Feb. 11, 1930. M. E. GATES 1,747,067

HEAT TREATING FURNACE

Filed Oct. 6, 1926 3 Sheets-Sheet 1

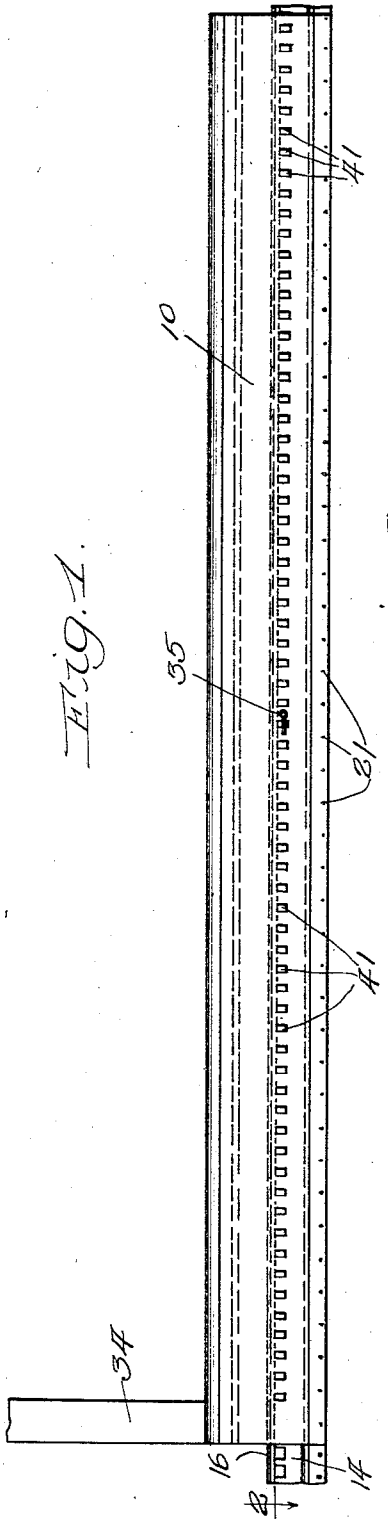

Fig. 1.

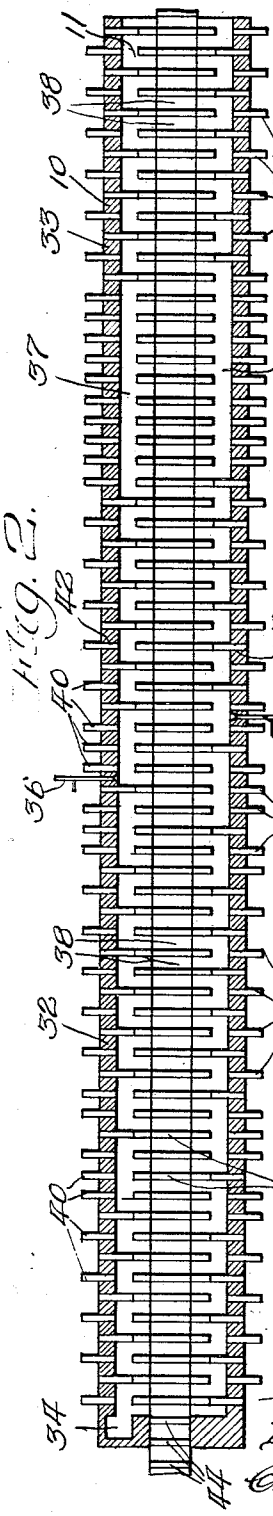

Fig. 2.

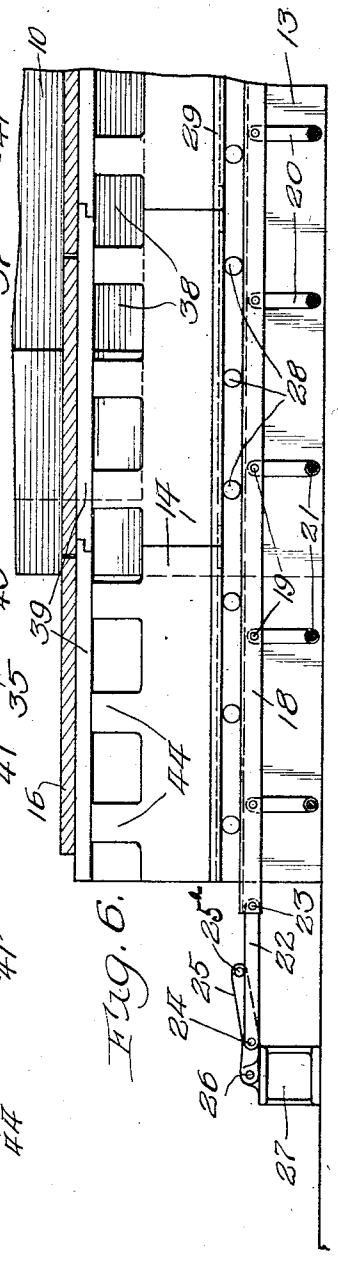

Fig. 6.

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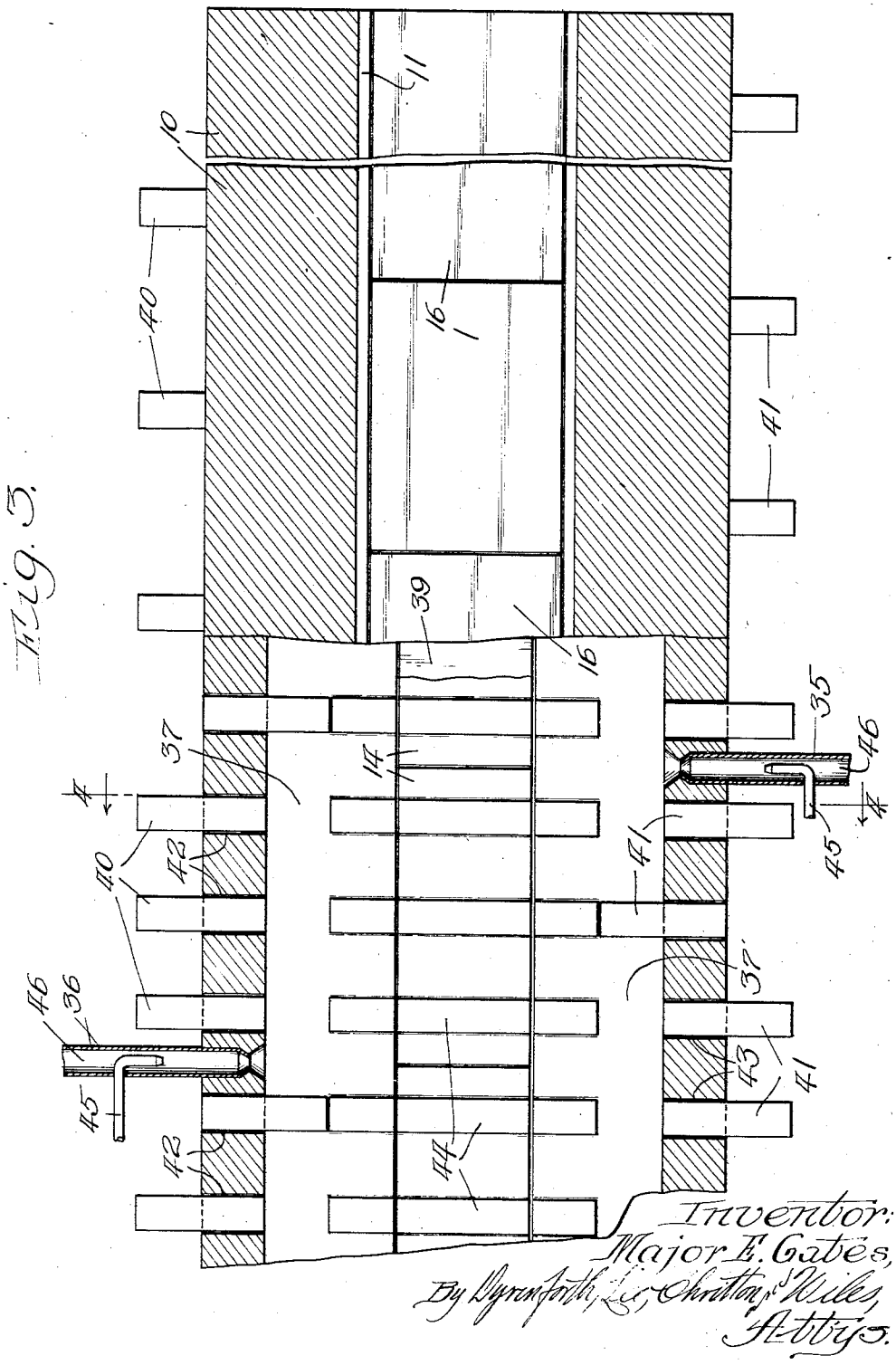

Fig. 5.

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Fig. 4.

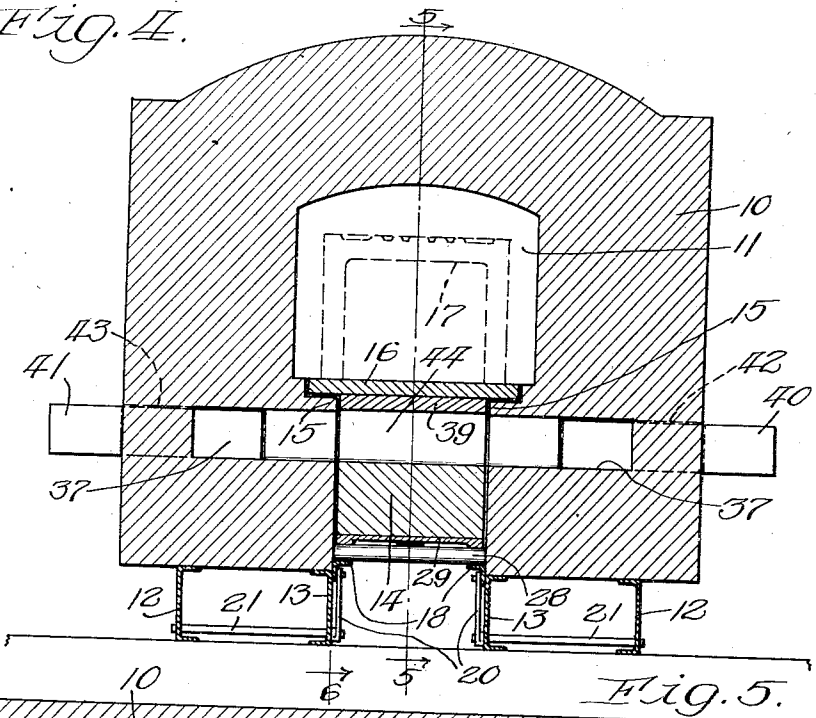
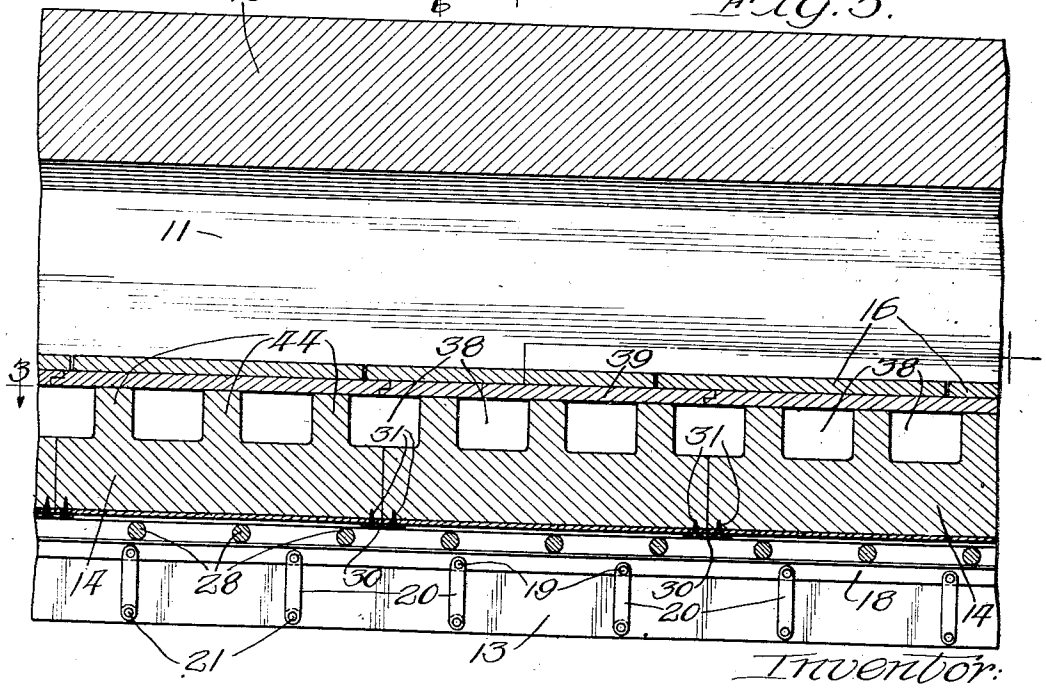


Fig. 5.



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HEAT-TREATING FURNACE

Application filed October 6, 1926. Serial No. 139,870.

My invention relates, more particularly, to furnaces for the heat-treating of articles, in general, as for example terra cotta to properly bake them to present the desired hardness and finish, and more especially to such furnaces of the so-called tunnel type involving the treatment of articles successively introduced into one end of the furnace and successively withdrawn from the other end.

My primary objects are to provide improvements in furnaces of the type stated to the end that a better, more uniformly treated, product may be produced and much more quickly than hitherto possible and with the minimum fuel consumption and by a furnace of the minimum length.

Referring to the accompanying drawings:—

Figure 1 is a view in side elevation, with certain of the end portions thereof broken away, of a heat-treating furnace constructed in accordance with my invention. Figure 2 is a plan sectional view, somewhat in the nature of a diagram taken through the furnace at such a plane as to show the various fuel passages and cooling-medium passages of the furnace. Figure 3 is a broken plan sectional view of the furnace, the section being taken at the irregular line 3—3 on Fig. 5 and viewed in the direction of the arrows. Figure 4 is a cross sectional view of the furnace, the section being taken at the line 4—4 on Fig. 3 and viewed in the direction of the arrows. Figure 5 is a broken view in longitudinal sectional elevation of the furnace, the section being taken at the line 5—5 on Fig. 4 and viewed in the direction of the arrow; and Figure 6, a broken view in longitudinal sectional elevation of the heating-end of the furnace, the section being taken at the line 6 on Fig. 4 and viewed in the direction of the arrow.

The body portion of the furnace which is represented generally at 10, and may be made primarily from refractory material of any desirable kind, as for example fire-brick, is built to provide a tunnel passage 11 extending throughout its length and through which the articles to be heat-treated are passed, the brick work of the body 10 being shown as supported on channel-beams 12 and 13 extending substantially parallel with each other and lengthwise of the furnace.

The bottom of the furnace is formed throughout its length of a section, represented at 14, which is movable lengthwise of the tunnel passage 11 and is adapted to be raised and lowered, as desired.

In the particular construction shown the bottom surface of the tunnel passage 11 is wider than the movable bottom portion 14, which latter is shown as located midway between the side edges of said bottom portion, whereby ledges, or seating portions, 15 are provided at opposite sides of the bottom portion 14, these ledges being superposed by slabs 16 of material highly conductive of heat, as for example carborundum, and upon which the articles, as for example tile to be treated, one of which is represented at 17, are supported.

It may be here stated that the bottom portion 14 of the furnace, which is also constructed of any suitable refractory material, is adapted to be raised and lowered and moved in a direction lengthwise of the tunnel passage 11, as stated, for the purpose of lifting the slabs 16 out of seating contact with the ledges 15 and thereafter moving these slabs, with the articles thereon, lengthwise of the furnace any desired distance, by lengthwise movement of the bottom portion 14, the latter, upon being lowered out of a position in which it supports the slabs 16, being movable lengthwise of the furnace to any desired position, while the slabs 16 and articles 17 remain in the position to which they are advanced as above stated. It will thus be understood that the bottom portion 14 while serving as a means whereby the articles may be advanced as desired through the tunnel-passage, may be caused to remain in the furnace at all times thereby conserving, to the maximum, the heat in the furnace, and also enhancing the effectiveness of the cooling medium.

The means shown for raising and lowering the bottom portion 14 comprise a pair of parallel angle-irons 18 located immediately below the bottom portion 14 and pivotally connected at 19 with the upper ends of horizontal series of links 20 pivoted at their lower

ends to axles 21, which connect together, at intervals, the pairs of channel-irons 12 and 13. The angle bars 18 connect with any suitable means for shifting them lengthwise to raise and lower them by reason of their link connection with the shafts 21, the means shown comprising a toggle mechanism for each of these bars each mechanism comprising a link 22 pivoted at 23 to the adjacent angle bar 18 and at its opposite end, as indicated at 24, to a rock lever 25 between the ends of the latter, the lever 25 being pivotally connected at 26 to a base member 27. In the position of the toggle mechanism shown in Fig. 6 the angle bars 18 are in raised position and are locked in this position against accidental displacement by reason of the location of the pivot 24 slightly below the plane of the pivots 23 and 26, a pin 25^a on the free end of the lever 25 bearing against the upper edge of the link 22 limiting the downward swinging of the latter. To lower the bars 18 the operator swings the lever 25 to the left in Fig. 6 thereby shifting the bars 18 to the left in this figure in which operation they lower because of their connection with the links 20.

Interposed between the angle bars 18 and the bottom portion 14 is a series of rolls 28 upon which the bottom portion 14 is supported adapting the latter to be moved along the angle bars 18 with relative ease and without undue wear of the parts, it being preferred that the bottom portion 14 be formed of metal plates 29 at which it rests upon these rollers. The construction and arrangement of the parts just described is such that when the angle bars 18 occupy the raised position shown in the drawings the slabs 16, carrying the articles 17, will be supported wholly on the bottom portion 14 and extend vertically spaced from the seating surfaces 15 of the furnace, whereby movement of the bottom portion 14 along the angle bars 18 carries the slabs 16 and the articles 17 along with it; and when the angle bars 18 are swung to lowered position, the bottom portion 14 will be lowered sufficiently to be withdrawn from contact with the slabs 16 which latter then rest upon the seating surfaces 15, permitting of the movement of the bottom portion 14 lengthwise of the furnace as desired.

In the particular arrangement shown the bottom portion 14 is formed of a longitudinal series of sections as illustrated in Figs. 3, 5 and 6, these sections being joined together by connecting plates 30 which are connected with the adjacent ends of the several sections, as by the screws represented at 31.

The furnace shown is provided with a heating zone 32 and a cooling zone 33 through which the articles to be treated are successively moved, the heat for heating the zone 32 being introduced into the furnace structure at a point substantially midway between the ends of the furnace, namely, at one end of the heating zone 32, the other end thereof being provided with a stack 34 through which the products of combustion resulting from the operation of the heating means are exhausted. The heating means, but which merely represent one type of means which may be employed, are of the fuel oil, or gas, type it being preferred that two burners represented at 35 and 36 be provided one at each side of the furnace.

According to one feature of my invention the heat for treating the articles is introduced into the bottom portion of the furnace, and to secure the desired distribution of the heat throughout the length of the heating zone 32 provision is made for causing the heating medium to traverse the heating zone in a more or less tortuous path, under the control of the attendant.

In accordance with another feature of my invention the cooling medium for cooling the articles in the cooling zone 33 after they have passed out of the heating zone 32, is introduced into the bottom of the furnace, the cooling zone 33 being likewise provided with passages so arranged that the cooling medium is caused to traverse a more or less tortuous path, under the control of the attendant.

In the particular construction illustrated those portions of the bottom of the furnace and which extend at opposite sides of the movable bottom-portion 14 contain passages 37 extending lengthwise of the furnace, these passages being open to the atmosphere at the outer end of the cooling zone 33, namely, at the right-hand end of the furnace in Figs. 1 and 2, with their opposite ends closed except for communication with the flue 34; and the bottom portion 14 is provided at intervals with passages 38 extending crosswise thereof and shown as spaced apart equal distances through the length of the movable bottom portion 14, the upper walls of the passages 38 being shown as closed by slabs 39, as for example of carborundum, the opposite ends of the passages 38 thus opening into the lengthwise-extending passages 37. As a means of controlling the courses travelled by the heating medium and the cooling medium I provide in the body 10 of the furnace and at opposite sides thereof horizontal series of dampers represented at 40 and 41. These dampers are shown as in the form of bars of rectangular shape in cross section and of refractory material, which are horizontally slidably mounted in openings 42 and 43, respectively, in the body 10 of the furnace, the dampers at opposite sides of the furnace being in alignment with each other and preferably of the same width as the partitions 44 between the passages 38, with the dampers of each series thereof spaced apart lengthwise of the furnace a distance equal to the spacing of the partitions 44 one from the other so that when the bottom portion 14 occupies the position

shown in Fig. 2, or is moved from such position a distance equal to the distance between centers of adjacent partitions 44, or multiples of such distance, the dampers 40 and 41 will be in alignment with the several partitions 44.

It will be manifest from the foregoing that by adjusting, selectively, the several dampers 40 and 41, the products of combustion travelling from the burners 35 to the flue 34, and the cooling medium, namely, air from the atmosphere, passing through the cooling zone 33, may be caused to travel a more or less tortuous course, as for example for the purpose hereinafter explained, to obtain the best results for the particular kind of articles being treated.

In the operation of the furnace the articles are applied to the left-hand end of the bottom portion 14 and their passage through the heating zone 32 and the cooling zone 33 controlled by the operator, the travel of the articles being effected by the operator moving the supporting structure of which the angle irons 18 are a part, to the raised position shown in the drawings, and in any suitable manner, moving the bottom portion 14 to the right in Figs. 1 and 2 to produce the desired step advance of the articles, whereupon the supporting structure referred to is lowered, the articles then becoming supported on the body portion of the furnace at the seating surfaces 15. The bottom portion 14 is then in position to be moved lengthwise of the furnace independently of the articles 17 to position it as desired, as for example to return it to the position it occupied lengthwise of the furnace at the beginning of the previous article-advancing movement, and these operations just described are repeated for each advancing movement of the articles, it being understood that by this arrangement the bottom portion 14 may be caused to occupy at all times substantially the same position lengthwise of the furnace. Thus after once heating that portion of the bottom 14 of the furnace which is located in the heating zone 32 the reheating of such portion is not rendered necessary, as would be the case were the conveying supports for the articles in the form of elements which advance through the furnace with the articles, as in the case of carriages upon which the articles are supported at all times during the treatment of the articles, and the same is true of those portions of the bottom 14 which are in the cooling zone, it not being necessary to cool down a highly heated conveying means as is the case with the carriages above referred to which pass from the heating zone into the cooling zone.

In operating the furnace the products of combustion from the burners 35 and 36 which, by way of example may be supplied with oil through pipes 45 and combustion supporting air through pipes 46, traverse the heating zone 32 of the furnace and discharge into the stack 34. Concurrently therewith air from the atmosphere is drawn into the right-hand end of the cooling zone 33, the air traversing the flues in the furnace in accordance with the setting of the dampers and upon reaching the burners 35 and 36 becomes mingled in relatively highly heated condition, with the discharge from the latter and aids in the supporting of combustion of the fuel.

Without intending to limit my invention to any particular arrangement of the dampers 40 and 41 I have illustrated an arrangement thereof for effecting stage heating and cooling of the articles to meet one set of conditions met with in the heat-treatment of articles. In this arrangement of the dampers the heat passing from the burners 35 and 36 to the stack 34 traverses paths variably tortuous along different parts of the heating zone, it being understood that where a plurality of adjacent ones of the dampers 40 and 41 are withdrawn from a position in which they obstruct the direct passage of the products of combustion through the flues 37, the path of the products of combustion would be along these straight, direct, flues and past the ends of the adjacent flues 38, whereas the products of combustion are forced through the flues 38 adjacent to those of the dampers which are closed. Thus by adjusting the dampers the rise in temperature between successive portions of the heating zone may be rendered more or less abrupt, and the maintenance of a substantially uniform temperature throughout a given portion of the heating zone 32 may be effected by selectively adjusting the dampers; the dampers in the cooling zone 33 of the furnace permitting of any desired stage-cooling involving substantially uniform temperature throughout a given portion of the furnace or rapid fall of temperature at certain portions of the furnace, it being understood in practice that in the heat-treating of articles it is oftentimes necessary to maintain the articles at a certain temperature for a given length of time before increasing the heat thereof and to hold them at a reduced temperature during the cooling thereof, before completing the cooling operation.

In the particular arrangement of the dampers as shown, the articles by way of example, would be heated in their passage substantially one-half of the distance through the heating zone 32, to gradually increasing heat from say about 100° F. to 1000° F. and maintained between say 1000° F. to 1300° F. during their movement through the next quarter of the heating zone, then quickly raised to say substantially 2200° F. and maintained at this heat until they pass a short distance beyond the burners 35 and 36, whereupon they rapidly cool down to about 1150° F. after traversing about one-third of the length of the cooling zone, then gradually

cooled down to about 1030° F. in traversing approximately the next third of the cooling zone and then rapidly cooled from about 1030° F. down to about 200° F. in traversing the remainder of the cooling zone.

One of the principal advantages of a furnace constructed in accordance with my invention is that the heat for heating the articles, is introduced into the bottom of the kiln. It has always been recognized that the most satisfactory results from the heat treatment of articles would be effected if the articles were heated to substantially the same temperature throughout their cross section, and this result I am able to obtain in my improved furnace inasmuch as by introducing the heat into the bottom thereof the surfaces of the furnace defining the tunnel passage are heated to substantially the same temperature at any given cross section of the furnace, as distinguished from those furnaces wherein the heat is introduced into the sides thereof above the bottom portion or into the top of the furnace. This advantage not only applies to a furnace in which the conveying means for the articles operates as above described, but also where the conveying means progressively move from one end to the other of the furnace, such as would be the case were the bottom portion 14 to be maintained at all times in raised article-supporting position and always move in one direction: viz, from the feeding-in end of the furnace to the outlet end thereof.

Another advantage is presented by reason of the introduction of the cooling medium into the bottom of the furnace, as distinguished from introducing the cooling medium through the sides of the furnace above the bottom portion or into the top of the furnace. This advantage not only applies to a furnace the conveying means of which is operated as above described to move back and forth, but also where the conveying means move only in the article-advancing direction. In the first case because usually the greater mass to be cooled is located closer to the bottom of the furnace than at the top thereof and thus the cooling medium is applied directly to such hotter parts effecting more rapid cooling. In the other case the conveying means as also the objects conveyed thereby are very hot as they enter the cooling zone presenting a relatively large highly heated mass which is most expeditiously cooled by applying the cooling medium directly thereto.

Also the feature of feeding the cooling medium after it has become heated by contact with the articles, to the fuel issuing from the burners is of advantage inasmuch as it effects saving in fuel because of the preheating of the combustion supporting air.

It will also be noted that the conveyor means for the articles may be caused to remain, if desired, at all times substantially in the same position lengthwise of the furnace and therefore in such case it is not necessary to repeatedly reheat the conveyor means operating in the heating zone or to repeatedly recool the conveyor means operating in the cooling zone. In this connection, however, it may be stated that inasmuch as the bottom portion 14 when in lowered position, is free to be moved at will lengthwise of the furnace without affecting the position of the articles, the bottom portion 14 may be fed along the furnace a greater distance upon each retractive step than the distance it is fed upon each article-advancing step and thus, if desired, effect a conservation of the heat in the furnace in the successive movement of those parts of the bottom portion 14 which are subject to the greatest heat in the heating zone, into those parts of the latter which are subjected to a lesser heat which is an advantage not obtainable in the case of tunnel kilns as commonly provided and employing conveying means upon which the articles are supported at all times and which conveying means are moved progressively from the feeding-in end of the furnace to the discharge-end thereof.

While I have illustrated and described a particular construction embodying my invention I do not wish to be understood as intending to limit it thereto as the same may be variously modified and altered without departing from the spirit of my invention.

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

1. In a heat-treating furnace of the tunnel type having a heat treating zone, means for effecting the heating of the side, top and bottom walls, defining the tunnel-passage in the furnace at said zone, to substantially the same temperature at any given cross-section of the furnace, and article-conveying means in said zone which are subjected at all times to the heat in said zone and the position of which lengthwise of the furnace is maintained substantially the same at all times.

2. In a heat-treating furnace of the tunnel type having a heat-treating zone, means for effecting the heating of the side, top and bottom walls, defining the tunnel-passage in the furnace at said zone, to substantially the same temperature at any given cross-section of the furnace, and article-supporting and conveying means in said zone which are subjected at all times to the heat in said zone and the position of which lengthwise of the furnace is maintained substantially the same at all times.

3. In a heat-treating furnace of the tunnel type, means for supplying heat to the furnace, the furnace containing heat-conducting passages extending lengthwise and crosswise thereof and in communication with said means, and means selectively controlling communication between said passages for vari-

ably controlling the temperature of various portions of the furnace.

4. In a heat-treating furnace of the tunnel type, means for supplying heat to the furnace and by which heat is introduced into the bottom of the furnace, the furnace containing heat-conducting passages extending lengthwise and crosswise thereof and in communication with said means, and means selectively controlling communication between said passages for variably controlling the temperature of different portions of the furnace.

5. In a heat-treating furnace of the tunnel type, means for supplying to the furnace fluid for affecting the temperature of articles therein, the furnace having a bottom portion reciprocable lengthwise of the furnace and movable up and down and on which the articles are advanced in the tunnel-passage, the furnace containing fluid-conducting passages extending lengthwise and crosswise thereof and in communication with said means, certain of said passages being in said bottom portion.

6. In a heat-treating furnace of the tunnel type, means for supplying to the furnace fluid for affecting the temperature of articles therein, the furnace having a bottom portion reciprocable lengthwise of the furnace and movable up and down and on which the articles are advanced in the tunnel-passage, the furnace containing fluid-conducting passages extending lengthwise and crosswise thereof and in communication with said means, certain of said cross passages being in said bottom portion.

7. In a heat-treating furnace of the tunnel type, means for supplying heat to the furnace, the furnace having a bottom portion movable lengthwise of the furnace and on which the articles are advanced in the tunnel-passage, the furnace containing heat-conducting passages extending lengthwise and crosswise thereof and in communication with said means, certain of said cross passages being in said bottom portion, and means selectively controlling communication between said passages for variably controlling the temperature of various portions of the furnace.

8. In a heat-treating furnace of the tunnel type, means for supplying heat to the furnace between the ends thereof, one end of the furnace constituting a cooling zone, said cooling zone containing cooling-medium-conducting passages extending lengthwise and crosswise thereof through which the cooling medium passes, and means selectively controlling communication between said passages for variably controlling the temperature of various portions of the cooling zone of the furnace.

9. In a heat-treating furnace of the tunnel type, means for supplying heat to the furnace between the ends thereof one end of the furnace presenting a cooling zone, the furnace containing cooling-medium-conducting passages extending lengthwise and crosswise thereof and through which the cooling medium passes, certain of said passages being in the bottom of the furnace, and means selectively controlling communication between said passages for variably controlling the temperature of various portions of said cooling zone.

10. In a heat-treating furnace of the tunnel type, means for supplying to the furnace fluid for affecting the temperature of the articles therein, the furnace having a bottom portion of refractory material movable lengthwise of the furnace and extending below the tunnel-passage and on which the articles to be treated are supported in the advancing of the articles in the furnace, said bottom portion being passage-equipped to permit such fluid to enter it and movable upwardly to a position for supporting the articles and downwardly out of supporting position, means in the furnace for supporting the articles when said bottom portion is moved out of article-supporting position, and lifting means for raising said bottom portion to article-supporting position and along which said bottom portion is movable.

11. In a heat-treating furnace of the tunnel type, means the position of which lengthwise of the furnace is maintained substantially the same at all times for supporting and conveying therein the articles to be heat-treated, and means for supplying to the portion of the furnace in which said first-named means are located fluid for affecting the temperature of articles therein and by which such fluid is introduced into the bottom of the furnace, said means comprising passages for the fluid certain of which are located in said first-named means.

12. In a heat-treating furnace of the tunnel type, means for supplying to the furnace fluid for affecting the temperature of articles therein, the furnace having a bottom portion reciprocable lengthwise of the furnace and movable up and down and on which the articles are advanced in the tunnel passage, the furnace containing fluid conducting passages in communication with said means, certain of said passages being in said bottom portion.

13. In a heat-treating furnace of the tunnel type, reciprocatory feed means for the articles to be fed through the furnace, said means extending at the lower portion of said tunnel and the position of which lengthwise of the furnace is maintained substantially the same at all times, and temperature producing means acting directly on the bottom portion of the zone in which said feed means operate for controlling the temperature of the articles by the temperature at the bottom of the furnace.

14. In a heat-treating furnace of the tunnel type, reciprocatory feed means for the

articles to be fed through the furnace, said means forming a bottom portion of the tunnel, the position of said means lengthwise of the furnace being maintained substantially the same at all times, and temperature producing means acting directly on said bottom portion for controlling the temperature of the articles by the temperature at said bottom portion.

15. In a heat-treating furnace of the tunnel type, means at a certain portion of the furnace for producing at the side, top and bottom walls defining the tunnel passage at said portion, substantially a given uniform temperature condition at any given cross section of said portion, and means in said portion of said furnace which are subjected to the temperature of said portion and the position of which lengthwise of the furnace is maintained substantially the same at all times, for conveying therein the articles to be operated on.

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