Oct. 13, 1931. H. M. ROBERTSON 1,827,543

KILN FOR DECORATING CERAMIC WARE AND OTHER PURPOSES

Filed Jan. 15, 1930 4 Sheets-Sheet 1

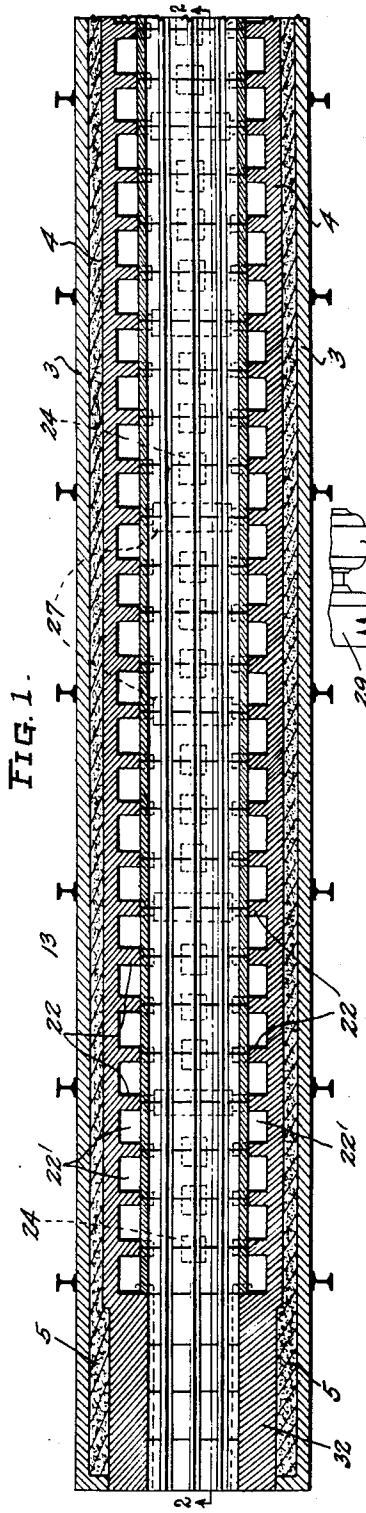


FIG. 1.

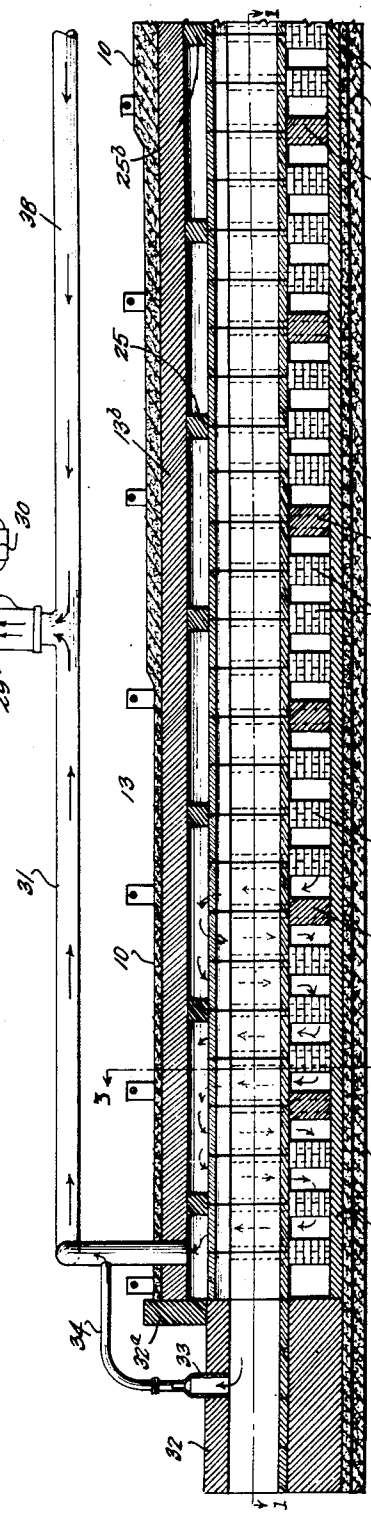


FIG. 2.

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Oct. 13, 1931. H. M. ROBERTSON 1,827,543

KILN FOR DECORATING CERAMIC WARE AND OTHER PURPOSES

Filed Jan. 15, 1930 4 Sheets-Sheet 2

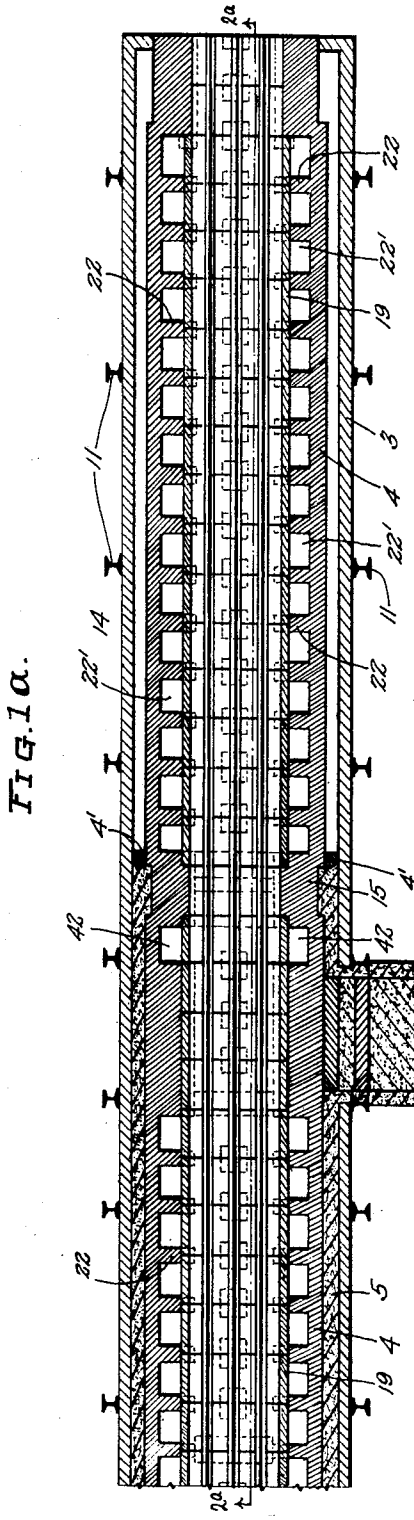


FIG. 1a.

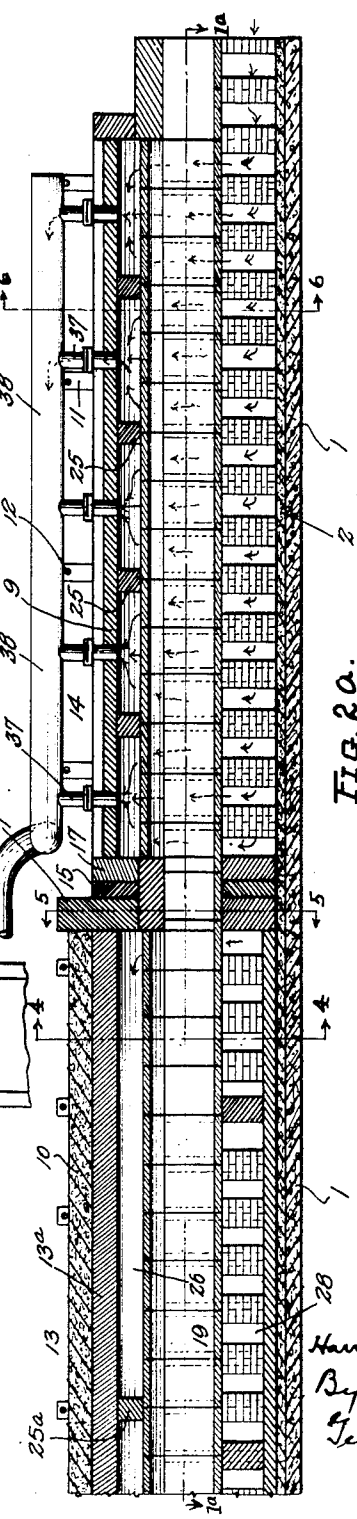


FIG. 2a.

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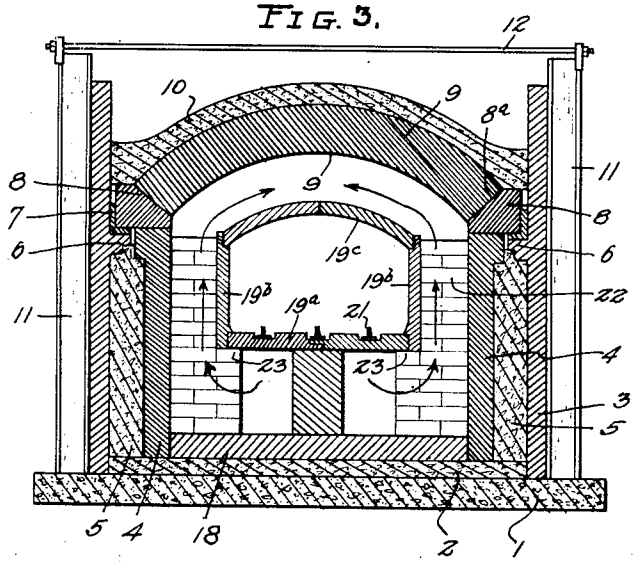
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Oct. 13, 1931. H. M. ROBERTSON 1,827,543

KILN FOR DECORATING CERAMIC WARE AND OTHER PURPOSES

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FIG. 3.



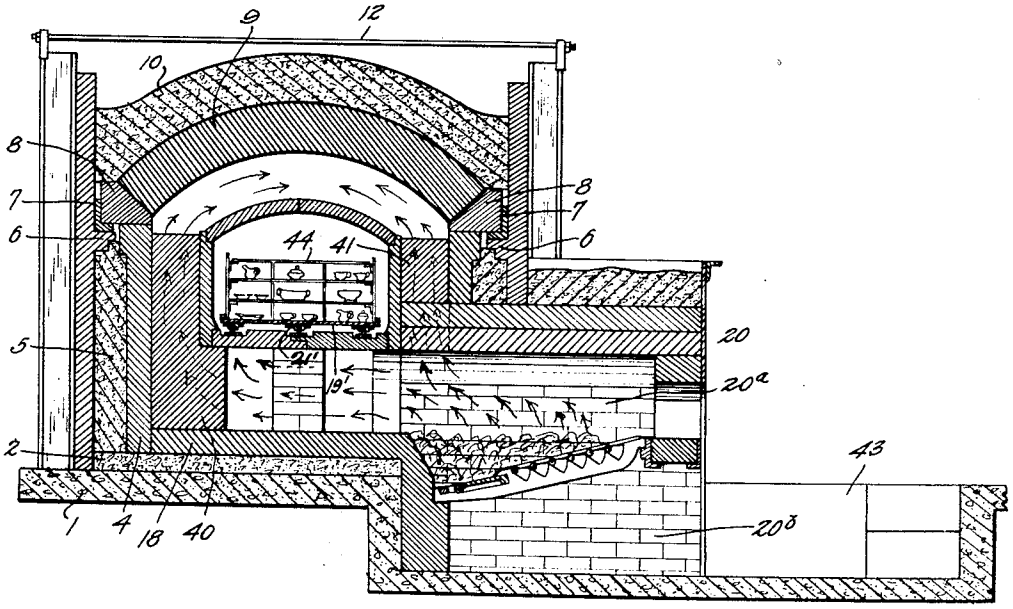


FIG. 4.

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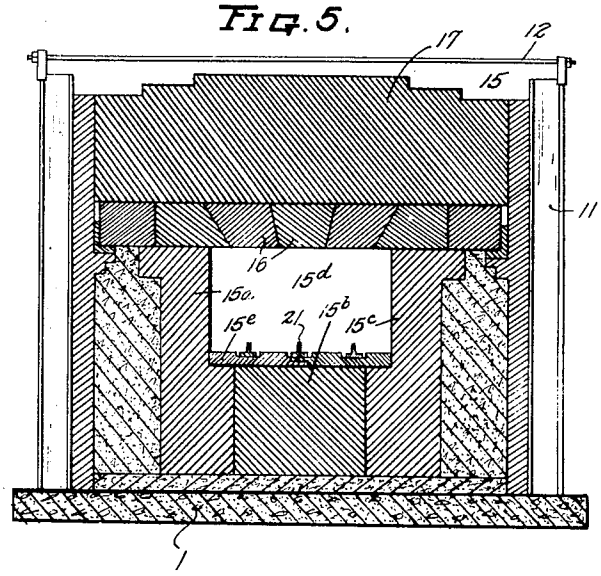
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KILN FOR DECORATING CERAMIC WARE AND OTHER PURPOSES

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FIG. 5.



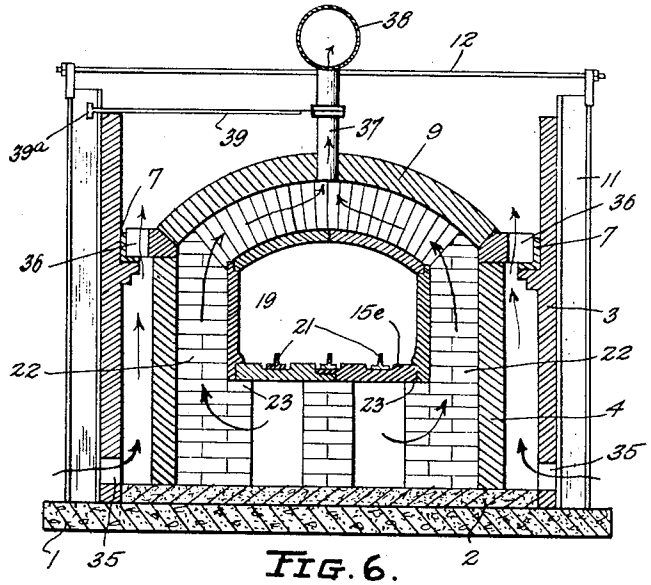


FIG. 6.

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Patented Oct. 13, 1931

1,827,543

UNITED STATES PATENT OFFICE

HARRY M. ROBERTSON, OF CLEVELAND, OHIO

KILN FOR DECORATING CERAMIC WARE AND OTHER PURPOSES

Application filed January 15, 1930. Serial No. 420,993.

This invention relates to a kiln of the tunnel type for burning or heat treating ware. It is well adapted for burning ceramic ware, and may be advantageously used for fixing or firing decorations thereon.

One object of the invention is to provide in a kiln of this type, an improved muffle and conveying means so arranged and constructed that the kiln is simplified in construction, may be operated economically and the ware may be heated uniformly and with less danger of waste.

Another object of the invention is to construct an improved kiln in which is provided a muffle extending from end to end of the kiln and channels extending around the muffle throughout its length so connected and related with each other that the heating gases and radiant heat, under the influence of a suction means, are caused to circulate around the muffle walls while traversing the kiln.

A further object of the invention is to provide in a kiln having a muffle for the ware, a heating section and a cooling section, means for completely closing off or separating the heating and firing section from the cooling section, whereby the heating and cooling mediums for these sections may be positively controlled.

Other objects of the invention will be apparent to those skilled in the art to which my invention relates from the following description taken in connection with the accompanying drawings, wherein

Figs. 1 and 1*a* together consist of a horizontal section, on the lines 1—1 and 1*a*—1*a* of Figs. 2, 2*a*, respectively, of a kiln embodying my invention.

Figs. 2 and 2*a* together consist of a vertical section of the kiln on the lines 2—2 and 2*a*—2*a* of Figs. 1, 1*a*, respectively.

Fig. 3 is a section on the line 3—3 of Fig. 2.

Fig. 4 is a section on the line 4—4 of Fig. 2*a*.

Fig. 5 is a section on the line 5—5 of Fig. 2*a*.

Fig. 6 is a section on the line 6—6 of Fig. 2*a*.

In the drawings, 1 indicates a suitable foundation, preferably comprising reinforced cement. The foundation 1 is provided with a base 2 of suitable insulating material. 3 indicates vertical walls rising from the foundation 1 at and along either longitudinal side of the base 2. The walls 3, which may comprise bricks formed from suitable material, constitute the outer side walls of the kiln. The inner side walls, indicated at 4, rise from the base 2 and are separated from the walls 1, the space between these walls throughout the heating and firing section being filled with suitable insulating material 5, preferably in powder form. The walls 4 may be formed from refractory brick. The inner faces of the walls 3, on their upper portions, are provided with ledges 6, which support angle shaped sills 7. The sills 7 cooperate with the upper edges of the walls 4 to support longitudinal members 8 formed from refractory material, the sills 7 forming seats for the outer edges of the members 8 and insulating the walls 3 against heating. The members 8 have inclined surfaces 8*a* on which rest the opposite longitudinal side edges of an arch or roof member 9. The roof member 9 is also formed of suitable refractory material and throughout the heating and firing section it is covered with a suitable insulation 10, the insulation being thicker throughout the hotter portion of this section. The side walls 3, 3, are re-inforced by upstanding I-beams 11, tied together at their upper ends by rods 12.

The construction described comprises a heating and firing section indicated as an entirety at 13, having a main heating portion 13*a* and a preheating portion 13*b*, and a cooling section, indicated as an entirety at 14, these sections being connected in end to end relation.

The sections 13, 14, are separated from each other by insulation means indicated as an entirety at 15, the purpose of these means being to prevent flow or drift of the heat into the cooling section. This makes it possible to secure more efficient heating and cooling and to control the heating gases and circulation of the air in a positive manner. These means preferably comprising the following: 15*a*, 15*b*, 15*c*, indicates sets of re-

lated slabs shaped as shown in Fig. 5. Referring to Fig. 2*a*, it will be understood that there are three sets of slabs 15*a*, 15*b*, 15*c*, positioned face to face and co-operating to form an opening 15*d* in which rests a bottom member or wall 15*e*, the purpose of which will later appear. 16 indicates refractory blocks related to each other and supported by the sills 7 and slabs 15*a*, 15*c*, to form a top wall for the opening 15*d*. These blocks have a length equal to the combined thickness of the sets of slabs 15*a*, 15*b*, 15*c*. 17 indicates vertical slabs mounted on the blocks 16 and extending transversely, these slabs corresponding in thickness to the sets of slabs 15*a*, 15*b*, 15*c*, respectively, and preferably formed of the same materials, each outer slab 17 and the adjacent set of slabs being formed of a refractory material such as fire brick and the intermediate slab 17 and intermediate set of slabs being formed of insulation material.

Between the walls 4 the base 2 of the heating and firing section is covered with a layer of refractory material 18, which constitutes the bottom wall of the chamber through which the heating gases circulate, as will be later set forth. The base 2 throughout the cooling section 14 constitutes the bottom wall thereof, it not being necessary to provide such section with a refractory bottom.

19 indicates a muffle extending continuously from end to end of the kiln structure and adapted to receive conveyors 19′ (Fig. 4), to be later referred to, for carrying the ware to be heat treated and cooled.

As shown in Figs. 1*a* and 2*a*, the muffle 19 is aligned with and connected to the ends of the opening 15*d* formed by the sets of slabs 15*a*, 15*b*, 15*c*, and blocks 16, so that the walls of such opening serve as a connecting passage through the insulation means 15, whereby the ware is muffled from end to end of the kiln. The muffle 19 is supported throughout its length in spaced relation to the bottoms 18, 2, side walls 4 and arch or roof member 9, so that (1) the hot gases and radiant heat from the heating means, indicated as an entirety at 20, may circulate below, around the sides and over the top of the muffle in traversing the kiln structure toward its inlet end and (2) the air may circulate in the same manner in traversing the cooling section of the kiln structure. The muffle 19 comprises a bottom wall 19*a*, side walls 19*b* and a top wall 19*c*, preferably arch shaped and extending parallel to the roof member; each of these walls being formed from refractory clay suitably fitted together. As shown, the bottom wall 19*a* of the muffle is disposed in the plane of the bottom member 15*e* so that the latter and the bottom wall may form a continuous support for tracks 21, preferably three tracks, on which the conveyors 19′ move. The tracks 21 may comprise inverted T-bars and the bottom walls 19*a* and wall 15*e* may be formed with longitudinal recesses to receive the bars, the sides of the recesses serving to keep the bars in position.

22 indicates a plurality of spaced pillars mounted on the bottom wall 18 throughout the heating and firing section 13 and bottom wall 2 throughout the cooling section 14, each pillar on one side of the muffle being aligned with a pillar on the other side thereof. The pillars are incorporated with the inner side walls 4, as a unitary structure, and extend inwardly therefrom to close the space between each of said walls 4 and the adjacent muffle side walls 19*b* and their lower portions extend inwardly far enough to form ledges 23 on which the muffle bottom and side walls rest, these ledges and columns 24 (to be later described) serving to space and support the muffle in the position already set forth. The pillars 22 extend upwardly to approximately the upper edges of the walls 4 and muffle side walls 19*b*, the spaces 22′ between the pillars forming up and down passages for the heating gases in the heating and firing section 13 and for the air in the cooling section 14.

The columns 24 are arranged centrally below the muffle bottom wall 19*a* and between and in line with the pillars 22, being mounted in spaced relation to each other on the bottom 18 of the heating and firing section 13 and bottom 2 of the cooling section 14. The columns 24 are formed of refractory brick and of such size transversely that ample circulation spaces are provided between their sides and the pillars 22.

25 indicates a plurality of transverse members each extending over the muffle top 19*c* from the upper end of one pillar 22 to the upper end of the adjacent aligned pillar 22 and closing the space between the muffle top and the roof member 9. The transverse members 25 are spaced relative to each other as follows:

Those in the cooling section 14 are uniformly spaced, being aligned with each third pair of aligned pillars 22, starting from the separating means 15. Those in the heating section 13 are spaced varying distances, the innermost one (25*a*) being spaced a relatively long distance from the separating means 15 to form a long chamber or passage 26 to permit the heating gases generated by the heating means 20 to be distributed to a large number of down passages 22′ and the next outer member 25*b* being spaced from the member 25*a* preferably a distance less than the distance between the remaining members 25 for a purpose later to appear. By passing the heating gases into the passage of chamber 26 and distributing them substantially simultaneously and uniformly to the down passages 22′ between the adjacent pillars at opposite sides of the muffle and collecting these gases below the muffle, that portion thereof co-ex-

tensive with the chamber 26 is uniformly heated to and maintained at the desired temperature, to form the main heating portion 13*a* of the heating section 13, so that the ware as it moves through such portion is subjected to such temperature for a predetermined period of time. The remaining members 25 may be spaced from each other any desired distance, but at least such distance that one passage 22′ may communicate at its upper end with an adjacent passage 22′, whereby the gases flowing up one passage or pair of aligned passages may communicate with and flow down the adjacent passage or aligned passages. By preference, the remaining members 25 in the preheating portion 13*b* are uniformly spaced, being aligned with each fourth pair of pillars 22, counting from the member 25*b*.

27 indicates a plurality of transverse members spaced relatively to each other and extending between the pillars 22 below the muffle bottom 19*a* and closing the space therebetween. The transverse members 27 are provided by building certain of the columns 24 laterally or entirely across the space between the pillars 22. The transverse members 27 are spaced from each other any desired distance, but at least such distance that one passage may communicate at its lower end with an adjacent passage, whereby the gases flowing down one passage 22′ or pair of aligned passages may communicate with and flow up the adjacent passage or aligned passages. By preference, each fourth column is constructed to form a transverse cut-off member 27 except that at the inner portion of the preheating portion I provide a transverse member 27*a* in the plane of the pillars that are between the transverse members 25*a*, 25*b*. As shown in the drawings the member 27*a* is the innermost one and thus forms a long receiving passage 28 into which the down passages 22′ of the main heating portion 13*a* merge, so that all of the heating gases distributed by the chamber 26 flow into this passage. By arranging the members 25*a*, 27*a*, 25*b* in relatively close relation, the heating gases collected in the passage 28 are directed upwardly at a relatively short angle and then downwardly at a relatively short angle, the effect of which is to retard their flow through the passage 26 and down passages conected therewith.

From the drawings it will be noted that the respective transverse members 25 above the muffle throughout the preheating portion 13*b* are disposed in vertical planes midway between the transverse members 27. In this arrangement, as well as the arrangement of the members 25*a*, 27*a*, 25*b*, the passages 22′ throughout the preheating portion 13*b* are connected in series so that the heating gases are directed upwardly and downwardly at either side of the muffle in traversing the preheating portion toward its outer end to effect preheating of the ware. As the passages 22′ merge at their upper and lower ends with the spaces above and below the muffle, the heating gases contact with the top and bottom thereof to preheat the ware as it moves forwardly to the main heating portion 13*a*. Also, in this arrangement the same volume of gases flows in contact with the progressive longitudinal portions of the muffle, so that the heat units of the gases are given up in a gradual manner as the gases flow through the circuitously related passages 22′ to the inlet end of the preheating portion 13*b*.

It will also be noted that the columns 24 between the transverse members 27 are relatively narrow and spaced, as already described, so that a relatively large area of the bottom wall is exposed to the heating gases as they pass from the respective down passages to the adjacent up passages.

To induce a positive flow of the gases in the manner described, I provide a power driven suction means, such as a fan enclosed in a casing 29, the fan being driven by a motor 30. The inlet end of the casing has connected to it a conduit 31, the outer end of the conduit extending through the roof member 9 near the inlet end of the kiln, beyond the outermost transverse member 25.

The inlet end of the kiln is provided with a charging section 32 in which the conveyors 19′ may be positioned preparatory to being moved into the muffle. The charging section is provided with an outlet 33, connected by a pipe 34 with the conduit 31, and adapted to collect any gases escaping into the muffle 19. The walls of the charging section 32 and an end wall 32*a* close the gas circulating space at the inlet end of the kiln.

From Fig. 1*a* it will be noted that the space between the walls 3, 4, throughout the cooling section is open for the circulation of air, which may be admitted through ports 35 formed in the lower portion of the walls 3 and allowed to escape through openings 36 formed in the blocks 8 (see Fig. 6). Baffle walls 4′ are provided as an end wall for the insulation 5 at the inner end of the cooling section 14 as shown in Fig. 1*a*.

Air passes into the passages 22′ throughout the cooling section 14 at the discharge end thereof, below the muffle, which is open. As the transverse members 27 are omitted from the cooling section, the air flows in contact with the muffle bottom and is distributed to all of the passages 22′, flowing upwardly through the latter into the spaces formed above the muffle by the transverse members 25. Each of the spaces just referred to is preferably provided with a valved outlet 37 connected to a conduit 38, which is connected to the conduit 31, so that the suction means may induce a flow of air through the spaces and passages surrounding the muffle through-

out the cooling section 14. Each valve in the outlets 37 is operated by a rod 39 having a handle 39*a*.

The heating means 20 may be adapted to the combustion of gaseous, liquid, powdered or solid fuel, as desired. The form of heating means shown is adapted for burning coal and comprises a combustion chamber 20*a* having a fire back and an ash pit 20*b*, formed by side and top walls which are incorporated with the walls 3 and 4 at one side of the kiln and extend outwardly therefrom. The walls for the heating means are so arranged that the combustion chamber 20*a* communicates directly with the space below the muffle 19. The space at the remote side of the muffle and the space above the top wall of the combustion chamber at the near side of the muffle are filled in with refractory walls 40, 41, so as to guide the heating gases into vertical conduits 42 between such walls and the separating means 15, which conduits are connected to the inner end of the passage 26. 43 indicates a well to facilitate access to the ash pit 20*b*.

The conveyors 19′ preferably consist of suitable metal supports treated to withstand those temperatures usually required for fixing or firing decorations on ceramic ware. Where higher temperatures are to be used these supports are constructed of heat resisting material. The supports 19′ may be provided with suitable wheels to roll on the tracks 21, but by preference they are provided with sets of shoes 21′ having grooves into which the tracks project. The tracks 21 and shoes 21′ are so arranged that the supports are spaced from the bottom walls 19*a* as they move through the muffle. Each conveyor carries a frame 44 having compartments into which the decorated ware is placed, as shown in Fig. 4.

The decorated ware is positioned in frames 44 and each frame is placed on a conveyor. The loaded conveyors are run on the tracks into the charging section and then power is applied to move it a predetermined distance; each loaded conveyor is similarly positioned and moved, each engaging with the next forward conveyor to move it and the previously introduced conveyors. The ware is gradually heated to the desired temperature as the conveyors move on the tracks through the muffle in traversing the preheating portion 13*b* and then the ware is subjected to such temperature for a predetermined period in traversing the main heating portion 13*a*. The conveyors 19′ then traverse the cooling section, during which the ware is cooled sufficiently to permit its exposure to the atmosphere. As the conveyors are discharged from the outer end of the cooling section they are unloaded and returned to the charging section for reloading.

I have not shown herein the means for moving each loaded conveyor into the inlet end of the muffle and the means for moving the empty conveyors from the discharge end of the muffle to the charging section. Each of these means may be of any desired form of construction.

To those skilled in the art to which my invention relates many changes in construction and widely differing embodiments and applications of my invention will suggest themselves without departing from the spirit and scope thereof. My disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

What I claim is:

1. In a kiln structure, the combination of a heating and firing section and a cooling section, a transverse separating wall structure between the inner ends of said sections and having insulation means, said wall structure having a longitudinal opening through it, a muffle in each section in line with said opening and connected thereto to form a continuous muffled passage for loaded conveyors, means for supporting each said muffle in spaced relation to the walls of the adjacent section, and means for supplying heat to the inner end portion of said heating section.

2. In a kiln structure having a bottom and sides and a roof forming a heating section and a cooling section connected in end to end relation, a muffle extending continuously through said sections, means for supporting said muffle in spaced relation to said bottom and sides and roof member, the connecting portion between said sections having a wall closing the space around said muffle to insulate said sections, and means for supplying heat to the inner end portion of said heating section.

3. A kiln structure comprising a bottom, outer walls and inner walls and a roof member, each outer wall and the adjacent inner wall being disposed in spaced relation and forming one side wall of a heating section and a cooling section, the spaces in said side walls throughout said heating section being filled with insulation and the walls of said side walls throughout the cooling section being formed with openings to permit the circulation of air in the spaces in said walls, a separating wall between said sections to prevent flow of heat or heating gases from said heating section into said cooling section, said separating wall being formed with an opening for the passage of ware, a muffle in said heating section extending from end to end thereof and disposed in spaced relation to the bottom, inner walls and roof member in said heating section, the inner end of said muffle being connected with the opening in said separating wall, and means for supplying heat into the inner end portions of said heating chamber.

4. In a kiln structure, the combination of

a heating and firing section and a cooling section, a separating wall structure between the inner ends of said sections, formed with a longitudinal opening through it, said wall comprising a plurality of sets of transversely arranged members, said sets of members being arranged in face to face relation and one set being formed of insulation material, a muffle in each said section in spaced relation to the walls thereof and in line with said opening and connected thereto to form a continuous muffled passage for loaded conveyors, and means for supplying heat to the inner end portion of said heating section.

5. A kiln structure having a bottom, sides and a roof member forming a heating section and a cooling section connected in end to end relation, a muffle extending through said heating section and disposed in spaced relation to said bottom, sides and roof member, pillars spaced from each other along either side of said muffle and each closing the space at either side thereof, a series of spaced transversely arranged members extending over the top of said muffle and each closing the space thereabove between said sides, a series of spaced transversely arranged members extending below the bottom of said muffle and each closing the space therebelow between said sides, and means for supplying heat to said heating section inwardly of one of said series of members.

6. A kiln structure having a bottom, sides and a roof member forming a heating section and a cooling section connected in end to end relation, a muffle extending through said sections and forming a continuous passage for the ware to be treated, said muffle being disposed in spaced relation to said bottom, sides and top, a heating means for supplying heating gases into the space around said muffle at the inner end portion of said heating section, and means throughout said heating section for directing the heating gases in a circuitous path to effect their contact with successive portions of said muffle toward the outer end thereof, whereby the ware moving in the opposite direction is gradually heated.

7. A kiln structure comprising a heating section and a cooling section, said sections being connected in end to end relation, a muffle in spaced relation to the bottoms, sides and tops of said sections, and extending entirely therethrough, a plurality of pillars extending vertically along the side walls of said muffle and spaced relatively to each other throughout said heating section and closing the space between each side wall of said muffle and the adjacent side of said heating section to form passages for the heating gases, means for supplying heat to the inner end portion of said heating section, a transverse member extending across the top of said muffle and closing the space thereabove between the sides of said heating section, said member being disposed at a point remote from the heat supply means, whereby the heat from said heat supply means is distributed to a plurality of passages between said pillars, and suction means connected to the outer end of said heating section for effecting the flow of the heat through the passages between said pillars throughout the remaining portion of said heating section.

8. A kiln structure comprising a heating section and a cooling section, said sections being in end to end relation, a muffle through which the ware to be treated is passed, said muffle extending entirely through said sections in spaced relation to their bottoms, sides and roofs, pillars on the bottom of said heating section in spaced relation longitudinally thereof and extending upwardly between each side of said section and the adjacent side of the latter and extending to the top thereof, to form circulation passages for the heating gases, upper and lower transverse members extending across the top and below the bottoms of said muffle to close the space thereabove and therebelow, each said upper transverse member being disposed in a vertical plane between two of the lower transverse members, whereby the passages between said pillars are connected in series and guide the heating gases into contact with successive portions of the muffle, heating means connected with the inner end portion of said heating section, and a discharge means for the spent gases at the outer end of said heating section.

9. A kiln structure comprising a heating section and a cooling section, said sections being connected in end to end relation, a muffle in spaced relation to the bottoms, sides and tops of said sections and extending entirely therethrough, a plurality of pillars extending vertically along the side walls of said muffle and spaced relatively to each other throughout said heating section and closing the space between each side wall of said muffle and the adjacent side of said heating section to form passages for the heating gases, combustion means connected with the inner end portion of said heating section for supplying the heating gases thereto, a series of cut-off members extending transversely across the top of said muffle between the sides of said heating section in spaced relation to each other, and a series of cut-off members extending transversely below the bottom of said muffle between the sides of said heating section in spaced relation, each member in one series being disposed in a vertical plane between two members of the other series, whereby said members co-operate to connect said passages in series to guide the heating gases in a circuitous path through said heating section.

10. A kiln structure comprising a heating section and a cooling section, said sections

being connected in end to end relation, a muffle in spaced relation to the bottoms, sides and tops of said sections and extending entirely therethrough, a plurality of pillars extending vertically along the side walls of said muffle and spaced relatively to each other throughout said heating section and closing the space between each side wall of said muffle and the adjacent side of said heating section to form passages for the heating gases, combustion means connected with the inner end portion of said heating section for supplying the heating gases thereto, a series of cut-off members extending transversely across the top of said muffle between the sides of said heating section in spaced relation to each other, and a series of cut-off members extending transversely below the bottom of said muffle between the sides of said heating section in spaced relation, each member in one series being disposed in a vertical plane between two members of the other series, whereby said members co-operate to connect said passages in series to guide the heating gases in a circuitous path through said heating section, and said innermost member of each series being disposed in planes remote from the connection with said combustion means to form a main heating portion in which the heating gases are substantially uniformly distributed.

11. A kiln structure having a bottom, sides and a roof member forming a heating section and a cooling section connected in end to end relation, a muffle extending through said heating section and disposed in spaced relation to said bottom, sides and roof member, pillars spaced from each other along either side of said muffle and each closing the space at either side thereof, series of transversely arranged members extending across the top of said muffle in spaced relation to each other in said heating section and said cooling section and each closing the space thereabove between said sides, a series of transversely arranged members extending below said muffle in spaced relation to each other in said heating section and closing the space therebelow between said sides, combustion means for supplying heat to the inner end portion of said heating section, and a valved discharge outlet leading through the roof member of said cooling section between each two adjoining transverse members.

12. A kiln structure comprising a heating section and a cooling section, said sections being disposed in end to end relation, a muffle through which the ware passes extending entirely through said sections and disposed in spaced relation to the bottoms, side walls and top thereof, pillars spaced relative to each other along either side of said heating section, extending inwardly therefrom in aligned relation and closing the spaces between the muffle sides and said side walls and forming passages for heating gases, combustion means connected with the space around said muffle at the inner end of said heating section, and means for closing the space between certain of the pillars in said heating section below the muffle and certain other pillars above the muffle, whereby the passages between the pillars are connected to direct the heating gases upwardly and downwardly relative to said muffle and in contact with its top and bottom walls.

13. A kiln structure comprising a heating section and a cooling section, said sections being disposed in end to end relation, a muffle through which the ware passes extending entirely through said sections and disposed in spaced relation to the bottoms, side walls and top thereof, pillars spaced relative to each other along either side of said heating section, extending inwardly therefrom in aligned relation and closing the spaces between the muffle sides and said side walls and forming passages for heating gases, combustion means connected with the space around said muffle at the inner end of said heating section, means for closing the space between certain of the pillars in said heating section below the muffle and certain other pillars above the muffle, whereby the passages between the pillars are connected to direct the heating gases upwardly and downwardly relative to said muffle and in contact with its top and bottom walls, and columns disposed centrally below said muffle and spaced relative to each other between adjoining closing means, each said column being disposed between and in line with aligned pillars.

In testimony whereof, I have hereunto subscribed my name.

HARRY M. ROBERTSON.