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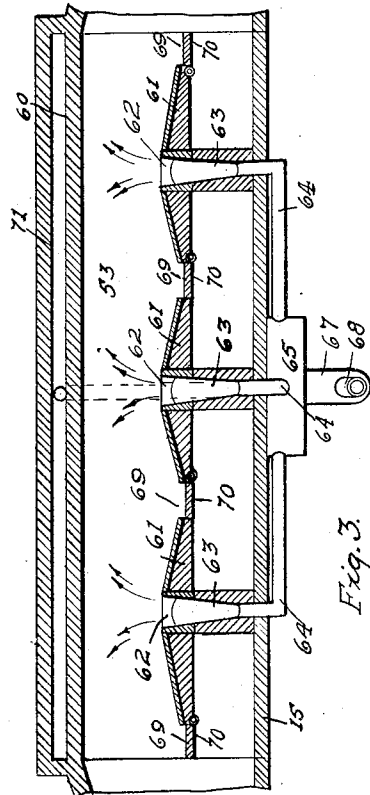
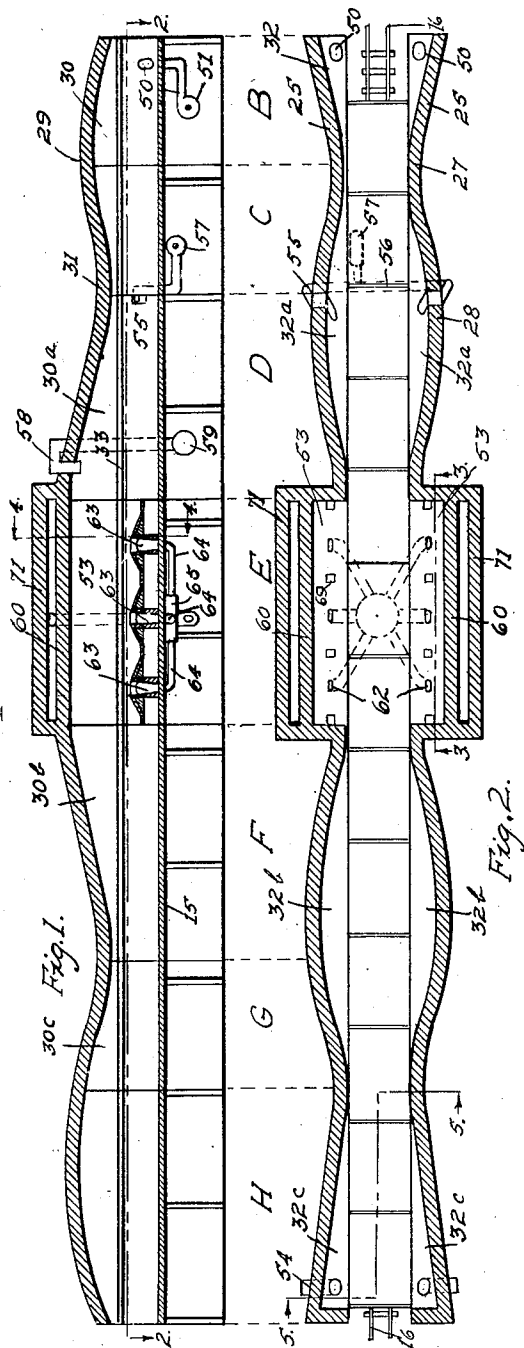
H. R. STRAIGHT

1,711,910

CONTINUOUS KILN

Filed Sept. 28, 1926

3 Sheets-Sheet 1



Inventor.
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May 7, 1929.

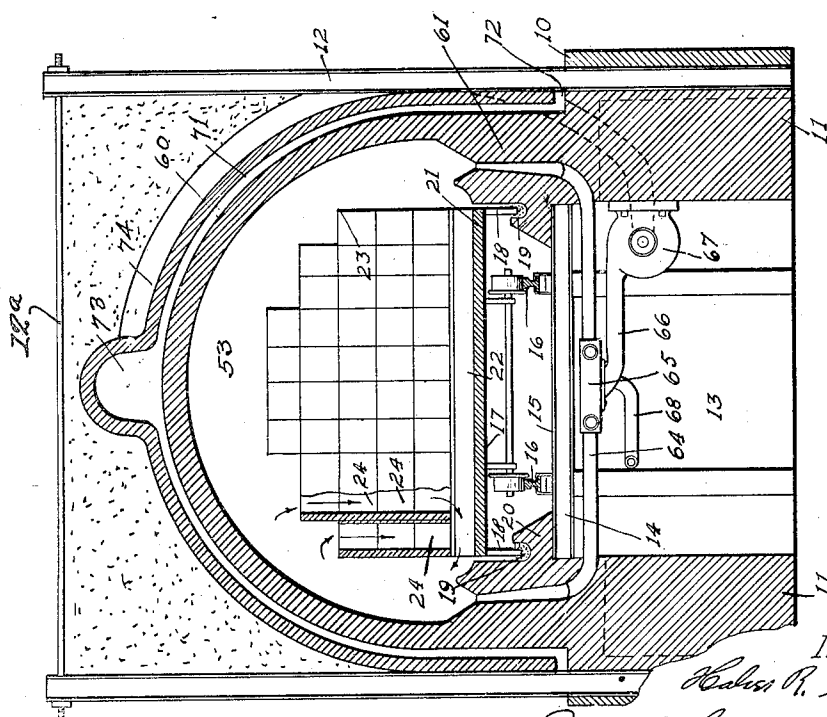
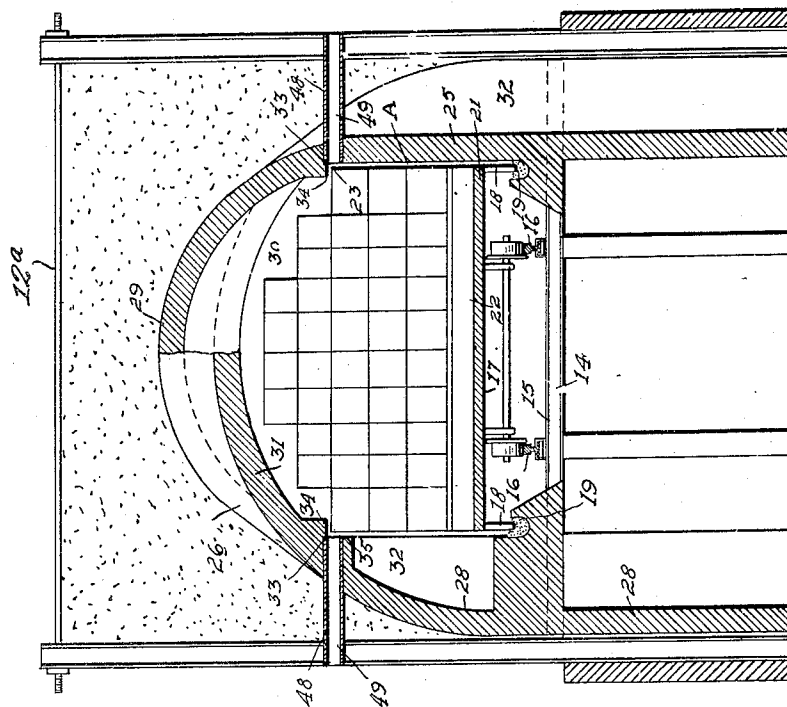
H. R. STRAIGHT

1,711,910

CONTINUOUS KILN

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3 Sheets-Sheet 2



Inventor.
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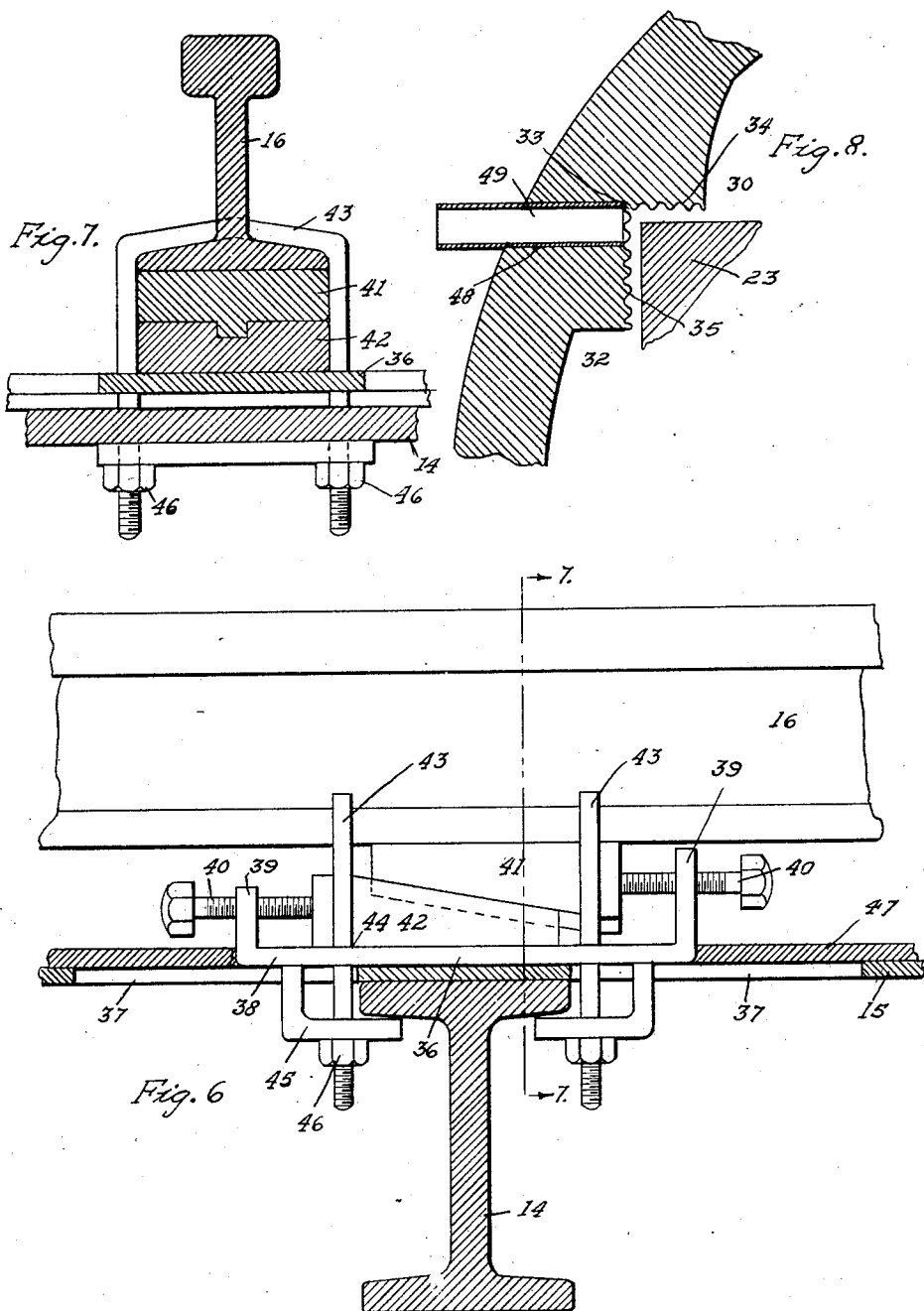
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1,711,910

CONTINUOUS KILN

Filed Sept. 28, 1926

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

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CONTINUOUS KILN.

Application filed September 28, 1926. Serial No. 138,192.

This invention relates to improvements in continuous kilns for burning ceramic ware, and to that particular type of kilns which comprises a horizontally arranged tunnel having a series of ware bearing cars which may be moved either intermittently or continuously through the kiln, the burning of the ware being completed during the time the ware passes through the kiln, which consists in gradually raising the temperature of the ware from the atmospheric temperature to a burning temperature or to the point of vitrification and gradually cooling the same during the time the ware passes through the said kiln.

The object of my invention is to provide a kiln of simple and durable construction which may be divided into a series of distinct compartments or zones for first preheating the ware, then vitrifying or soaking and then cooling, each of these three main sections being divided into sub-sections in such a manner that as the ware is being advanced through the kiln in a continuous and progressive manner from one section to another, the same may be accomplished without any sudden changes in the temperature of the ware, and so arranged that the ware may pass through the complete burning operation in a minimum of time.

A further object is to so construct the walls of the tunnel that the abrupt piers or baffles, or restricted conduits, may be entirely eliminated to reduce to a large extent the friction of the heating and cooling mediums, and at the same time provide the necessary, and somewhat independently operating, sections or divisions.

A further object is to provide means whereby an excess amount of air may be removed from the inner end of the cooling zone, and only a sufficient amount of air permitted to pass into the vitrifying or burning zone to complete the combustion, and to introduce between the inner and outer ends of the cooling zone a predetermined volume of cold air to assist in rapidly reducing the temperature at or near the inner end of said ware.

A further object is to provide means for delivering a constant volume of cold air to

the cooling end of the kiln, which moves through the kiln in a more or less continuous manner, and to adjust the velocity of the air in a given division or section by simply increasing or decreasing the length of said section, thereby eliminating any auxiliary mechanism for increasing or decreasing the volume of the air in said given section.

A further object is to so construct the kiln that when the cars of ware are being passed through the kiln, a chamber may be formed above the ware and one on each side to form conducting means for the circulation of air, and to provide in connection therewith improved means for dividing the top chamber from the two side chambers.

A further object is to provide in a continuous kiln, which is in the form of a tunnel having substantially parallel and vertical walls carrying an arch shaped top, and having means for advancing cars of ware to be burned through said kiln, said ware being stacked in rectangular formation in transverse section, so that the upper corners of the stacks of ware may be utilized to form means for dividing the space within the arch into upper and side compartments, means whereby the stacks of ware may be adjusted to be elevated or lowered or moved transversely while the car is in operation within the kiln, so that the corners of the ware may be made to always clear the arch even if the arch is somewhat moved or warped due to expansion and contraction.

A further object is to provide improved means for distributing the heating medium to the combustion or burning zone.

A further object is to provide means whereby the position of the corners of the ware, relative to the arch, may be readily determined at predetermined points while the kiln is in continuous operation.

A further object is to provide in a continuous kiln a basement compartment in which the various air and fuel conducting conduits, and various apparatus for operating the kiln, may be located, and to provide a compartment which the operator may enter so that the car supporting rails may be adjusted transversely and vertically at vari-

ous points for alining the top corners of the ware, as above referred to, through suitable openings in the kiln floor.

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 longitudinal sectional view of my improved kiln.

Figure 2 is a detail sectional view taken on the line 2—2 of Figure 1.

Figure 3 is an enlarged, detail, sectional view taken on the line 3—3 of Figure 2.

Figure 4 is an enlarged, detail, sectional view taken on the line 4—4 of Figure 1.

Figure 5 is a detail sectional view taken on the line 5—5 of Figure 2.

Figure 6 is a detail, side elevation of my improved device for elevating and lowering the car supporting rails.

Figure 7 is a transverse sectional view of the same taken on the line 7—7 of Figure 6.

Figure 8 is an enlarged, detail, sectional view showing the manner in which the upper and side compartments of the kiln are separated.

My improved kiln is constructed by first excavating a channel 10 from the ground surface and supporting therein a pair of parallel abutments 11 formed of masonry such as concrete. The said abutments 11 are provided with upwardly projecting buck stays 12 formed preferably of I-beams, said beams extending a considerable distance above the said abutments and having their upper ends connected by truss rods 12^a, which provide anchorage for the said beams to support them in an upright position. The abutments 11 are spaced apart to form a basement compartment 13 which extends longitudinally throughout the full length of the kiln.

Supported transversely on the abutments 11 is a series of beams 14 which provides means for supporting the kiln floor 15 and the car tracks 16, said tracks being designed to carry a series of ware supporting cars 17. The side edges of the cars 17 are provided with downwardly extending plates 18 designed to enter sand seals formed in suitable masonry walls 20, which run parallel with the tracks 16 and beneath the side edges of the car floor, as clearly shown in Figures 4 and 5. The top of each car is provided with a floor 21 formed of fireproof and insulating material, said floor being provided with a series of transversely arranged grooves or passages 22, which provide means for conducting the heating and cooling mediums from the ware supported thereon transversely to the side of the cars. The ware is stacked on said cars in the manner clearly illustrated

in Figures 4 and 5, the main body portion of the stack of ware being substantially rectangular in cross section so that corner portions 23 are provided. These corners serve to provide means for separating the compartments above the ware from those at the sides of the ware, in the manner hereinafter made clear. The ware is stacked on the cars in such a manner that vertical passages 24 are provided, the lower ends of which communicate with the passages 22 of the floor 21, so that the heating medium may be carried vertically through the ware.

As before stated, it is my object to divide the kiln into a series of sections, one section being so arranged that the air will pass downwardly through the ware, and the next adjacent section being arranged to cause the air to be moved upwardly through the ware. To accomplish this result, I have constructed on each of the abutments 11 suitable side walls 25 carrying an arch portion 26 to provide a cover for the kiln. The base of said side walls is formed curved, in the manner clearly illustrated in Figure 2, the curves of one wall being in opposite relation to those of the adjacent wall. The said walls are provided with what I shall term contracted portions 27 and expanded portions 28. The inner faces of the contracted portions are designed to rest adjacent to the side edges of the stack of ware, as clearly illustrated at the point "A" in Figure 5. The upper edge of the said contracted portion of the wall terminates substantially on a level with the corner 23 of the ware. The upper ends of said contracted portions are provided with an arch portion 29, which is taken on a comparatively short radius so that a considerable distance is provided between the arch portion 29 and the upper face of the stack of ware, providing a compartment 30 above the ware. The upper edges of the expanded portions 28 are provided with an arch section 31, which has a comparatively large diameter so that the said arch rests above the stack of ware just enough to provide clearance, and providing compartments 32 at the side edges of the stack of ware. The arch portion 31 gradually terminates into the arch portion 29. The arches are so constructed that all of the transverse arch sections between the arch portions 29 and 31 intersect a common longitudinal line opposite the corners 23, so that at any point along the corners 23 of the stack of ware the arch rests adjacent to said corners to separate the side compartments 32 from the top compartment 30.

On the inner face of the arch adjacent to the corners 23, I have provided longitudinally extending grooves 33 formed substantially rectangular in cross section to fit the contour of the said corners. The faces of said grooves adjacent to said corners are pro-

vided with corrugated portions 34, in the manner clearly shown in Figure 8. Thus it will be seen that a slight passage 35 will be provided between the corners 23 and the face of the groove 33, the corrugations 34 extending longitudinally with the corners 23 so that a high resistance is offered to any movement of air between the compartments 30 and 32. The space 35 is provided for clearance between the ware and the arches and should be as small as possible.

To provide means whereby the corner 23 may be properly spaced from the groove 33, I have provided at a number of points beneath the rail 16 adjustable chairs 36, said chairs being supported above the cross beams 14. The floor 15 is provided with openings 37 on each side of the said beams 14 at a point where it is desired to support the chair. Each of the said chairs comprises a plate 38 supported transversely across the beam 14 and beneath the rail 16. Each end of the plate 38 is provided with an upwardly projecting portion 39 to receive set screws 40. The rails 16 are carried by wedges 41 and 42 which are adjustably mounted relative to each other to increase or decrease the elevation of said rail, said wedges being actuated by the set screws 40, the rail being locked in position by means of downwardly extending U-bolts 43 having their downwardly projecting ends extended through suitable openings 44 in the plate 36. The lower ends of said bolts are provided with clamps 45 and nuts 46 by means of which the said rails are clamped to the beam 14 in the manner clearly illustrated in Figures 6 and 7. This provides means whereby the rails may be elevated or lowered to adjust the top of the corner 23 with the horizontally extending face of the groove 33. The vertical edge of the corner 23 may be adjusted relative to the vertical face of the groove 33 by simply loosening the nuts 46 and sliding the rails 16 transversely together with the plates 36. The set screws 40 are operated by the operator reaching through the openings 37 in the floor 15. Loosely mounted cover plates 47 may be provided for the openings 37. Thus it will be seen that the corners 23 may be adjusted relative to the grooves 33 while the kiln is in operation.

To ascertain the position of the corners 23 relative to the grooves 33 I have provided in the arch portion 26 a series of openings 48 which are opposite the corner 23. Said openings 48 are provided with suitable tubes 49 which extend through the wall for supporting the arches in the manner clearly illustrated in Figure 5. These openings 48 provide means whereby the elevation of the corners 23 may be ascertained by sight. The transverse position of said corners being determined by placing a measuring stick within the tube 49 until it engages the outer edge of the corner 23 and then measuring the distance

between said corners 23 and the outer end of the tube 49.

The openings 48 are located in transverse vertical planes extending through the chairs 36 so that said openings and chairs may be provided with corresponding numbers to provide means whereby the proper chair may be easily and quickly found for adjusting the corners 23 relative to the grooves 33 at any given point.

Referring to Figures 1 and 2 it will be seen that I have shown vertical dotted lines for the purpose of indicating the various sections of the kiln. Sections B, C and D form the cooling zone, section E the burning zone and sections F, G and H constitute the pre-heating zone. It will be seen that sections B and C are substantially the same length, while section D is considerably longer. Cold air is delivered through openings 50, said air being delivered by a suitable blower 51. The air will then be moved inwardly through the passages 22 of the floor member 21, thence upwardly through the vertical passages 24 of the stack of ware into the compartment 30 above the ware, thence downwardly through the ware in section C and delivered to the compartment 32^a, and then upwardly through the ware in section D and delivered to the compartment 30^a above the ware, and delivered to the compartment 53 above the ware in the burning zone E. It will then be advanced to the compartment 30^b above the ware in section F, then downwardly through the ware in said section to the compartments 32^b of said sections F and G, thence upwardly through the ware into the compartments 30^c of sections G and H, thence downwardly through the ware in section H and finally to the compartment 32^c of section H, where it is delivered through suitable openings 54. The air is fed to the openings 50 at a fixed speed, which, however, may be varied at the will of the operator and consequently a constant volume of coil air will be delivered to the compartments 32.

It will be seen that as the air enters the compartment 32 it is forced through the transverse passages 22 on account of the seal between the corners 23 of the stack of ware and the grooves 33, and also on account of the contracted portions 27 of the walls 25, said contracted portions being located at the inner end of section B, and the air being forced upwardly through the ware into the compartment 30, which is so arranged that the contracted portion of the arch 29 is supported above the inner end of section C. In other words, the compartment 30 is of a length equal to the sum of the lengths of compartments C and D. The contracted portion 31 of the arch 29 is supported immediately above the ware to force the air downwardly through the vertical passages in the compartment C and outwardly through the

passages 22 into the compartment 32^a. This cycle of operation is continued throughout the entire length of the kiln. By this arrangement it will be seen that air is either moved upwardly or downwardly through the ware in such a manner that the velocity of the air at all points in any given transverse section of the ware in a given compartment is substantially the same.

It will be seen that the sections are arranged in various lengths for the following reasons: In this connection it should be borne in mind that the ware is being advanced through the kiln in the opposite direction from the general longitudinal movement of the air through the kiln, and that it is of a high temperature when in section D and is being cooled as it is moved into sections C and B. As the air is moved upwardly through the ware in section B, it will gradually become heated and will increase in volume, and as section C is substantially of the same length as section B, the cooling air will move more rapidly through section C and the cooling of section C will be relatively greater than in section B, due to the increased velocity, and due to the fact that the difference between the temperature of the air and the temperature of the ware being cooled in section C is greater than the difference between the temperature of the air and the temperature of the ware being cooled in section B. Section D, however, is arranged longer than either sections C or B, on account of the temperature of the air rapidly increasing and, therefore, expanding to greater volume.

I find to prevent making section D too long on account of the reasons above stated, that it is advisable to inject additional cold air into the compartments 32^a. This I have accomplished by means of nozzles 55 connected to a supply pipe 56, which in turn is connected with the blower fan 57 mounted in the basement compartment. The nozzles 55 are arranged in such a manner that the cold air will be delivered and mixed with the heated air in the compartments 32^a before entering the passages 22. This provides means for more rapidly cooling the ware in section D, which is at a very high temperature. The heated air is then delivered to the compartment 53 of the burning zone E, only in such quantities as to support combustion therein, the excess heated air being removed through a pipe 58 located in the inner end of the compartment 30^a. This air is removed by means of a suitable exhaust fan 59 and may be delivered to a drier if so desired. The air is circulated through the ware in the burning zone (section E) by induction from the burners which are so located that eddy currents will be formed, and heated gases caused to move downwardly through the ware and recirculated in such a manner that the temperature of the ware within the burning zone is very

uniform. The longitudinal advance of the ware is very slow, due to the fact that the capacity of the compartment 53 is comparatively large.

To provide for induction and recirculation in section E, as well as supplying the necessary heat to the burning zone, I have provided the following arrangement. Referring to Figures 4 and 5, it will be seen that the compartment 53 extends on the sides of the ware as well as the top, and is enlarged to such an extent that a considerable space is provided around the ware. The said compartment E is provided with an arch portion 60 which is of a uniform radius throughout its length. Between the bases of the arch 60 and the ware are masonry walls 61 in which are provided vertically arranged openings 62, best shown in Figures 1 and 3. Each of these openings is provided with a flattened nozzle 63. Each of the said nozzles is provided with a pipe 64, all of said pipes communicating with a common drum 65, which in turn is provided with a supply pipe 66 having a pressure fan 67 for delivering air to the said nozzles. A fuel pipe 68 is also provided which injects fuel into the drum 65 where it is mixed with the air as it is delivered to the nozzle 63. This fuel may be either a liquid or powdered coal, the latter being preferable. The pressure from the fan 67 will cause the fuel to be delivered from the nozzles 63 at a considerable velocity, some of which will be ignited as it leaves the burner, the flames being discharged adjacent to the arch 60 and will be moved downwardly through the ware by induction, in a manner more fully set forth in my co-ending application filed May 25, 1926, Serial Number 111,528, which has become Patent No. 1,663,029.

It will be seen that the nozzles 63 are spaced apart a considerable distance, and that the top portions of the walls 61 are inclined downwardly and inwardly to openings 69, which are provided with trap doors 70 to provide means for the removal of the ashes from the fuel, which will settle on the inclined portions of the member 61, the ashes being removed through the basement compartment below.

The wall 60 is provided with a passage 71, which has openings 72 at its bottom and an outlet passage 73 at its top. The passage 73 is provided with a pipe 74 which provides an intake for the fan 67. By this arrangement it will be seen that the air delivered to the burners is drawn through the passage 71 and is heated by radiation and conduction from the arch 60, and provides means for delivering slightly heated air to the burners, which is always at a temperature below the ignition point of the fuel. The heated gases from the compartment 53 are advanced through the chamber 30^b (section F) for the purpose of

preheating the ware and are circulated in the manner before described. It will be seen that a comparatively large volume of gas will be delivered from the compartment 53 and inasmuch as it is desirable to keep the velocity of the gases through the ware in said section quite low, so that the chemical action taking place inside the ware may be comparatively slow, as the said chemical action is regulated to a considerable extent by the temperature, which in turn is regulated by the velocity of the heated gases through the ware, and further due to the fact that a considerable oxidation takes place in said section, which of itself creates a considerable amount of heat. Section G is comparatively short, due to the fact that the temperature of the ware has not been raised to the point of active oxidation, and further to the fact that the gases are being cooled as they are advanced through the ware, and still further to the fact that a comparatively slow velocity is desirable in what is known as the water smoking and oxidation zone, which largely takes place in sections F and H. Very little chemical action takes place in section G. The ware having been thoroughly dried by the water smoking process in section H, a rapid increase in temperature may be applied to the ware without damage. Section H is comparatively long due to the fact that it is necessary to slowly remove the chemical moisture from the ware in what is commonly known as the water smoking process, and to maintain a relatively slow velocity of the heating gases.

By this arrangement it will be seen that the heating, cooling and burning mediums may be moved through the ware at the proper velocity at the various points, in such a manner that the ware may be moved through the kiln at a comparatively high rate of speed without cracking or warping the ware, and at the same time giving plenty of time for the proper chemical changes to take place.

By making the walls of the kiln in curved formation with the contracted and expanded portions, it will be seen that the gases may be circulated in a very uniform manner through the ware to secure the maximum efficiency with a minimum amount of friction or resistance, due to the absence of sharp curves and corners.

It will further be seen that I have provided means whereby the upper corners of the stack of ware may be always kept within the proper relation with the grooves 33, which provides a cheap and efficient means for separating the compartments above the ware from those at the sides of the ware. The corrugated faces of said grooves 33 provide means whereby high resistance will be offered to any gases which might have a tendency toward moving through the passage 35.

It will further be seen that by providing

a basement below the kiln, I have provided means whereby the auxiliary mechanism such as air conducting pipes, fans and fuel supplying mechanism may be so located as to be always accessible by the operator, and furthermore so that the pipes leading from the various floors to the point of delivery may be as short as possible, to thereby further decrease the amount of power necessary for operating the kiln.

It will further be seen that I have provided means for utilizing a large percent of the waste heat which is conducted and radiated from the combustion chamber.

It will be seen by providing the drum 65 common to all of the burners, and each of the burners with a separate conducting pipe 68, I have provided means whereby the pressure on each of the nozzles 63 will be substantially the same, so that a uniform velocity of fuel will be delivered to the chamber 53. This arrangement is quite essential when using powdered coal as a fuel, inasmuch as the drum 65 provides a suitable mixing chamber where the fuel and air will be thoroughly and uniformly mixed before being delivered to the pipes. In this connection it should be noted that the powdered fuel is very advantageous in burning ceramic ware, inasmuch as the particles of fuel do not burn instantaneously, but become ignited at a point near the nozzles, and are then delivered to the chamber 53 and downwardly through the passages in the ware. The small particles settle on the surface of the ware and adhere thereto. The burning is then completed in the form of minor coals of fire, thereby applying heat in direct and close relation to the ware. I find by actual experience that the time of burning can be reduced fifty percent over the best methods of burning with liquid fuels.

It will also be seen that a considerable advantage is gained by supporting the lower ends of the buck stays or beams 12 in the masonry walls 11. Said stays should be mounted to such a depth that they will be supported rigidly against outward and lateral movement to form anchorage for the base of the arches. The top ends of the stays are secured together by means of suitable truss rods.

I claim as my invention:

1. A continuous kiln comprising an arched wall construction to form a tunnel, a floor for dividing the space within the tunnel into kiln and basement compartment, tracks on the floor of said kiln, cars for said tracks having ware stacked thereon, the interior face of said arch being provided with longitudinal grooves to receive the longitudinal and upper corners of said stack of ware, means for adjusting said tracks vertically and transversely to adjust the corners of said stack of ware relative to said grooves.

2. A continuous kiln comprising an arched wall construction to form a tunnel, a floor for dividing the space within the tunnel into kiln and basement compartments, tracks on the floor of said kiln, cars for said tracks having ware stacked thereon, the interior face of said arch being provided with longitudinal grooves to receive the longitudinal and upper corners of said stack of ware, means for adjusting said tracks vertically and transversely to adjust the corners of said stack of ware relative to said grooves, the inner faces of said grooves being provided with longitudinal corrugations to offer resistance to the passage of air between said corners and said faces.

3. In a continuous kiln comprising an arched tunnel, the combination of a stack of ware rectangular in cross section and adapted to be moved longitudinally through said tunnel with the upper longitudinal corners of said stack of ware lying adjacent to the inner face of the arch in such a manner as to divide the tunnel into upper and side compartments, and means for restricting any movement of gases between the side and upper compartments comprising a longitudinal groove for receiving each of said corners, the inner face of said grooves being roughened to offer resistance to the passage of said gases.

4. In a continuous kiln comprising an arched tunnel, the combination of a stack of ware rectangular in cross section and adapted to be moved longitudinally through said tunnel with the upper longitudinal corners of said stack of ware lying adjacent to the inner face of the arch in such a manner as to divide the tunnel into upper and side compartments, means for restricting any movement of gases between the side and upper compartments comprising a longitudinal groove for receiving each of said corners, the inner faces of said grooves being roughened to offer resistance to the passage of said gases, and means for adjusting the corners of said stack of ware relative to said grooves.

5. In a continuous kiln comprising an arched tunnel, the combination of a stack of ware rectangular in cross section and adapted to be moved longitudinally through said tunnel with the upper longitudinal corners of said stack of ware lying adjacent to the inner face of the arch in such a manner as to divide the tunnel into upper and side compartments, means for restricting movement of gases between the side and upper compartments comprising a longitudinal groove for receiving each of said corners, the inner faces of said grooves being roughened to offer resistance to the passage of said gases, means for adjusting the corners of said stack of ware relative to said grooves, and means for determining the location of said corners relative to said grooves.

6. In a kiln for burning ceramic ware, an arched wall to provide a combustion chamber, a number of nozzles for injecting combustible fuel into said chamber, a drum for supplying fuel to all of said burners located below the ware carrying means, said drum being located between said burners, each of said burners being located with a separate conducting pipe radiating from said drum, and means for supplying fuel to said drum under pressure.

7. In a kiln for burning ceramic ware, an arched wall to provide a combustion chamber, a number of nozzles for injecting combustible fuel into said chamber, a drum for supplying fuel to all of said burners, said drum being located centrally between said burners, each of said burners being provided with a separate conducting pipe radiating from said drum, said arched wall being provided with a jacketed air passage for absorbing radiated heat therefrom, means for drawing air through said passage and delivering it to said drum under pressure, and means for injecting a powdered fuel into said drum.

8. A kiln comprising a pair of parallel upright walls having an arched cover, means for advancing stacks of ware longitudinally through said kiln, a series of upwardly extending nozzles located in rows between said stack of ware and said walls, said nozzles being below the bottom edge of said stack of ware and spaced apart, a trap door located between two adjacent nozzles, a drum located below and between said rows of nozzles, a separate conductor for communicating each of said nozzles with said drum, and means for supplying said drum with air and powdered fuel under pressure.

9. A kiln comprising oppositely arranged walls having an arched cover, a floor for dividing the interior of said walls into kiln and basement compartments, a series of nozzles extending upwardly through said floor, said nozzles being spaced apart, an ash door between two of said nozzles, and means for supplying fuel to said nozzles.

10. A continuous kiln comprising upright walls having an arched cover to form a tunnel, said walls being so arranged that when ware is being passed through the kiln the interior of said kiln will be divided into cooling, combustion and preheating zones, means for supplying cooling air to the delivery end of said kiln and said cooling zone, means for supplying additional air midway between the outer and inner ends of said cooling zone, means for removing a predetermined amount of heated gases from a point near the inner end of said cooling zone, the heated gases not removed by the last said means being moved forwardly over the top of the ware into the combustion chamber, means for supplying combustible material to said combustion chamber.

tion chamber, said fuel being introduced in upwardly extending jets to circulate the heated products of combustion together with the heated gases from said cooling chamber through the ware in said combustion chamber by induction, and means for causing the heated gases from said combustion chamber to be circulated through the ware in the preheating zone.

11. A continuous kiln comprising upright walls having an arched cover to form a tunnel, said walls being so arranged that when ware is being passed through the kiln the interior of said kiln will be divided into cooling, combustion and preheating zones, means for supplying cooling air to the delivery end of said kiln and said cooling zone, means for supplying additional air midway between the outer and inner ends of said cooling zone, means for removing all heated gases from the inner end of said cooling zone other than are needed to complete combustion in said combustion zone, means for injecting fuel into said combustion zone, means for supplying said fuel injecting means with heated air, said air being heated by radiated heat from the exterior of said combustion chamber, and means for circulating the heated gases from said combustion chamber through the ware passing through the preheating zone.

12. In a continuous kiln having a combustion chamber, the walls of said combustion chamber being provided with an air passage, means for injecting fuel into said combustion chamber, and means for drawing air through said air passage and delivering it to said fuel injecting means.

13. In a continuous kiln comprising upright and arched walls to form a tunnel, a pair of rails mounted longitudinally on the bottom of said tunnel, means for providing a combined vertical and transverse adjustment to said rails.

14. A continuous kiln comprising an arched wall construction to form a tunnel, rails on the floor of said kiln, cars for said rails having ware stacked thereon, the interior face of said arch being provided with longitudinal grooves to receive the longitudinal and upper corners of said stack of ware, means for adjusting said rails vertically and transversely to adjust the corners of said stack of ware relative to said grooves, the inner faces of said grooves being provided with longitudinal corrugations to offer resistance to the passage of air between said corners and said faces.

15. In a continuous kiln comprising an arched tunnel, the combination of a conveyor designed to support a stack of ware rectangular in cross section and adapted to be moved longitudinally through said tunnel with the upper longitudinal corners of said stack of ware lying adjacent to the inner face of the arch in such a manner as to divide the tunnel

into upper and side compartments, means for restricting any movement of gases between the side and upper compartments comprising a longitudinal groove for receiving each of said corners, means for adjusting the corners of said stack of ware relative to said grooves, and means for determining the location of said corners relative to said grooves.

16. In a continuous kiln comprising an arched tunnel, the combination of a conveyor designed to support a stack of ware rectangular in cross section and adapted to be moved longitudinally through said tunnel with the upper longitudinal corners of said stack of ware lying adjacent to the inner face of the arch in such a manner as to divide the tunnel into upper and side compartments, and means for determining from the outside of said kiln the positions of said corners relative to the inner face of said arch.

17. In a continuous kiln comprising an arched tunnel, the combination of a conveyor designed to support a stack of ware rectangular in cross section and adapted to be moved longitudinally through said tunnel with the upper longitudinal corners of said stack of ware lying adjacent to the inner face of the arch in such a manner as to divide the tunnel into upper and side compartments, means for determining from the outside of said kiln the positions of said corners relative to the inner face of said arch, and means for adjusting the relative position of said corners to said arch.

18. In a continuous kiln comprising an arched tunnel, the combination of a conveyor designated to support a stack of ware rectangular in cross section and adapted to be moved longitudinally through said tunnel with the upper longitudinal corners of said stack of ware lying adjacent to the inner face of the arch in such a manner as to divide the tunnel into upper and side compartments, and means for restricting any movement of gases between the side and upper compartments comprising a longitudinal groove for receiving each of said corners.

19. In a continuous kiln comprising an arched tunnel, the combination of a conveyor designed to support a stack of ware rectangular in cross section and adapted to be moved longitudinally through said tunnel with the upper longitudinal corners of said stack of ware lying adjacent to the inner face of the arch in such a manner as to divide the tunnel into upper and side compartments, means for restricting any movement of gases between the side and upper compartments comprising a longitudinal groove for receiving each of said corners, and means for adjusting the corners of said stack of ware relative to said grooves.

20. In a kiln for burning ceramic ware, an arched wall provided with a combustion chamber, said walls and said arch being provided with a jacketed air passage, means for

circulating air through said passages for absorbing radiated heat from the said combustion chamber.

21. In a kiln for burning ceramic ware, an
5 arched wall provided with a combustion chamber, said walls and said arch being provided with a jacketed air passage, means for

circulating air through said passages for absorbing radiated heat from the said combustion chamber, fuel burners for said chamber, 10
and means for conducting the heated air from said jacketed passages to said burners.

Des Moines, Iowa, September 21, 1926.

HALVER R. STRAIGHT.