downwardly directed end portions, of a series of mechanically unconnected articles to be treated, means for raising said articles through one of said end portions while holding them upright, means for lowering said articles through the other of said end portions while still held upright, and means for advancing said articles along the middle portion while holding them upright.

13. A continuous kiln comprising a system of shafts forming a continuous passageway for articles to be treated therein, the central portion of said system from the inlet to the exit being raised above the level of the inlet and exit, and means for heating said central portion, and means for moving a plurality of unconnected articles to be treated in series through said system.

14. The combination in a continuous kiln including a continuous elongated chamber or passageway for articles to be heated having in its bottom a straight-sided central longitudinal opening of uniform breadth from end to end the inlet and outlet ends of said passageway extending upwardly and inwardly at corresponding angles towards each other and the upper connecting central portion being horizontal, means horizontally disposed along the margin of said central opening for supporting in upright position and spaced longitudinally from each other a series of separate articles from one end of the passageway to the other, the supporting means on the inclined end portions having a stepped formation, and means within said central opening for moving the articles step by step up the entrance portion across the horizontal central portion and down the outlet portion.

15. The combination in a continuous kiln including a continuous elongated chamber or passageway for articles to be heated having in its bottom a straight-sided central longitudinal opening of uniform breadth from end to end the inlet and outlet ends of said passageway extending upwardly and inwardly at corresponding angles towards each other and the upper connecting central portion being horizontal, means horizontally disposed along the margin of said central opening for supporting in upright position and spaced longitudinally from each other a series of separate articles from one end of the passageway to the other, the supporting means on the inclined end portions having a stepped formation and means within said central opening for simultaneously moving all of the articles in the series one step at a time forward through the passageway from the inlet to the outlet.

16. The combination in a continuous kiln including a continuous elongated chamber or passageway for articles to be heated having in its bottom a straight-sided central longitudinal opening of uniform breadth from end to end, the inlet and outlet ends of said passageway extending upwardly and inwardly at corresponding angles towards each other and the upper connecting central portion being horizontal, means horizontally disposed along the margin of said central opening for supporting in upright position and spaced longitudinally from each other a series of separate articles from one end of the passageway to the other the supporting means on the inclined end portions having a stepped formation, a central bottom member fitting said central bottom opening in said passageway movable vertically and longitudinally therein, its upper surface having inclined end portions in stepped formation corresponding to the incline of the end portions of said passageway and to the stepped formation of the supporting means therein but having a horizontal central top portion one step longer than the central horizontal supporting means, means for moving said bottom member to position with its stepped upper surface on the inlet side of the passageway slightly below the stepped supports and the articles carried thereby and with its horizontal central top portion slightly more than one step below the central horizontal supporting means, means for elevating the central member slightly more than the height of a step and moving it forward the width of a step and then lowering it slightly more than the height of a step, whereby the articles on the entrance side will all be lifted and moved forward one step, those on the central support will be slightly lifted and moved forward one step, and those in the outlet portion will be lifted slightly and moved forward and downward one step.

17. In a kiln of the continuous type having an elongated heating chamber open at its ends with its center portion elevated above said ends, means for moving a series of articles to be treated through said chamber including a vertically and horizontally movable member along the bottom thereof.

18. A continuous kiln comprising a muffle or hot chamber, means for so heating it as to cause it to be progressively hotter from its lower portion to its upper portion or top, means for admitting and discharging articles at a level materially below the top and means for intermittently moving a series of admitted articles step by step from said point of entrance upwardly through a progressively hotter portion and then downwardly through a progressively cooler portion to the point of discharge.

19. A continuous kiln comprising a muffle or hot chamber, means for so heating it as to cause it to be progressively hotter from its lower portion to its upper portion or top, means

for admitting and discharging articles at a level materially below the top and means for moving a plurality of unconnected articles in series from said point of entrance upwardly through a progressively hotter portion and then downwardly through a progressively cooler portion to the point of discharge, said moving means being so constructed as to maintain the surfaces of said articles in the same angular relation to horizontal planes throughout their passage through the kiln.

20. A kiln comprising a muffle or hot chamber provided with means for admitting and discharging articles materially below its roof or crown, means for so heating said kiln as to cause the temperature in said chamber to vary from high heat at the top below the crown to comparative coolness at the level at which articles are admitted and discharged, and means including fixed and movable portions of the kiln for successively moving step by step a series of articles as they enter up into the highly heated portion and then down to the discharge.

21. The combination with a chamber adapted to receive articles to be treated provided with an entrance and exit for articles, of fixed horizontal supports for articles in symmetrical successive stepped arrangement in series extending upwardly from said entrance to the upper portion of said chamber and then downwardly to the exit, movable lifting means having upper horizontal portions corresponding in stepped arrangement with said fixed supports arranged in vertical planes within the margins of said supports and adapted to act as supports for said articles, but normally resting with its horizontal supporting portions a distance below the fixed supports slightly greater than the height of a step, means for moving said lifting means horizontally towards said entrance until its horizonal step portions on the entrance side are under and slightly below the fixed supports on that side which are next below those in the series with which they correspond, for then moving said lifting means vertically a distance slightly greater than the height of a step, for then moving it horizontally towards the exit a distance equal to the width of a step portion and for then lowering it a distance slightly greater than the height of a step.

22. A kiln comprising a muffle so formed as to furnish a passageway through which articles to be treated may pass from their entrance to their discharge and having its bottom wall upwardly inclined from the entrance and discharge with its central portion at a materially higher level, means for so heating said kiln that the temperature in said passageway will gradually increase from the entrance to the highest point and gradually decrease to the discharge, and means for intermittently moving articles to be treated in said passageway step by step up to and through the zone of highest heat to gradually bring them to the desired temperature and then down step by step to the point of discharge gradually cooling them.

23. A kiln comprising a muffle so formed as to furnish a passageway through which the articles to be treated may pass in succession from their entrance to their discharge, the bottom or floor of that portion of the passageway at approximately the midway point of travel being a fixed material distance above the level at which the articles enter and are discharged, means for heating that elevated or midway portion whereby its temperature will be highest, and means for supporting and intermittently lifting and moving horizontally and vertically step by step a series of articles to pass them in succession through said passageway.

In testimony whereof I affix my signature.

WALTER G. DE STEIGNER.