March 20, 1928. 1,663,029

H. R. STRAIGHT

TUNNEL KILN

Filed May 25, 1926

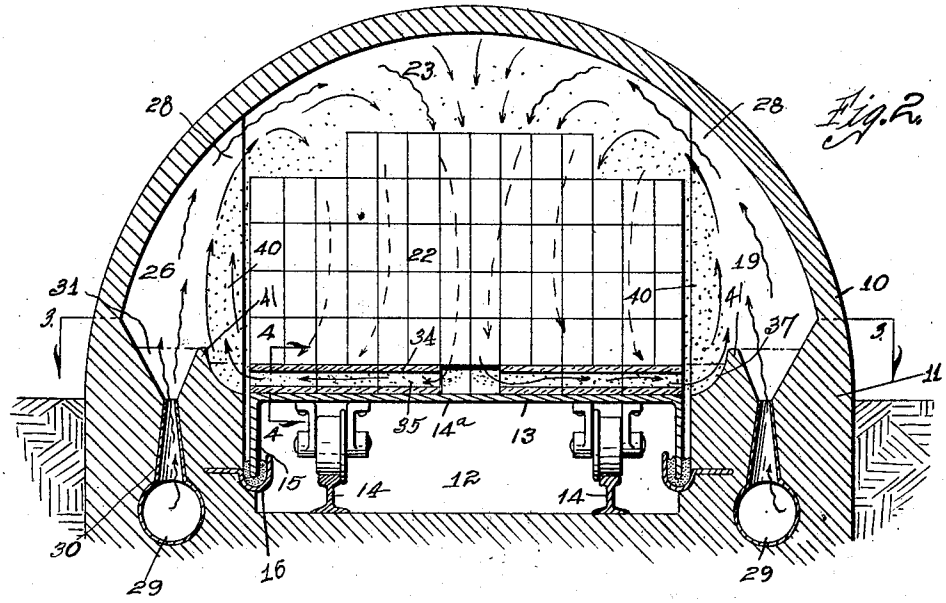


Fig. 2.

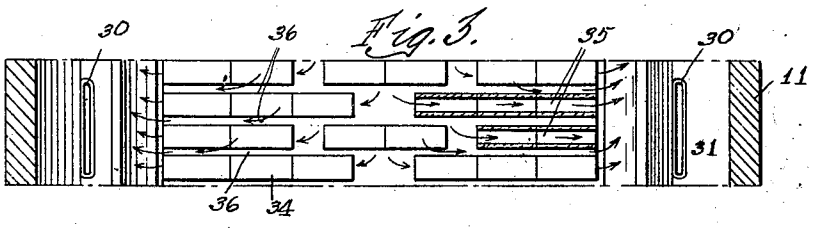


Fig. 3.

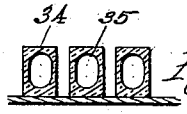


Fig. 4.

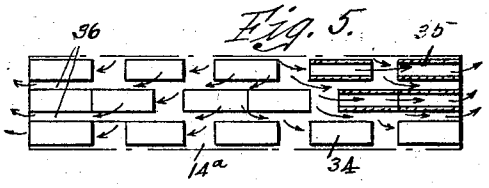


Fig. 5.

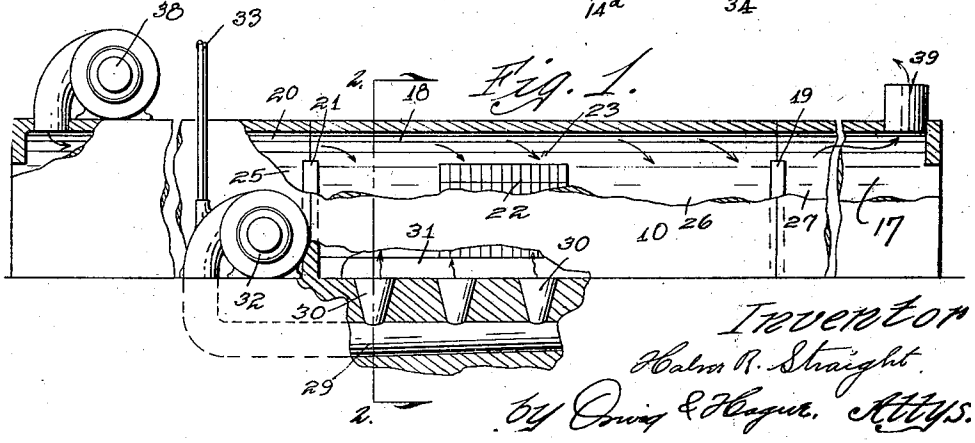


Fig. 1.

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Patented Mar. 20, 1928. 1,663,029

UNITED STATES PATENT OFFICE.

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TUNNEL KILN.

Application filed May 25, 1926. Serial No. 111,528.

The object of my invention is to provide a tunnel kiln having improved means for introducing a fuel for burning the ware and for controlling and circulating the fuel evenly and uniformly through the ware while combustion is taking place.

More specifically it is the object of my invention to introduce the fuel for burning the ware at points on opposite sides of the ware, the fuel being fluid or powdered material such as coal and introduced under pressure, and caused to be delivered to the combustion chamber in such a manner that a pressure head is created above the ware by the combustion of the fuel in such a manner that the heated gases will be forced downwardly through the ware and to cause a recirculation of the products of combustion in such a manner that a blanket of the products of combustion and excess air may be maintained adjacent to the side faces of the stack of ware to protect the same against excessive temperatures and discoloration.

A further object is to provide in a tunnel kiln, having means for feeding the products of combustion upwardly on opposite sides of the stack of ware, improved means for supporting the ware on suitable kiln cars, whereby the ware may be stacked with vertical passages and have in communication therewith horizontal passages arranged transversely with the movement of the cars, said means being so constructed that it may be arranged in such a manner to cause a uniform distribution of the downwardly moving currents of gases passing through the ware.

A further object is to provide a floor construction for kiln cars of hollow blocks made of highly refractory material, which may be formed cheaply by being constructed on the ordinary tile machines, and serve to support a stack of ware arranged with vertical passages and arranged in such a manner that transverse and horizontal passages will be provided in communication with the vertical passages, said blocks being formed of comparatively short lengths so that passages of various lengths may be provided by simply placing a number of the blocks end to end.

My invention consists in the construction, arrangement and combination of the various parts of the device, whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims, and illustrated in the accompanying drawings, in which:

Figure 1 is a segmental side elevation of my improved tunnel kiln, portions of the sides being broken away to show certain details of construction.

Figure 2 is a transverse sectional view taken on the line 2—2 of Figure 1,

Figure 3 is a detail sectional view taken on the line 3—3 of Figure 2.

Figure 4 is a detail sectional view taken on the line 4—4 of Figure 2.

Figure 5 is a plan view showing a modified form of my improved floor construction.

The numeral 10 indicates a tunnel which is of arch construction and substantially semicircular in cross section. The base of said arch is supported on comparatively heavy foundation members 11, which project inwardly a considerable distance so that a passage 12 is provided centrally through the bottom of the kiln, said passage being adapted to receive the kiln cars 13 supported on suitable tracks 14. Each of said kiln cars is provided with a platform 14ª. Each edge of said platform is provided with downwardly extending members 15 designed to travel in suitable sand seals 16.

The tunnel 10 is divided into preheating, burning an cooling compartments or zones. The preheating zone 17 is separated from the burning zone 18 by partitions or walls 19, while the cooling zone 20 is separated from the burning zone 18 by similar walls 21. The inner edges of the walls 19 and 21 are vertical and terminate at a point adjacent to the outer face of the stack of ware 22, which is supported on the kiln cars 13. The ware is stacked substantially as illustrated in Figure 2 in such a manner that a comparatively large chamber 23 is provided above the ware, while chambers 25, 26 and 27 are provided at the sides of the ware. The chamber 25 is in the cooling zones, the chamber 27 in the preheating zone, and the chamber 26 between the walls 19 and 21 in the burning zone. The stack of ware is of such height that a restricted passage 28 is provided between the chambers 25, 26 and 27 and the chamber 23, for the purpose hereinafter made clear.

That portion of the foundation 11 between the walls 19 and 21 is provided with a pipe 29 having in its upper surface upwardly projecting nozzles 30, which are mounted in

the bottom of a substantially V-shaped groove 31, which extends the entire length of the burning zone. The top of each of the nozzles 30 is flattened in the manner clearly illustrated in Figures 1 and 3. The pipe 29 is connected to a fan 32 to provide means for introducing to the nozzles 30 a quantity of air under pressure. A pipe 33 communicates with the pipe 29 at a point near the fan 32, and provides means for introducing into the air either gas or powdered fuel, which will be mixed with the air as it is advanced through the pipe 29 and discharged through the nozzle 30.

The stack of ware 22 is supported by means of a series of rows of hollow blocks 34, the said rows of blocks being arranged transversely on the platform 14ª, said blocks being formed with longitudinal passages 35. The blocks of each row are arranged end to end to form what I shall term groups of blocks to form sections of various lengths, said rows of blocks being spaced apart to form passages 36. The ware is stacked on the blocks in such a manner that vertical passages are provided, which communicate with the passages 35 and 36, thereby providing means whereby gases may be moved downwardly through the ware and outwardly through the said passages 35 and 36 in a manner hereinafter more clearly set forth.

The inner edge of each of the upright wall members 11 is provided with a groove 37, the bottom edge of said groove being slightly below the groove 35 of the blocks 24. The top edge of the inner portion of the members 11 terminates substantially at a point near the bottom of the stack of ware. A blower fan 38 is provided for forcing fresh air into one end of the compartment 23, which is expelled through the pipe 39 at the opposite end of the kiln.

The operation of my device is substantially as follows: Assuming that the floor has been laid on platforms 14ª, and the ware 22 has been stacked thereon in the manner shown in Figure 2, and that the fans 32 and 38 are being operated and that fuel is fed through the pipe 33, then it will be seen that a current of fresh air will be moved longitudinally through the compartment 23, which will be circulated through the ware in the preheating zone by means not illustrated in the drawings, the present application pertaining more specifically to the action in the burning zone. It will be seen that as the blower 32 is operated, fuel will be discharged through the nozzles 30 at considerable velocity. The nozzles are so located that the fuel will be discharged upwardly against the inner face of the arch 10, which will then move upwardly through the restricted passage 28 into the chamber 23. It should be borne in mind that this action is taking place on both sides of the kiln, the pressure being substantially the same on both sides. The mixture of fuel and air from the fan 32 and the pipe 33 is such that combustion is incomplete in the chamber 26, and will be completed in the chamber 23 where it is mixed with the excess of preheated air. It will be seen that considerable amount of pressure will be created by the combustion of the fuels which will cause the heated gases to move downwardly through the vertical passages in the ware 22. It will further be seen that on account of the upwardly moving gases from the nozzle 30, a partial vacuum will be created adjacent to the outer faces of the stack of ware in the stippled area of the drawings indicated by the numeral 40, so that a suction is established in the outer ends of the passages 35.

Thus it will be seen that the products of combustion and the cooler gases will be drawn upwardly into the area 40 adjacent to the outer faces of the stack of ware, forming a recirculation. The products of combustion in the area 40 also serve to blanket the outer surface of the stack of ware against the action of the free carbonaceous substantances of the fuels as they are discharged from the nozzles 30, thereby protecting to a considerable extent the outer face of the ware against discoloration, and also against the rapidly varying temperatures due to the uneven burning of the fuel in the chamber 26. The blanket area 40 is of substantially uniform temperature, due to the presence of the products of combustion at that point.

It will be seen that by providing a floor construction of hollow blocks arranged in rows, each of the rows being formed in groups of blocks, I have provided means whereby the proper downward circulation of the gases may be adjusted, which may be done by the proper arrangement of the groups in the rows, which may be easily accomplished, due to the fact that the blocks are of comparatively short lengths. In Figure 5 I have shown a somewhat different arrangement from that illustrated in Figure 3. It will be seen in Figure 3 that each alternate outer group is provided with two blocks and each of the other alternate groups is provided with three blocks, while in Figure 5 each of the said groups is provided with one less block. In Figure 5 it will be seen that more gases may be moved downwardly near the outer faces of the ware than would be in the arrangement illustrated in Figure 3. The downward circulation of the gases may be also varied by the spacing between the rows of blocks. This spacing, however, is somewhat dependent upon the length of the blocks of ware stacked thereon.

It will be seen that considerable advantage is gained by locating the upper ends of

the nozzles at a point somewhat below the bottom line of the stack of ware and below the passages 35, and in providing the upwardly projecting portion 41 of the wall 11 between the discharge ends of the nozzles 30 and the outer ends of the passages 34, so that there will be a considerable tendency toward forming a vacuum in the groove 37.

A considerable advantage is also gained in providing the restricted passage 28, which will greatly increase the velocity of the gases at that point, and cause more complete mixing of the products of combustion and excess air recirculated with the combustible just introduced, causing an increased pressure head at the central portion of the chamber 23, due to the momentum of incoming gases.

Thus it will be seen that if the fans 32 and 38 are continuously operated, fuel will be continuously fed to the chamber 23 and combustion will take place in a continuous manner as the ware is being advanced through the burning chamber, and that a continuous downward draft of heated gases will be maintained. It should be borne in mind that the natural tendency of the heated gases is to move downwardly after being introduced into the vertical passages, due to the cooling effect of the ware. The gases are recirculated through the ware in two helical streams operating in opposite directions, due to the combined action of the recirculating gases and the advancing movement of the incoming pure air.

Thus it will be seen I have provided a kiln of simple, durable and inexpensive construction, in which the burning of the ware may be uniformly maintained throughout the burning zone, due to the fact that the natural laws of circulation have been economically applied, and that the counteracting resistances have been largely eliminated, thereby permitting free and uniform circulation of the gases with a minimum amount of power.

I claim as my invention:

1. In combination, a kiln car having a platform, of a ware supporting floor carried by said platform comprising a series of spaced and transverse rows of hollow tile, the tile of each row being arranged in separated groups.

2. In combination, a kiln car having a platform, of a ware supporting floor carried by said platform comprising a series of transverse rows of hollow tile, each row comprising a number of separated sections of tile.

3. In combination, a kiln car having a platform, of a ware supporting floor carried by said platform comprising a series of spaced and transverse rows of hollow tile, the tile of each row being arranged in separated groups, the groups of one row being in staggered relation to those of an adjacent row.

4. In combination, a kiln car having a platform, of a ware supporting floor carried by said platform comprising a series of spaced and transverse rows of hollow tile, the tile of each row being arranged in separated groups, the groups of a given row being of various lengths, substantially as described and for the purposes stated.

5. In combination, a kiln car having a platform, of a ware supporting floor carried by said platform comprising a series of spaced and transverse rows of hollow tile, the tile of each row being arranged in separated groups, the outer ends of the end groups of said rows of groups being in common longitudinal alinement.

6. In combination, a tunnel, a kiln car, means carried by said car for supporting ware thereon, means for circulating a fluid downwardly through said ware then outwardly beneath said ware, comprising a series of supporting members for said ware arranged to form transverse passages, said supporting members being arranged to form passages of various lengths to cause a uniform downward movement of the fluid through the ware.

7. In combination, a tunnel kiln, means for conveying a stack of ware having vertical and transverse passages longitudinally through said tunnel kiln, said tunnel kiln being constructed with a mixing chamber at each side of the stack of ware and a combustion chamber above the ware, said combustion and mixing chambers communicating by restricted passage, the bottom of each of said mixing chambers being provided with a series of vertically projecting fuel delivery nozzles, the discharge end of said nozzles being below the lower line of said stack of ware and arranged to discharge the fuel upwardly and somewhat spaced from the outer face of said stack of ware.

8. In combination, a tunnel kiln, means for conveying a stack of ware having vertical and transverse passages longitudinally through said tunnel kiln, said tunnel kiln being constructed with a mixing chamber at each side of the stack of ware and a combustion chamber above the ware, said combustion and mixing chambers communicating by a restricted passage, the bottom of each of said mixing chambers being provided with series of vertically projecting fuel delivery nozzles, the discharge end of said nozzles being below the lower line of said stack of ware and arranged to discharge the fuel upwardly and somewhat spaced from the outer face of said stack of ware, means for delivering a fluid fuel under pressure to said nozzles, and means for advancing air longitudinally through the combustion chamber.

9. In combination, a tunnel kiln, means for conveying a stack of ware having vertical and transverse passages longitudinally through said tunnel, said tunnel being constructed with a mixing chamber at one side of said stack of ware and a combustion chamber above the ware, said combustion chamber and said mixing chamber communicating by a restricted passage, the bottom of said mixing chamber being provided with a vertical projecting fuel delivery nozzle, the discharge end of said nozzle being below the lower line of said stack of ware, for the purposes stated.

10. In combination, a tunnel kiln, means for conveying a stack of ware having vertical and transverse passages longitudinally through said tunnel, said tunnel being constructed with a mixing chamber at one side of said stack of ware and a combustion chamber above the ware, said combustion chamber and said mixing chamber communicating by a restricted passage, the bottom of said mixing chamber being provided with a vertically projecting fuel delivery nozzle, the discharge end of said nozzle being below the lower line of said stack of ware, said nozzle being located outwardly from the ware so that the fuel discharged therefrom will be moved upwardly some distance from the outer surface of the stack of ware to form an induction area in communication with the outer end of said transverse passages.

11. In combination, a tunnel kiln, means for conveying a stack of ware having vertical and transverse passages longitudinally through said tunnel, said tunnel being constructed with a mixing chamber at each side of the stack of ware and a combustion chamber above the ware, said combustion and mixing chambers communicating by restricted passages, the bottom of each mixing chamber being provided with a vertically projecting fuel delivery nozzle, the discharge end of said nozzle being below the floor line of said stack of ware and said transverse passages, and outwardly from the discharge end of said passages a considerable distance, means for feeding fuel and air to said nozzles in such proportions as to form an incomplete combustion in said mixing chamber, and means for feeding pure air to said combustion chamber, substantially as described and for the purposes stated.

Des Moines, Iowa, May 17, 1926.

HALVER R. STRAIGHT.