Nov. 26, 1929. H. M. ROBERTSON 1,737,540

KILN

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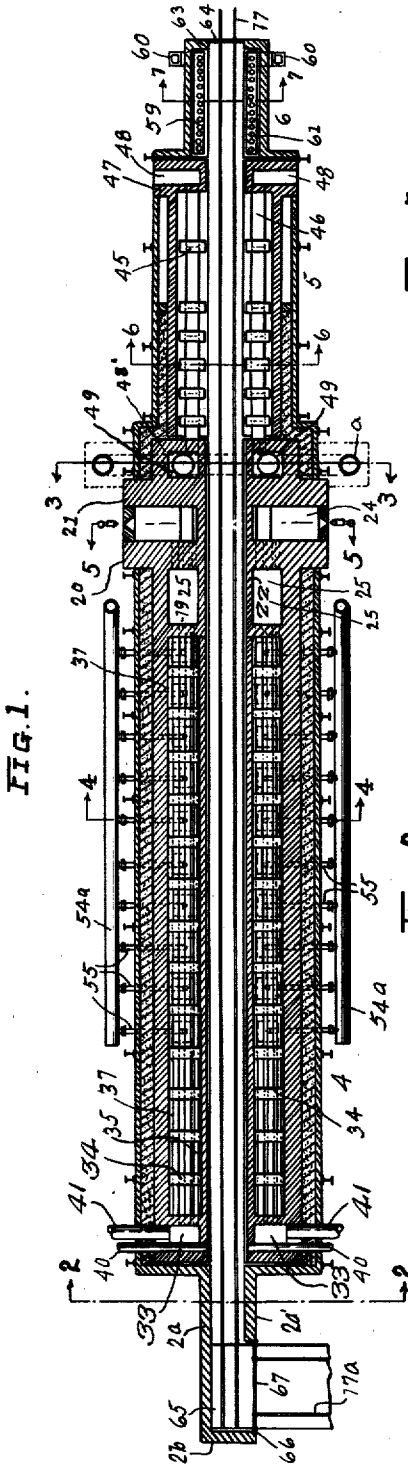

FIG. 1.

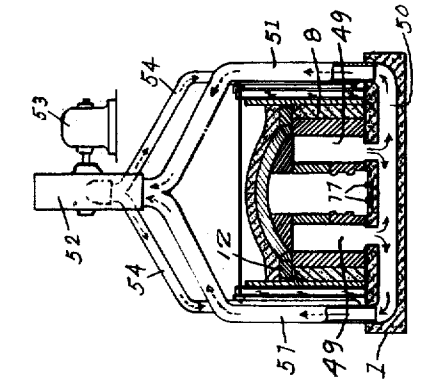

FIG. 3.

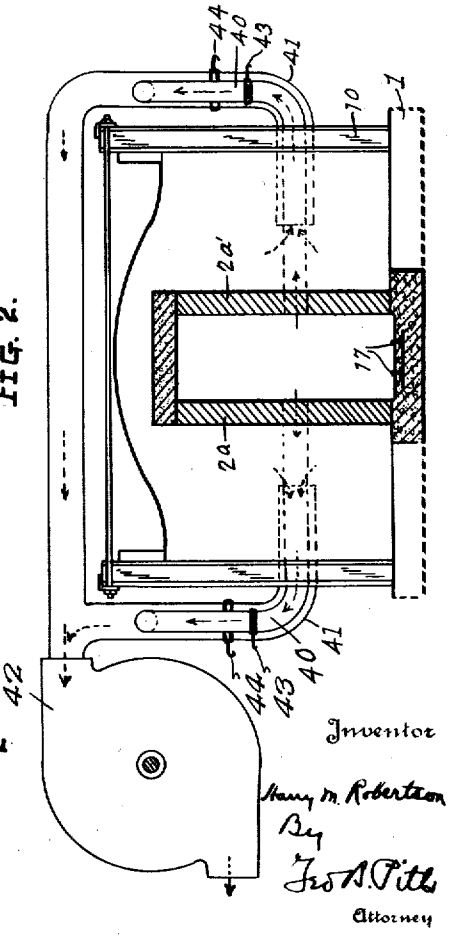

FIG. 2.

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FIG. 4.

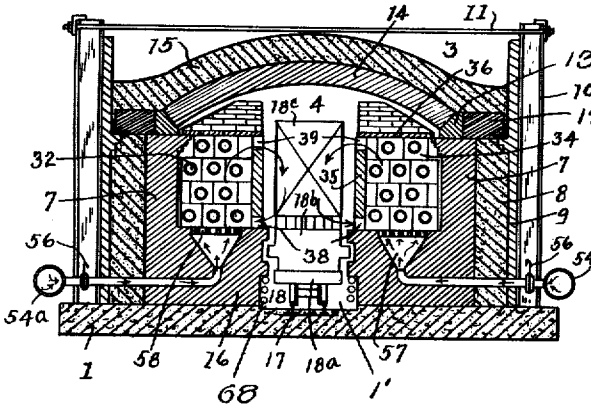


FIG. 6.

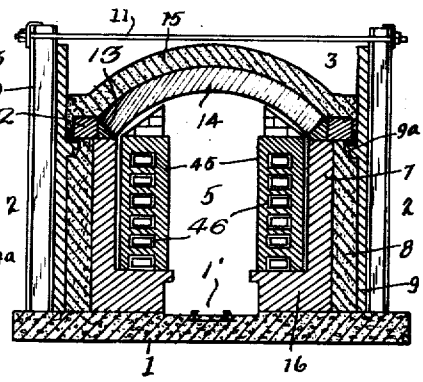


FIG. 5.

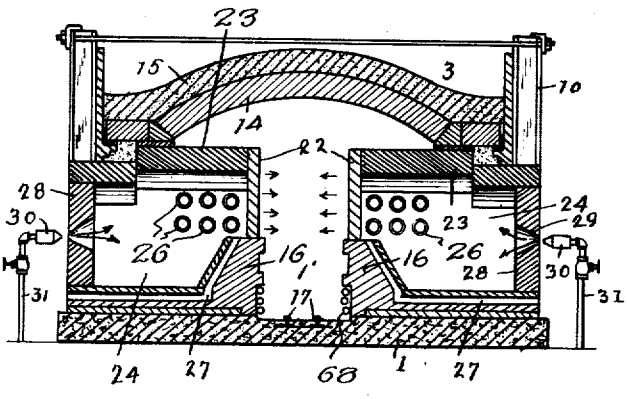
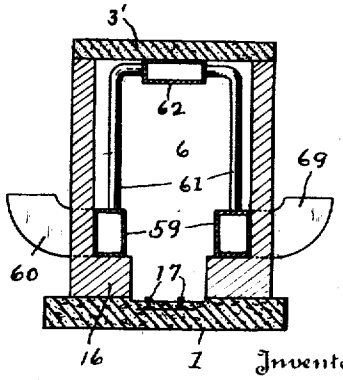


FIG. 7.



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Patented Nov. 26, 1929 1,737,540

UNITED STATES PATENT OFFICE

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KILN

Application filed February 25, 1928. Serial No. 256,953.

This invention relates to a kiln of the tunnel type adapted for burning or heat treating materials or bodies formed of clay or like materials or of metal.

One object of the invention is to provide a kiln of this type so constructed that the bodies or materials may be subjected to a relatively high temperature in an oxidizing atmosphere.

Another object of the invention is to provide an improved kiln of the muffle type wherein provision is made for supplying and circulating heated air in direct contact with the materials or bodies being treated.

Another object of the invention is to provide an improved tunnel kiln of the muffle type so constructed that the materials or bodies passing through the tunnel are simultaneously subjected to the desired temperature by means of radiating heat and heated air in circulation with the result that all portions of the materials or bodies are uniformly and completely treated or conditioned.

A further object of the invention is to provide an improved tunnel kiln of the muffle type capable of treating materials or bodies in an oxidizing atmosphere in a rapid and economical manner.

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

Fig. 1 is a horizontal section of a kiln embodying my invention.

Fig. 2 is a section on the line 2—2 of Fig. 1.

Fig. 3 is a section on the line 3—3 of Fig. 1.

Fig. 4 is a section on the line 4—4 of Fig. 1.

Fig. 5 is a section on the line 5—5 of Fig. 1.

Fig. 6 is a section on the line 6—6 of Fig. 1.

Fig. 7 is a section on the line 7—7 of Fig. 1.

In the drawings, 1 indicates a suitable foundation or base preferably formed of suitably reinforced concrete. Mounted on the base 1 are vertical walls 2, 2, supporting a roof 3 to form a heating zone or chamber 4, the outer end portion of which constitutes a preheating zone, a main cooling zone or chamber 5 and a secondary cooling chamber 6. Each wall 2 may comprise an inner portion 7 built of suitable refractory material or materials, an intermediate portion 8 of suitable insulating material and an outer portion 9 preferably formed of brick; and the walls 2 may be reinforced by vertical beams or struts 10 mounted in the base 1 and connected by tie rods 11. Each of the outer wall portions 9 is provided on its inner surface with a ledge 9^a which cooperates with the upper end of the inner wall portion 7 to support refractory members 12 which form abutments for the blocks 13. The blocks 13 have inclined faces on which the opposite ends of the inner arch member 14 rest. The arch member 14 and blocks 13 are formed of suitable refractory material and they and the members 12 are covered with suitable insulating material 15, to form the roof 3. 16 indicates the benches formed of suitable refractory material and extending from end to end of the walls 2 and forming between them a passage or space 1′ through the chambers 4, 5, and 6. Between the benches 16, the base 1 may be provided with tracks 17 for wheel mounted carriers 18, each comprising a frame 18^a, a refractory base portion 18^b and a holder 18^c of refractory material for holding the ware to be treated. Between the heating chamber 4 and main cooling chamber 5 I provide transverse walls 19, 20, 21, closed at their inner ends at each side of the passage 1′ by a vertical wall 22, supported on the adjacent bench 16 near its free edge and closed at their tops by slabs 23; the wall 19 being connected to the inner wall portion 7 (see Fig. 1). The spaces between the walls 20, 21, 22, form primary combustion chambers 24, whereas the spaces between the walls 19, 20, 22, 7, form secondary combustion chambers 25 wherein the combustion of the fuel is completed to provide at the inner end of the chamber 4 heat therefor. Each primary combustion chamber 24 is connected with the adjacent secondary chamber 25 by a plurality of openings or ducts 26 formed in the wall 20 (see Fig. 5), each opening being lined with a tubular member capable of resisting the high temperatures resulting

from the combustion. The wall forming the bottom of each primary combustion chamber 24 may be formed with an air intake passage 27 having its discharge end disposed at the inner portion of the chamber to provide air for combustion or mixing with the host gases which are to circulate through the heating zone 4, as will later appear. Where coal or coke is used as a fuel, each primary combustion chamber is provided with a suitable grate; where gas or oil is used, the chamber is closed at its outer end by a refractory wall 28, formed with an opening 29 through which the flame from a burner 30 projects; the fuel being supplied by the valved pipe 31. The walls 22, which close the inner sides or ends of the combustion chambers 24, 25, are formed of a material which has a relatively high coefficient of conductivity, so that heat will readily pass through the wall and by radiation (see arrows in Fig. 5) effectively heat the ware, whether the latter consists of materials in bulk or shaped bodies, passing through this portion of the kiln.

32 indicates a series of conduits extending longitudinally through the space above each bench 16, the conduits extending at their inner ends through the adjacent wall 19 so as to receive heat and hot gases from the secondary combustion chamber 25 and at their outer ends extending into a manifold 33, from which the cooled gases are conveyed away in the manner to be later set forth, the manifolds being preferably arranged at or adjacent the entrance end of the chamber 4. As shown in Fig. 4, the conduits 32 are disposed in rows and in staggered, spaced relation to insure contact of air therewith and a mixing of all portions of the air to uniformly and quickly heat it, the air being supplied in the manner to be later set forth. At spaced points along each bench 16, the conduits 32 are supported by transverse walls 34 supported on the bench and through which the conduits extend. 35 indicates a vertical wall extending along each bench 16 near its side edge and 36 indicates a top member resting on the upper edges of the walls 34, 35, the wall 35 and top 36 serving to enclose the adjacent series of conduits and the transverse walls 34 cooperating with the walls 35, 36, to form a plurality of substantially closed spaces 37 between them. Between adjoining walls 34, the wall 35 is cut away along its top and bottom as shown, to form inlets 38 and outlets 39 for the air heated by contact with the conduits 32 and the heat radiating therefrom. As indicated by the arrows in Fig. 4, the air which is heated by radiation from the conduits 32 or contact therewith passes through the openings 39 and downwardly into and through the ware on the carriers 18; the air then passes out through the openings 38 into the spaces 37 where it is reheated. The walls 35 may be formed of a material having a relatively high co-efficient of heat conductivity so that the heat given off from the conduits may be absorbed by these walls and then radiated to the ware. Excess air in the chamber 4 is drawn through it toward its entrance end, thereby serving to heat the fresh or green ware within the kiln, and flows into discharge pipes 40. The pipes 40 may be connected with a suction fan (not shown). The manifolds 33 are connected with discharge pipes 41 and these in turn are connected to the inlet of a casing 42 enclosing a power driven suction fan or vacuum creating device. The flow of the air from the chamber 4 through the pipes 40 is controlled by valves 43, one in each of the discharge pipes 40; and the flow of the cooled gases from the manifolds 33 through the pipes 41 is controlled by valves 44, one in each pipe.

Means are provided for supplying air under pressure to certain of the spaces 37 and by preference this air is pre-heated by the ware as it passes through the main cooling chamber 5, thereby serving to rapidly cool the treated ware and to more quickly as well as economically heat the air to be conducted through and around the conduits 32.

As shown in Fig. 6, the benches 16 in the chamber 5 support a plurality of columns or pillars 45 having aligned openings through which piping 46 extend, the piping at their outer ends leading through transverse walls 47 to receive air from the spaces 48. At their inner ends, the piping 46 lead through transverse walls 48′ into manifolds 49, which have openings at their lower ends connected to a duct 50 formed in and extending transversely of the base 1. Either or both ends of the duct 50 are connected by pipes 51 with the inlet of a casing 52 enclosing a blower or fan driven by the motor 53. The outlet for the casing 52 is connected to pipes 54, having portions 54^a which lead to opposite sides of the chamber 4 and extend longitudinally thereof, as shown in Fig. 1.

Branch supply pipes 55 lead from the pipes 54^a into as many of the spaces 37 as desired, but preferably into all of the spaces except those nearer the outer end of the chamber where the gases flowing through the conduits 32 have cooled to a temperature to make them ineffective for heating the supplied air. Each pipe 55 is provided with a valve or damper 56 and leads through the adjacent wall 2 and adjacent bench 16 and connects with an enlarged opening or chamber 57 formed in the latter. The upper end of each chamber 57 is provided with a plate 58 formed with perforations which diffuses or breaks the air up into small streams for circulation to and around the conduits 32.

By providing along each bench 16 in the heating chamber 4 separate spaces each having an air ontlet at its upper end and an air

inlet at its lower end and delivering preheated air to each of the spaces under pressure, a rapid circulation of the air across and through or between the flue conduits to increase the temperature of the air takes place so that air having a relatively high temperature is directed into direct contact with the ware and an induced draft results to insure circulation through the ware to treat the latter uniformly and quickly and with minimum consumption of fuel.

The secondary cooling chamber 6 may be provided with manifolds 59 extending longitudinally of the benches 16, each having an outlet section 60 leading through the side wall and open at its outer end. The manifolds have connected to them a series of pipes 61 which lead upwardly at either side of the space for the ware and at their upper ends the pipes 61 are bent inwardly for connection with a manifold 62 adjacent the roof 3′ of the chamber 6 and disposed centrally and extending longitudinally thereof, the manifold 62 having an inlet (not shown) leading through the roof 3′. The inlet may have connected to it a supply pipe leading from a suitable blower so as to force air through the pipes 61 for cooling purposes. The chamber 6 is provided with a discharge opening 63 which is closed by a suitable door 64. The tracks 17 extend beyond the opening 63, so that the carriers 18, prior to or after being unloaded may be successively run on to transfer platforms suitably mounted on a trackway and then moved to the loading position, and finally transferred to the tracks 17 and moved into the chamber 4. The construction at the discharge end of the kiln is similar to that at its charging or inlet end, but for convenience I have shown the form of construction and arrangement for handling the carriers 18 at the inlet end only. As illustrated in Fig. 1, the side walls of the kiln are extended as shown at 2^a, $2^{a'}$, 2^b, the walls $2^{a'}$, 2^b, forming an inlet or charging opening 66, which is closed by a door 67 after the transfer platform 65 with a carrier 18 thereon and mounted on tracks 17^a is run into the extended portion of the kiln with the tracks on the platform in aligned relation with the tracks 17.

In my construction of kiln it will be noted that the primary and secondary combustion chambers are disposed at the inner end of the heating chamber 4 and that their inner walls are arranged closely adjacent to the ware as it passes through the chamber and serve as heat transfer walls to subject the ware to the maximum temperature. By regulating the flow of the hot gases through the conduits 32 and the supply of air to the spaces 37, the ware is gradually heated as it moves toward the outlet end of the heating chamber or to the portion therein having the highest temperature. It will also be noted that the primary combustion chambers 24 and manifolds 49 for the air heated in the primary cooling chamber 5 are adjacent and separated by a single wall so that the heat incident to combustion will tend to maintain the air in the manifolds heated or raise its temperature. It will be obvious that the pipes 54, 54^a may be suitably insulated.

68 indicates series of pipes disposed on the sides of the benches 16 and serving to convey air through the carrier space 1′ below the upper surface of the benches, whereby the frame and mountings for the wheels of the carriers will not become overheated.

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

What I claim is:

1. A kiln comprising heating and cooling chambers forming a passage through which loaded carriers pass, combustion chambers between said chambers at opposite sides of said passage, manifolds adjacent the outer end of said heating chamber, a series of conduits for the heat and hot gases disposed at each side of said passage and connected to and leading from each said combustion chamber to one of said manifolds, and walls enclosing each said series of conduits, said walls having a portion disposed vertically at the side of the ware on the carriers as the latter move through said passage and said vertical portion having supply openings arranged opposite the upper portion of the ware and discharge openings arranged opposite the lower portion of the ware.

2. A kiln comprising heating and cooling chambers forming a passage through which loaded carriers pass, combustion chambers between said heating and cooling chambers, manifolds adjacent the outer end of said heating chamber, a series of conduits for the heat and hot gases disposed at each side of said passage and leading from each said combustion chamber to one of said manifolds, and walls enclosing each said series of conduits, said walls having a portion disposed vertically at the side of the ware on the carriers as the latter move through said passage and said vertical portion having supply openings arranged opposite the upper portion of the ware and discharge openings arranged opposite the lower portion of the ware, and means for supplying air to the lower portion of the space enclosing each series of conduits.

3. A kiln comprising heating and cooling chambers forming a passage through which loaded carriers pass, combustion chambers between said heating and cooling chambers, manifolds adjacent the outer end of said

heating chamber, a series of conduits for the heat and hot gases disposed at each side of said passage and leading from each said combustion chamber to one of said manifolds, and walls enclosing each said series of conduits, said walls having a portion disposed vertically at the side of the ware on the carriers as the latter move through said passage and said vertical portion having supply openings arranged opposite the upper portion of the ware and discharge openings arranged opposite the lower portion of the ware, means for supplying air to the lower portion of the space enclosing each series of conduits, and means at the outer end of said heating chamber for conveying away excess air in said chamber.

4. A kiln comprising heating and cooling chambers forming a passage through which loaded carriers pass, connected primary and secondary combustion chambers at each side of said passage between said heating and cooling chambers, the inner side walls of said combustion chambers being in opposed relation to the ware on the carriers as they pass through said passage and formed of a material having a relatively high co-efficient of conductivity, manifolds adjacent the outer end of said heating chamber, a series of conduits for the heat and hot gases disposed at each side of said passage and leading from one of said secondary combustion chambers to the adjacent manifold, walls enclosing each said series of conduits and formed with an outlet arranged opposite the upper portion of the ware on the carriers and with an inlet arranged near the lower portion of the ware.

5. A kiln comprising heating and cooling chambers forming a passage through which loaded carriers pass, combustion chambers between said heating and cooling chambers, manifolds adjacent the outer end of said heating chamber, a series of conduits for the heat and hot gases disposed at each side of said passage and leading from said combustion chamber to one of said manifolds, walls enclosing each said series of conduits, said walls including a vertical portion disposed in opposed relation to the ware on the carriers as the latter move through said passage, and transverse walls through which said conduits extend and co-operating with said enclosing walls to form a series of separate spaces, said vertical portion of said enclosing walls being formed with an outlet leading from each said space arranged opposite the upper portion of the ware and with a discharge opening arranged opposite the lower portion of the ware leading into each said space.

6. A kiln comprising heating and cooling chambers forming a passage through which loaded carriers pass, combustion chambers between said heating and cooling chambers, manifolds adjacent the outer end of said heating chamber, a series of conduits for the heat and hot gases disposed at each side of said passage and leading from each said combustion chamber to one of said manifolds, walls enclosing each said series of conduits, said walls including a vertical portion disposed in opposed relation to the ware on the carriers as the latter move through said passage, and transverse walls through which said conduits extend and co-operating with said enclosing walls to form a series of separate spaces, said vertical portion of said enclosing walls being formed with an outlet leading from each said space arranged opposite the upper portion of the ware and with a discharge opening arranged opposite the lower portion of the ware leading into each said space, and means for supplying air under pressure to each said space.

In testimony whereof, I have hereunto affixed my signature.

HARRY M. ROBERTSON.