Nov. 21, 1950 E. BLAHA 2,530,595

TILE FURNACE

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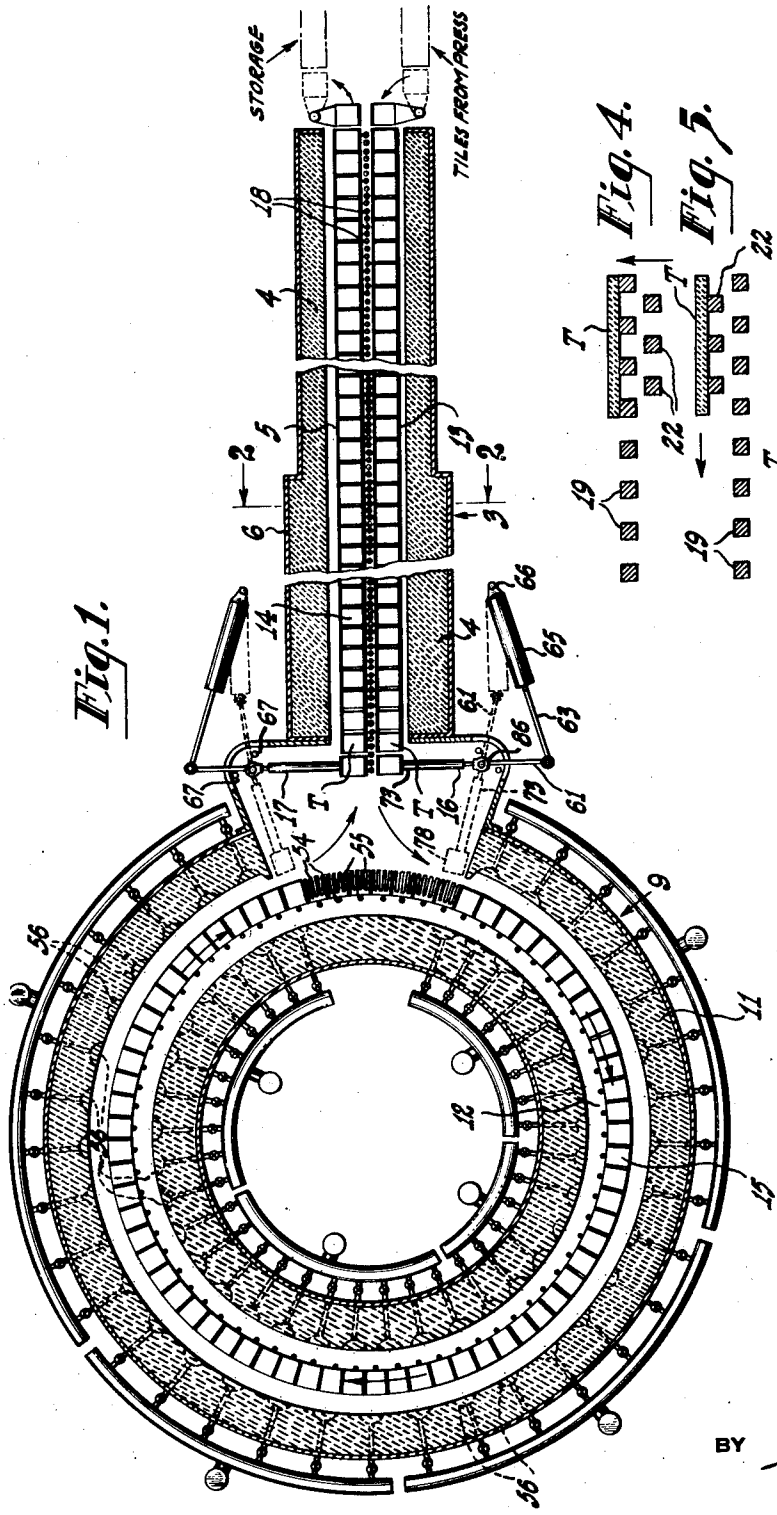


Fig. 1.

Fig. 4.



Fig. 5.

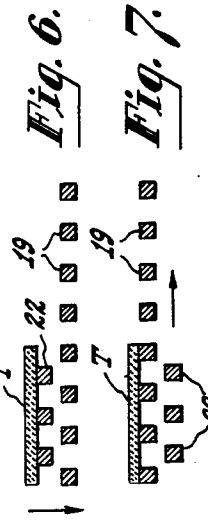


Fig. 6.

Fig. 7.

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Fig. 2.

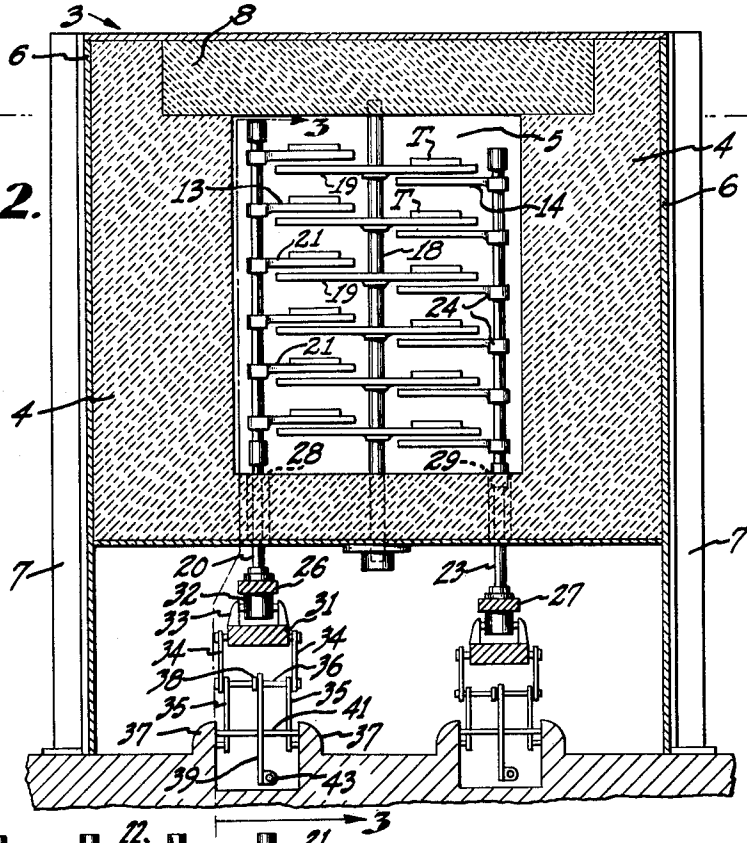
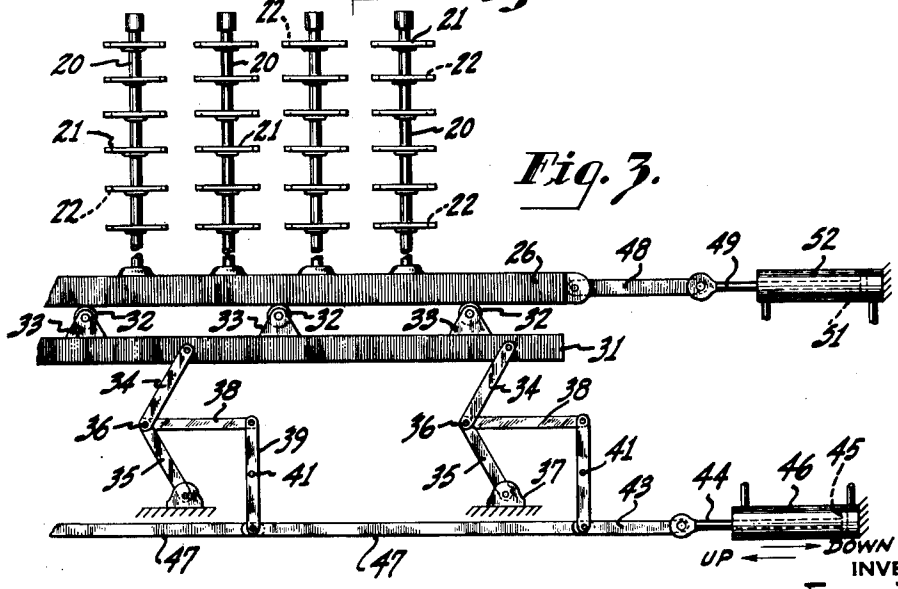


Fig. 3.



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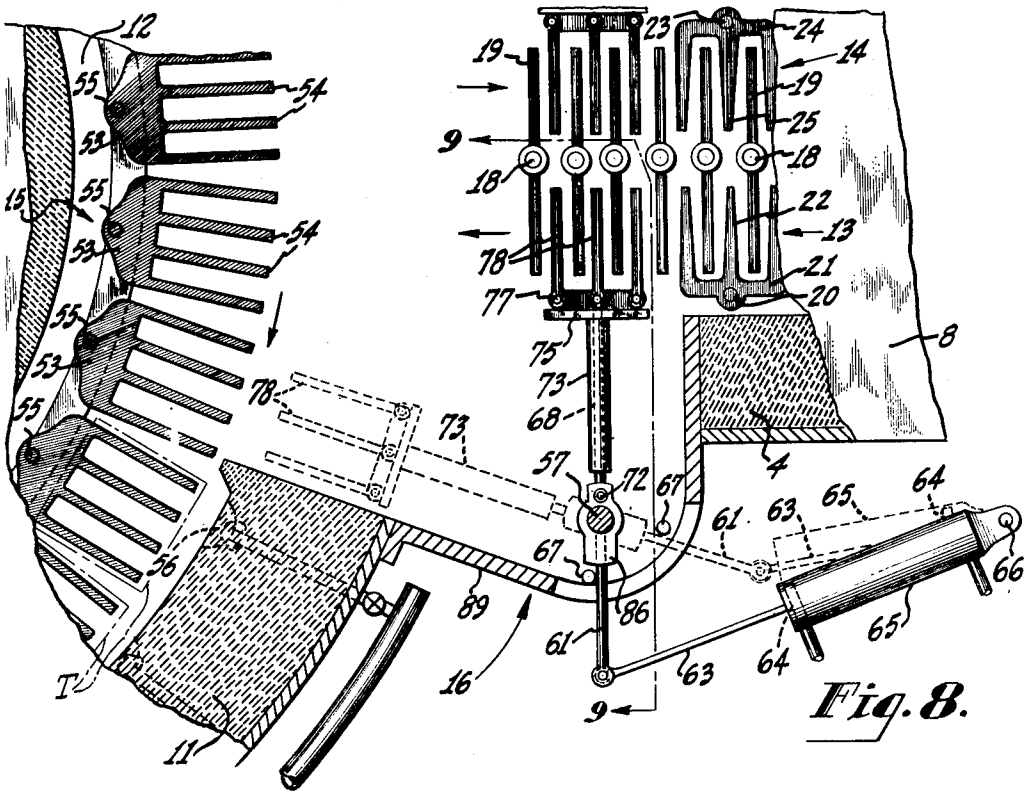


Fig. 8.

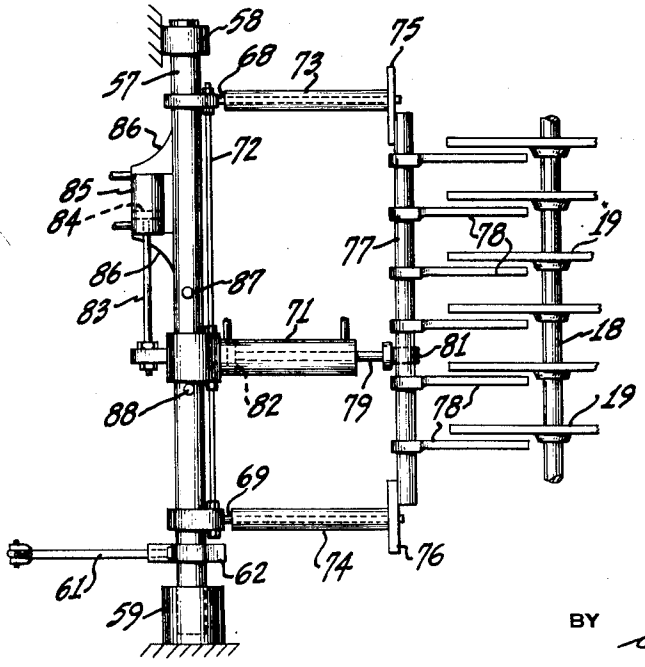


Fig. 9.

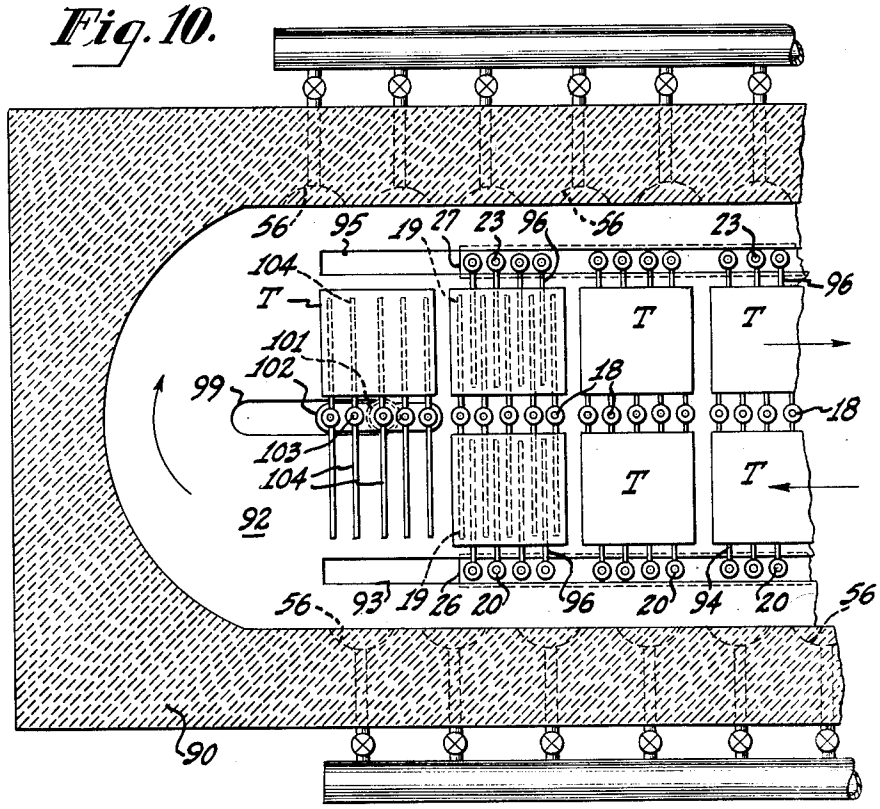
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Fig. 10.



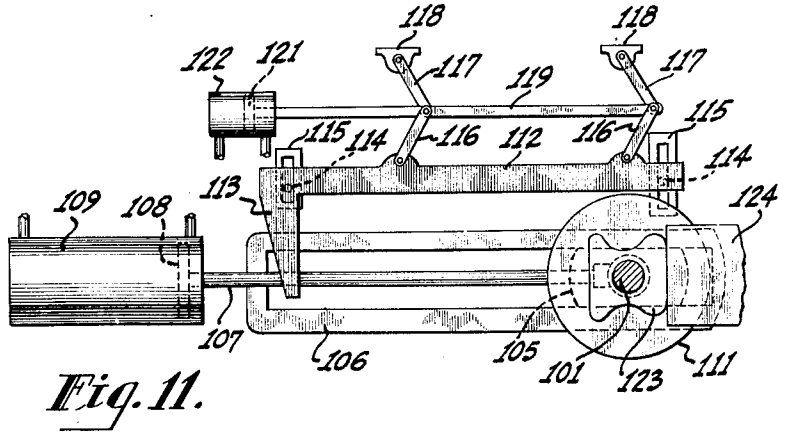


Fig. 11.

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Patented Nov. 21, 1950 2,530,595

UNITED STATES PATENT OFFICE

2,530,595

TILE FURNACE

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Application August 27, 1947, Serial No. 770,839

10 Claims. (Cl. 25—142)

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The object of the present invention is to provide an improved method of and apparatus for the production of tile such as ordinary bathroom floor and wall tile, and analogous articles of ceramic material, and for use in enamelling metallic tile and in heating tile and analogous objects to temperatures substantially lower than those required for the production of ceramic tiles.

A more specific object of the invention is to provide a method of and apparatus for firing bodies of ceramic material pressed into tile shape by passing them through a continuous kiln or kilns without the use of saggers or manual handling, and without the use of kiln cars or analogous tile handling and transporting apparatus which must be periodically moved into and out of the kiln heating space with resultant heat losses.

In the production of ceramic tile by the use of a preferred form of the invention, the tiles are heated up from atmospheric temperature to a temperature of 1200° F. or so while moving in one direction through an elongated preheating kiln chamber, in heat transfer relation with tiles moving through the chamber in the opposite direction and entering the chamber at a temperature of 1400° F. or so from a high temperature kiln chamber. The latter is of the rotary hearth type and is located at the end of the preheating kiln toward which the tiles being preheated are moved. The preheated tiles are transferred from the preheating kiln to the high temperature rotary hearth kiln. In the latter, the tiles are heated up to a temperature of 2000°–2400° F., and are then cooled down to an exit temperature of 1400° F. or so, before their return to the low temperature kiln chamber.

In the preferred form of apparatus disclosed, the preheating kiln is a tunnel kiln of the walking beam type having separate walking beams for progressively moving the two tile streams in opposite directions through the kiln chamber, and the high temperature kiln is a circular kiln through which the tiles are moved by a supporting turntable.

In each of the kiln chambers, the tiles are individually supported on a plurality of vertical racks distributed along the length of the goods' pathway and are spaced apart by finger-like portions of supporting elements so that the superposed row of tiles in each stack are spaced apart vertically to permit the envelopment and exposure of both the under and upper sides of each tile to the heating chamber atmosphere and also to permit the individual tiles in the stack to be separately engaged by the supporting fingers of

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the tile handling apparatus comprising a plurality of such fingers at different levels simultaneously to engage and disengage the undersides of the vertically spaced apart tiles in the stack.

In the preferred form of the low temperature heating chamber, each of the two streams of tiles moving through the chamber in opposite directions are given intermittent movements longitudinally of the kiln by separate side by side walking beams, each of which is provided with a plurality of tile supporting devices each having fingers for engaging the underside of each of the tiles in a single stack and thus lifting the tiles off the supporting fingers of a series of stationary tile supporting devices.

In the preferred form of apparatus shown, the tiles are moved through the circular heating chamber by supporting devices comprising columns or posts extending upwardly through a slot in the bottom wall of the chamber from the subjacent turntable and within the chamber each post is provided with a series of tile supporting fingers at successively higher levels. The tiles may be transferred from the heating up walking beam in the low temperature chamber to the turntable carried supports in the high temperature chamber by a transfer mechanism comprising supporting elements given both vertical movements and rotative movements about a vertical axis, and the tiles may be transferred to the cooling off walking beam from the high temperature chamber by a similar transfer mechanism.

Alternatively, the tiles may be heated up and cooled down in a single elongated twin kiln heating chamber through which each of two streams of tiles is moved in opposite directions along side by side heat transfer paths with means for supplying heat to the central portion of the kiln. In the operation of such a kiln, the tiles in each of the streams moving in opposite directions to the kiln chamber is heated up in an entrance portion of its path of movement and is cooled down to a suitable exit temperature in an exit portion of its path and is heated to the maximum temperature required in the central portion of its path of movement. In such a twin kiln, the supporting elements may be formed of metal in the end portions of the kiln chamber and of nonmetallic refractory material in the central portion of the kiln chamber.

The invention is also well adapted for use in the production of enamelled metallic wall tiles and analogous articles by moving them successively by one walking beam in one direction through an elongated straight furnace chamber

and then moving them in the opposite direction back to the end of the chamber by which they entered by a second walking beam, and in supplying heat to the furnace chamber at and adjacent its second end, to the enamelling temperature of 1400° F. to 1600° F., or so. In such a furnace the tile supporting devices may be exactly like those employed in the low temperature heating chamber first described, and in addition, a suitable transfer mechanism at the high temperature end of the furnace for transferring tiles from the walking beam moving the tiles toward that end of the furnace to the walking beam after moving the tiles away from that end of the furnace.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

Of the drawings:

Figure 1 is a sectional plan view taken on line 1—1 of Figure 2;

Figure 2 is a section taken on line 2—2 of Figure 1;

Figure 3 is a diagrammatic side view of the walking beam mechanism taken generally on line 3—3 of Figure 2;

Figures 4 to 7 are views showing the operation of the walking beam mechanism;

Figure 8 is an enlarged view showing the transfer mechanism;

Figure 9 is a sectional view taken on line 9—9 of Figure 8;

Figure 10 is a plan view partly in section showing the invention used in a different type of kiln; and

Figure 11 is a plan view of the return or turntable mechanism used with the kiln of Figure 10.

In Figure 1, there is shown a plan view of the apparatus which includes an elongated tunnel kiln portion 3 including side walls and floor 4 of suitable refractory material to stand the heat to which the kiln is subjected. The sides and floor along with a roof 8 form a kiln chamber 5. As is usual in constructions of this type, metal sheathing 6 is used to hold the bricks of which the sides and roof are made in place and the entire kiln is mounted on supports 7. Located within the kiln chamber 5 are a pair of walking beams, one indicated at 13 for feeding in tile to be fired, and the other indicated at 14 for feeding the tile out after it has been fired. It will be seen that the tile moving into the kiln will be heated by the tiles that are moving out so that this kiln chamber 5 serves a dual purpose of preheating the tiles going into the firing zone and cooling those that are moving from the firing zone. The firing zone consists of a high temperature rotary kiln portion 9, which has side walls and roof indicated at 11 that are also made of some suitable high temperature refractory which will withstand the heat to which it is subjected. The walls 11 form a chamber 12 in which is located a rotating mechanism indicated generally at 15 upon which the tiles are placed and moved in a clockwise direction from an entrance to an exit opening as they are being fired. A mechanism 16 is provided to transfer the tiles from the kiln chamber 5 to the high temperature kiln chamber 12 and a second transfer mechanism 17 is used to transfer the tiles from the firing zone in the high temperature chamber to the cooling and preheating zone in chamber 5.

Referring to Figure 2, it will be seen that the kiln chamber 5 is provided with a number of center posts 18 that are anchored in the roof and in the floor of the chamber. These posts are provided with horizontally extending supporting fingers 19 that are attached to the posts 18 and project from each side thereof. As shown in the drawing, there are six of these horizontally extending fingers on each post, but it will be understood that any number may be used, depending upon the size of the kiln chamber. Also extending into the kiln chamber and forming part of the walking beam mechanism 13 are rods 20 upon which are mounted rack supports 21, each of which has three supporting pins 22 extending to the left therefrom. There are also provided rods 23 forming part of the other walking beam mechanism 14 which has racks 24 attached to it each of which is provided with three supporting pins 25 extending to the right. The rods 20 and 23 are supported respectively by beams 26 and 27 which extend the full length of the kiln and are located below the floor thereof. In order to permit rods 20 and 23 to move vertically and horizontally these rods extend through elongated openings 28 and 29 in the floor of the kiln.

The beams 26 and 27 are moved to give in sequence the conventional four movements of a walking beam system. To this end, the rods 21 and 23 are moved upwardly, horizontally in one direction, downwardly, horizontally in the other direction and upwardly again so that the tiles mounted on the supporting pins which project from the rods are moved progressively through the kiln chamber. As both of the walking beam mechanisms are similar, mechanism 13 for feeding the tile to the firing zone will be described. The vertical movements are accomplished by mechanism including an elevator beam 31 having rollers 32 mounted in bearings 33 thereon upon which beam 26 rests. The member 31 is supported on upper links 34 which are pivoted to lower links 35 by a pin 36 extending between these links, as is best shown in Figure 2. The lower links 35 are pivoted at their lower ends in brackets 37, so that in conjunction with the upper links a toggle mechanism is formed. Changing the angular relation between links 34 and 35 serves to raise and lower the member 31 carried thereby. This is done by means of horizontal bar 38 that has one end attached to pivot pin 36 and its other end pivoted to the upper end of a lever 39 which is in turn pivoted at 41 to portions of the bracketes 37. Lever 39 is moved around its pivot 41 by means of a connecting link 43, attached at one end thereto and at its other end to a piston rod 44. This piston rod is fastened to a piston 45 that is located in a cylinder 46. It is noted that a number of the toggle links 34 and 35 may be used to support member 31 and that motion is imparted simultaneously to each of the levers 39 by means of connecting links 47 extending between the lower ends of these levers.

Beam 26 is moved horizontally by a link 48 which extends between that beam and one end of piston rod 49 to the other end of which is attached a piston 51 that moves in a cylinder 52.

The beam 27 forming part of mechanism 14 is moved vertically and horizontally by mechanism similar to that that has been described except that the rods 23 attached to it are in their lower

positions while the rods 20 attached to beam 26 are in their upper position. This is accomplished by having piston 45 of that mechanism in the opposite end of cylinder 46 from the position shown in the drawing for mechanism 13.

The operation of the walking beam mechanisms is described in connection with Figures 4 to 7. With the parts in the position shown in Figure 4, the supporting pins 22 are below the supporting fingers 19 and a tile T is resting on fingers 19. A suitable fluid, such as oil, is admitted to the right end of cylinder 46 in Figure 3 to move the piston in that cylinder to the left. This motion straightens out toggle links 34 and 35 so that rods 28 carrying supporting pins 22 are raised. In this fashion the supporting pins 22 move between fingers 19 to raise the tile T to the position shown in Figure 5. Fluid is then admitted to the right end of cylinder 52 to move piston 51 and the parts attached thereto to the left so that the tile is moved to a position above other of the supporting fingers 19 as shown in Figure 6. Liquid is then supplied to the left end of cylinder 46 moving piston 45 to the right to the position shown in Figure 3 of the drawing, thereby lowering the supporting pins 22 from the position shown in Figure 6 to that shown in Figure 7. During this movement supporting pins 22 move downwardly between fingers 19 and place the tile upon these fingers. Liquid is then forced into the left end of cylinder 52 to move piston 51 and the parts attached thereto to the right so that they will return to the position shown in Figure 4. Thus by properly admitting fluid to the one end or the other of cylinders 46 and 52, the tiles are progressively moved through the furnace from the feeding end toward the transfer mechanism 16 where they are placed in the firing zone portion of the kiln. The action of the walking beam 14 is exactly the same as that described in connection with walking beam 13, except that the position of piston 45 in cylinder 46 is reversed. In each case the beams 26 and 27 are moved simultaneously and in the same horizontal direction and when rods 20 and the supporting pins 22 carried thereby are raised, rods 23 and supporting pins 25 carried thereby will be lowered so that the tiles carried by the walking beam structure 14 will be moved away from the rotary hearth section of the kiln or to the right in Figure 1 of the drawings.

The mechanism in the rotary hearth portion 9 of the kiln is used to move the tiles in a clockwise direction in Figures 1 and 8 through the firing zone. To this end there is provided a plurality of racks 53 each of which has fingers 54 projecting outwardly from it upon which individual tiles are supported. Six of these supports are mounted on each post 55 at levels corresponding to the levels of the fingers 19 in the tunnel portion 5 of the kiln. The posts 55 and the supports carried by them are moved in a clockwise direction in Figures 1 and 8 in any desired conventional manner in steps corresponding to the steps of movement of the tiles through the tunnel portion of the kiln.

Heat is supplied to the chamber 15 in this section by any suitable type of burner to fire the tiles. As herein disclosed burners 56 take the form of those burners shown in Hess Patent No. 2,215,079, because burners of this type are particularly adapted to a kiln of this sort. The burners of the Hess patent are supplied with a combustible mixture of air and gas which is burned to complete combustion in the cups of the burners so that the walls of these cups are heated to incandescence. Radiant heat is supplied from these cups to the material passing in front of them and a portion of the heat of the furnace is supplied by the gases of combustion. The burners are located at suitably spaced points around both the inside and outside walls of the chamber 15 so that the proper firing is obtained as tiles travel through this chamber.

The burners are supplied with fuel through suitable manifolds with a valve individual to each burner between it and the manifold. One arrangement of manifolds is shown in the drawing, although other arrangements may be used if desired.

The transfer mechanisms 16 and 17 are provided to move the tiles from the tunnel or preheating and cooling portion of the kiln to the rotary or firing portion of the kiln and back again. The mechanism 16 will be described in detail since the mechanism 17 is identical to it, except that the transfer mechanism 17 is in its lower position while the transfer mechanism 16 is in its upper position. This corresponds to the difference between the walking beam mechanisms 13 and 14; when one of these is in its lower position, the other is in its upper position.

The transfer mechanism is shown in Figures 8 and 9, includes a shaft 57 which is suitably pivoted in bearings 58 and 59 and is moved through an arc of approximately 90° in these bearings by means of a rod 61 that is attached at one end to shaft 57 by a collar 62 and at its other end to one end of a piston rod 63 that has a piston 64 fastened to it. This piston slides in a cylinder 65 that is in turn pivoted at 66. As fluid is introduced into one end or the other of this cylinder, shaft 57 will be moved through an arc which is limited by stops 67.

Shaft 57 has a frame mounted upon it that will turn with the shaft but may move in a vertical direction. The frame includes supporting members 68 and 69 that are slidably mounted on the shaft and project therefrom in a horizontal direction. There is also provided a cylinder 71 that is similarly mounted on the shaft and projects in a similar direction. These three parts are joined together and held in proper spaced relation by a brace 72. The members 68 and 69 are surrounded by sleeves 73 and 74, respectively, which have plates 75 and 76 attached to their outer ends. Extending in a vertical direction between and attached to these plates are three rods 77, each of which has mounted upon it supporting pins 78 that are located one above the other as is best shown in Figure 9. The plates, rods, and fingers are moved away from and toward the shaft 57 by means of a piston rod 79 that is attached to the middle shaft 57 by a collar 81 and which has on its other end a piston 82 that is received in cylinder 71. The entire frame is moved in a vertical direction by means of a piston rod 83, the lower end of which is attached to a projection extending to the left from cylinder 71 and the upper end of which has a piston 84 that is received by a cylinder 85. This cylinder is rigidly mounted on shaft 57 by brackets 86. The vertical motion of the frame is limited by stops 87 and 88 that project outwardly from the shaft 57. The entire mechanism may, if desired, be surrounded by a shield 89 of any suitable material that extends between the outer wall 11 of the rotary portion of the kiln and the wall 4 of the tunnel portion of the kiln.

In the operation of the transfer mechanism, with the parts in the position shown in Figures 8 and 9, liquid will be introduced to the lower portion of the cylinder 85 to raise the frame. When this takes place, pins 78 will lift tiles from supporting fingers 19. Liquid will then be admitted to the upper end of cylinder 65 so that shaft 57 and the parts carried thereby will be moved in a counter-clockwise direction to the position indicated in dotted lines shown in Figure 8 of the drawing.

Liquid will then be admitted to the inner end of cylinder 71 to force the piston 82, piston rod 79 and the parts attached thereto outwardly so that the tiles carried by pins 78 will be in a position above supports 53 in the hearth. Liquid will then be admitted to the upper end of cylinder 85 to lower the framework and deposit the tiles on fingers 54 of supports 53. The entire framework will then be moved away from supports 53 by forcing liquid into the outer end of cylinder 71 and the framework will be moved in a clockwise direction by forcing liquid into the lower end of piston 65 to bring the parts back to the position shown in full lines of Figure 8 of the drawing.

Transfer mechanism 17 is operated in exactly the same manner and simultaneously with transfer mechanism 16 except that liquid will be admitted to the upper end of cylinder 85 of transfer mechanism 17 when it is being admitted to the lower end of cylinder 85 of transfer mechanism 16 and vice versa.

From the above it will be seen that the walking beam mechanism is used to move tiles through the tunnel kiln toward chamber 15 in the firing zone of the kiln and a transfer mechanism is used to move these tiles into the rotary firing zone. A similar transfer mechanism is used to move the tiles out of the firing zone and to place them again on fingers 19 where the other walking beam mechanism will move the tiles back through chamber 5. The complete sequence of operation of these parts will now be described.

In order for the mechanism of the kiln to function properly the operation of the walking beam mechanisms must be synchronized with that of the transfer mechanisms as well as that of the mechanism which is used to move rods 55 through the firing zone. This may be easily done in any conventional manner such as, for example, by controlling the flow of fluid to the opposite ends of the various cylinders by the use of solenoid valves in the fluid lines, and energizing these valves in a predetermined sequence. It is sufficient for the purposes of the description to relate the movements of the various parts that take place at the same time, and how these movements are accomplished.

With the parts positioned as shown in the drawings:

First, liquid will be forced into the right end of cylinder 45 of mechanism 13 to raise rods 20 and lift a tile by pins 22, and liquid will be admitted to the left end of cylinder 45 of mechanism 14 to lower rods 23 to place a tile on the fingers 19 from pins 25. At the same time liquid will be admitted to the lower end of cylinder 85 of mechanism 16 to lift a tile by the transfer pins 78, and liquid will be admitted to the upper end of cylinder 85 of mechanism 17 to place a tile on supporting fingers 19.

Second, liquid will be admitted to the right ends of cylinders 52 of mechanisms 13 and 14 to move pins 22 of mechanism 13 to transfer tiles

toward the firing zone and to move the pins 25 of mechanism 14 to a position to pick up another tile. At the same time liquid will be admitted to the upper ends (Figure 8) of cylinders 65 to swing the frames carrying transfer pins 78 of mechanism 16 toward the firing zone with a new tile and to swing the supports of mechanism 17 toward the firing zone to pick up a tile.

Third, liquid is admitted to the inner end of both cylinders 71 to move the frames of both mechanisms 16 and 17 so that pins 78 of these mechanisms will be in a position above or below, respectively, fingers 54 of racks 53.

Fourth, liquid is admitted to the opposite ends of cylinders 45 from that in the first operation so that rods 20 will be lowered to place the tiles carried on pins 22 on fingers 19 and rods 23 will be raised to lift tiles from the right fingers 19 in Figure 2 on pins 25. Simultaneously liquid will be admitted to the upper end of cylinder 85 of mechanism 16 to lower the frame of this mechanism and place tiles on fingers 54 of supports 53 while the frame of mechanism 17 is being raised to lift tiles from supports 53 on the exit side of the firing zone onto the pins 78 of the transfer mechanism.

Fifth, liquid is admitted to the outer ends of cylinders 71 of both mechanisms 16 and 17 to retract the frames of those mechanisms to the dotted line position of Figure 8.

Sixth, the second operation is reversed to bring the parts of the transfer mechanisms back to the full line position of Figure 8 and to admit fluid to the left end (Figure 3) of cylinders 52 of the walking beam mechanisms so that pins 22 will move to a position to pick up another tile and pins 25 will move the tile carried thereby toward the exit of the chamber 5. While this is taking place the mechanism by which rods 55 are supported will be moved sufficiently to bring another tile out of the firing zone into a position to be picked up by transfer mechanism 17 while a rack 53 is positioned to receive a tile from transfer mechanism 16.

From the above description, it will be seen that the tiles are moved in closely adjacent streams into and out of the kiln. The preheating and the cooling of the tiles takes place simultaneously and is accomplished by the counterflow of the tiles through chamber 5 of the tunnel portion of the kiln. As hot tiles are moved from the firing zone to the inner end of chamber 5, they are spaced closely adjacent to the tiles that are being moved from the outer end of chamber 5 toward the firing zone. Since the mechanism of the walking beam does not move out of the given portion of the chamber, no heat is lost by the parts of the walking beam being moved from the chamber. Therefore, there is accomplished a highly efficient preheating and cooling of the tiles with a minimum cost of fuel. As a matter of fact, it has been found that there is no necessity for having any burners in chamber 5, since the hot tiles moving into that chamber from the firing zone carry with them sufficient heat to preheat the tiles moving to the firing zone. The heated parts of the kiln and the mechanism for moving the tiles remain, in all zones, at substantially the same temperature. The mechanism in the rotary portion of the furnace in which the firing of the tiles takes place moves continuously in a circle as the tiles are carried through the firing zone. Thus, there are no bulky cars that absorb large quantities of heat moving into and out of this firing zone. After the zone is brought

up to temperature only enough heat to take care of radiation losses and the losses in the tiles themselves is needed. Because of the fact that all of the mechanism of the firing zone remains in that zone, a much closer control of temperature of the tiles may be obtained than is possible with ordinary furnaces. It will therefore, be seen that the kiln of the present invention utilizes most efficiently the heat that is supplied to it and that none of the heat is lost due to movement of the tile carrying apparatus into and out of the furnace.

In Figures 10 and 11 there is shown another form of the invention in which the tiles are moved through a preheating and cooling zone and through a firing zone. In this case, however, the various zones are in one chamber instead of being divided into two chambers as was previously described. In this case the tiles are moved on a walking beam on one side of the furnace chamber and placed on a turntable mechanism where they are moved through one half revolution before being placed on the outgoing walking beam. The firing zone is formed in one end of the kiln chamber and is provided with a number of burners of the type shown in connection with the form of the invention of Figure 1. As in the previous form of the invention any desired number of burners and arrangement of these burners and their supply manifolds may be used in order to fire the tiles properly.

As shown herein the kiln 90 is provided with a preheating and cooling zone 91 and a firing zone 92 that are in different portions of the kiln chamber. The floor of the kiln chamber is provided with an opening 93 below which the walking beam rod 26 is located and through which extends rods 20 upon which are mounted supporting pins 94 projecting toward the center of the kiln chamber. As shown herein each rod has a series of supporting pins extending from it toward the center of the chamber rather than having mounted upon it a support which has a plurality of pins as was shown in Figure 1. There is provided a second opening 95 beneath which the walking beam 27 is located. Extending through the opening 95 are rods 23 which have mounted on them supporting pins 96 that project toward the center of the kiln chamber. The walking beams in this form of the invention operate in the same manner as that previously described to move the tiles from the entrance of the kiln through the preheating zone and to the firing zone and from the firing zone back through the cooling zone to the exit. As in the previous case, the heated tiles that are moving out of the furnace serve to heat the tiles moving into the furnace.

The turntable mechanism is located at the end of the furnace and is used to transfer tiles from the walking beam on the lower side to that on the upper side. The operating mechanism for the turntable extends through an opening 99 in the floor of the kiln chamber. As shown herein, the turntable is supported on a shaft 101 that has a member 102 mounted on it. Projecting upwardly from the member 102 are a plurality of rods 103 each of which has supporting fingers 104 extending outwardly therefrom and aligned with the fingers 19 of the stationary part of the walking beam mechanism. By reference to Figure 11 of the drawing, it will be seen that shaft 101 is mounted in a base 105 that can move back and forth in a guide way 106. Movement is imparted to the turntable mechanism by means of a piston rod 107 that has a piston 108 on its end which is received in a cylinder 109. As the mechanism is moved to the left in Figure 11 the turntable is rotated through a half revolution and as the mechanism is moved to the right the turntable is not rotated, so that in its final position a tile T mounted upon it will be located, as shown in Figure 10 of the drawing.

Rotation is imparted to the mechanism by means of engagement between a disc 111 that is mounted on shaft 101 and a friction member 112 located beside the disc. The friction member 112 may be moved into and out of engagement with disc 111 and it is provided with a projection 113 that serves to stop rotation of the turntable at the left portion of its stroke. Member 112 is guided in its movement by pins 114 projecting therefrom into guides 115, and the member is moved by toggle levers 116 and 117 that are joined together in their centers and the latter of which has its outer ends journalled in supports 118. The center portion of the toggle links are connected by means of a piston rod 119 that has a piston 121 attached to its end. This piston is received in a cylinder 122.

When a tile has been placed on the lower side of the turntable as shown in Figure 10, fluid will be admitted to the right end of cylinder 109 and to the right end of cylinder 122. This fluid will move piston rod 119 to the left so that member 112 is moved downwardly into engagement with disc 111. The fluid in cylinder 109 will move the turntable mechanism to the left and as this movement takes place disc 111, rod 101 and the parts mounted thereon will be rotated until the disc engages the stop 113. Fluid will then be admitted to the right end of cylinders 109 and 122. The latter operation moves member 112 away from disc 111 to the position shown in the drawing and piston 108 in its movement to the right will push the turntable mechanism back to the position shown in the drawing. Shaft 101 is provided with a member 123 that in its final position engages the edge of stop 124 so that the parts of the turntable will be aligned accurately with fingers located in the kiln proper.

The operation of the walking beams moving the tiles into and out of the kiln is the same in this form of the invention as that in the previously described form. With the various parts in the position shown in Figure 10, and with walking beam 26 in its upper position and walking beam 27 in its lower position the next operation will be to move both of the walking beams in a horizontal direction to the left. This places a tile T on pins 94 over the left side of the turntable and places pins 96 under the tile T on the right side of the turntable. Walking beam 26 will then be lowered to place the tile carried thereby on the turntable fingers 104, and walking beam 27 will be raised to lift the tile from the turntable. The next movement of the walking beams brings them to the right to move tiles on the cooling side toward the exit of the cooling chamber while walking beam 26 is moved to a position so that pins 94 are in position to lift the next set of tiles.

The next operation is to admit fluid to the right end of cylinders 109 and 122 to move the turntable away from the secondary tile supporting racks and rotate it through one-half revolution. Fluid is then admitted to the left end of cylinders 122 and 109 to move member 112 away from disc 111 and to return the turntable to the position shown in Figure 10. This completes a cycle of operation which is continuously repeated while

the kiln is in operation. As in the case of Figure 1, the flow of fluid to the opposite ends of the various cylinders may be controlled in sequence by means of solenoid valves or in any other desired fashion.

With this form of the invention, as with that of Figure 1, the moving parts of the system stay in substantially the same position in the kiln chamber. Consequently there is no loss of heat due to movement of the tile moving mechanism. Since the entire firing zone is closed and none of the heat therein is carried away by moving parts into and out of this zone the desired temperature can be maintained with a minimum of fuel. As in the form of Figure 1 the preheating of tiles moving to the firing zone is accomplished by the hot tiles moving away from this zone, thus utilizing heat that otherwise would be lost. The entire arrangement is such that a constant firing temperature may easily be obtained with a minimum of heat loss in the entire system.

While in accordance with the provisions of the statutes I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention, as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantages without a corresponding use of other features.

What is claimed is:

1. In apparatus for firing ceramic ware and the like, a kiln having a first zone for preheating and cooling the ware and a second zone for firing the ware, said first zone including an elongated chamber having an exit and entrance at one end thereof, supports extending centrally of said chamber and having members thereon extending from each side thereof to support a plurality of layers of ware, a first walking beam mechanism to move the layers of ware on the members extending from one side of said supports inwardly toward said second zone, a second walking beam mechanism to move the layers of ware on the members extending from the other side of said supports outwardly from said second zone, means to move the layers of ware from members on one side of said supports into said second zone and from said second zone to members on the other side of said supports, and means to supply heat for firing the ware while it is in said second zone.

2. In apparatus for firing ceramic ware and the like, a kiln having an elongated preheating and cooling chamber and a separate circular firing chamber, supporting and moving means in said first mentioned chamber to move ware to said firing chamber and from said firing chamber in side by side and heat transfer relation, means to move said ware through said circular chamber from a point adjacent one side of said first chamber to a point adjacent the other side of said first chamber, means to transfer ware from said first chamber to the said first point in said second chamber and means to transfer ware from said second chamber at said second point after it has been fired to said first chamber.

3. Apparatus for firing ceramic ware and the like, including a kiln having a first elongated chamber and a second circular chamber, supports in said first chamber for a stream of ware moving inwardly toward said second chamber and a stream of ware moving outwardly from said second chamber, said streams of ware being closely adjacent each other in heat exchange relation,

means to move the stream of ware inwardly along said supports, means to transfer the ware from said first chamber to said second chamber, means to move the ware through said second chamber, means to transfer the ware from said second chamber to the stream of ware moving outwardly along said supports, means to move the stream of ware outwardly along said supports, and means to fire the ware in said second chamber, the ware that has been fired loosing its heat to the ware to be fired to thereby preheat the same.

4. In apparatus for firing ceramic ware and the like, a first elongated chamber forming a preheating and cooling zone, a second chamber forming a firing zone, supports extending centrally of said first chamber to support two streams of ware, means to move one stream of ware to be fired inwardly along said supports, means to move the other stream of ware outwardly along said supports after it has been fired, said streams being in heat transfer relation whereby the heat from the fired ware may preheat the unfired ware, means to transfer the ware from said first stream to said second chamber and from said second chamber to said second stream, and means to move the ware through said second chamber from and to said transfer means.

5. In apparatus for firing ceramic ware and the like, a kiln having a first elongated chamber forming a preheating and cooling zone and a second chamber forming a firing zone, supporting and moving means located in given portions of said first chamber for supporting and moving ware through said first chamber into and out of said second chamber whereby said supporting and moving means will remain at the same temperature as the portion of said first chamber in which they are located, separate means remaining at all times in said second chamber to move ware through said second chamber, and means located between said chambers to transfer ware from said first chamber to said second chamber and back again.

6. In apparatus for firing ceramic ware and the like, a kiln having an elongated chamber and a circular chamber provided with an opening adjacent an end of said elongated chamber, means to move a stream of ware in one direction through said elongated chamber to the end thereof adjacent a first point in said opening, means to move a stream of ware from the end of said elongated chamber adjacent a second point in said opening and through said elongated chamber, means to move a stream of ware in said circular chamber from said first point through said chamber to said second point, means to transfer ware from said elongated chamber to said circular chamber at said first point, means to transfer ware from said second point to said elongated chamber whereby a continuous stream of ware passes in through said elongated chamber, through said circular chamber and out through said elongated chamber, and means to fire the ware in said circular chamber, the hot ware passing from said circular chamber to said elongated chamber serving to preheat the ware coming into said circular chamber.

7. In apparatus for firing ceramic ware and the like, a kiln having an elongated chamber being open at one end and closed at the other, said chamber having a firing zone at the closed end and a preheating and cooling zone at the open end, means to support two streams of ware in side by side relation and extending from the open end of the chamber to the closed end there-

of, a pair of oppositely acting walking beam mechanisms cooperating with said means to support to move one stream of ware inwardly in said chamber and to move the other stream of ware outwardly therefrom, and means located adjacent the closed end of said chamber to transfer ware from one walking beam mechanism to the other whereby ware may be moved into and out of said chamber to be successively preheated, fired and cooled.

8. In apparatus for firing ceramic ware and the like, a kiln having an elongated chamber in which there is located a first cooling and preheating zone and a second firing zone, the end of said chamber containing said firing zone being closed, the other end being open, first supports for ware to be fired, second supports for ware that has been fired, said first and second supports being located in said first zone and extending from the open end of said chamber to adjacent the closed end thereof, means to move a stream of ware to be fired along said first supports from the open end of said chamber to adjacent the closed end thereof, means located adjacent the closed end of said chamber to shift the ware from the first supports for ware to be fired to the second supports for ware that has been fired, and means to move the ware along said last mentioned supports to the open end of said chamber.

9. Apparatus for firing ceramic material and the like comprising a kiln having a plurality of zones including a circular firing zone and an elongated preheating and cooling zone, stationary supports in said preheating and cooling zone, supports in said firing zone, means to move pieces to be fired along said stationary supports and onto the supports in the firing zone, means to move the supports in the firing zone through said zone, and means to move pieces that have been fired from the supports in the firing zone along the stationary supports away from the firing zone, said moving means being so positioned relative to each other that the pieces going to the firing zone move adjacent to the pieces moving away from the firing zone.

10. Apparatus for firing ceramic material and the like comprising a kiln having an elongated preheating and cooling zone and a firing zone, a plurality of stationary supports located in said preheating and cooling zone, each support being operative to hold a plurality of vertically displaced layers of work pieces, a plurality of supports located in said firing zone, each support being operative to hold the same number of layers of work pieces as those on the first-mentioned supports, means to move work pieces along the supports in the preheating and cooling zone toward the firing zone, means to transfer work pieces from the first-mentioned supports to those in the firing zone, means to move the supports in the firing zone to move the work pieces through said zone, means to transfer work pieces from the supports in the firing zone to said first-mentioned supports, and means to move work pieces along the supports in the preheating and cooling zone away from the firing zone, said moving means and transfer means operating synchronously whereby the plurality of layers of work pieces are moving substantially continuously through said kiln.

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