J. B. OWENS.

CONTROLLABLE DRAFT FOR TUNNEL KILNS.

APPLICATION FILED MAR. 3, 1917.

1,289,889. Patented Dec. 31, 1918.

4 SHEETS—SHEET 1.

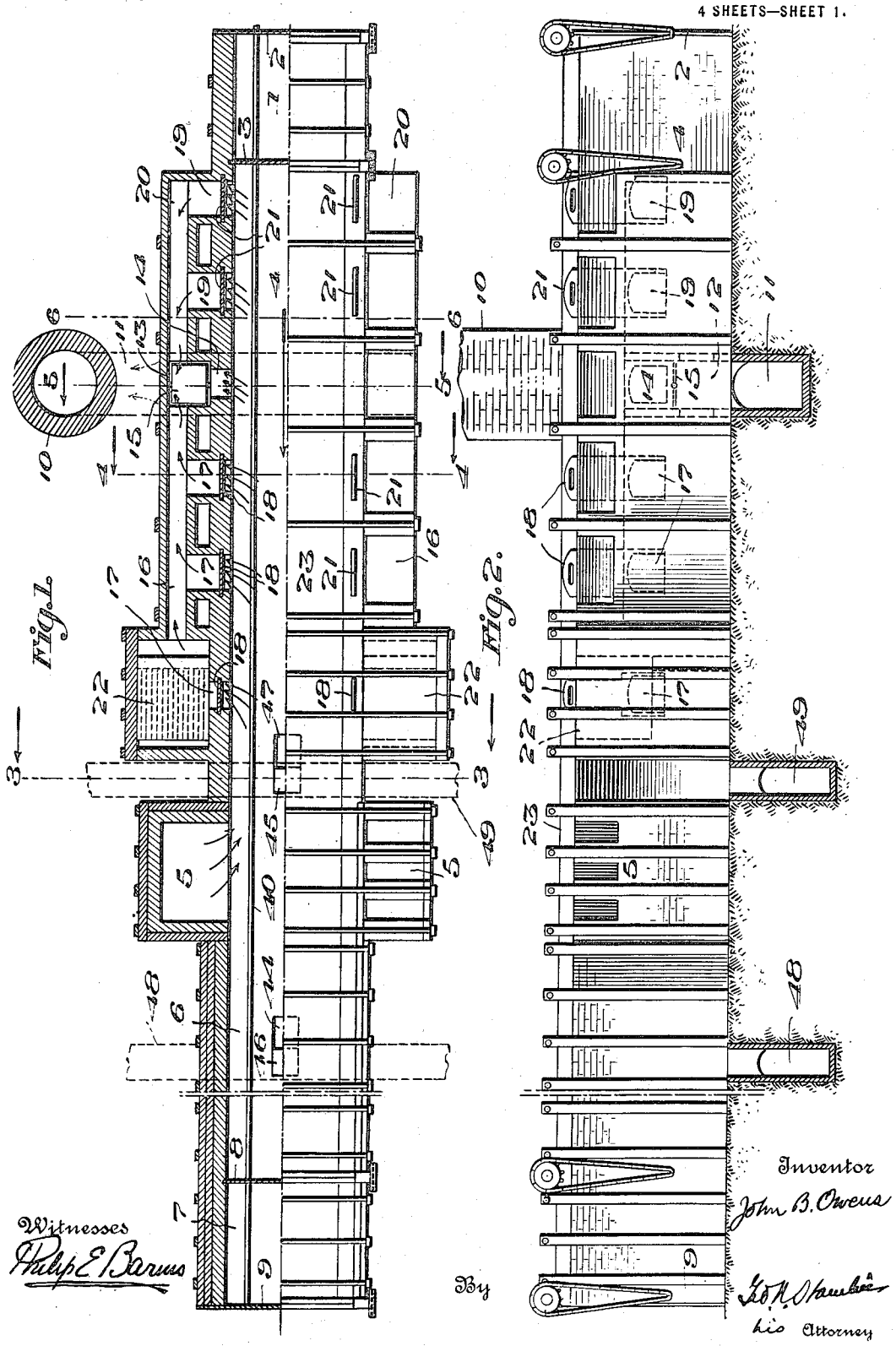


Fig. 1.

Fig. 2.

Witnesses

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4 SHEETS—SHEET 2.

Fig. 3.

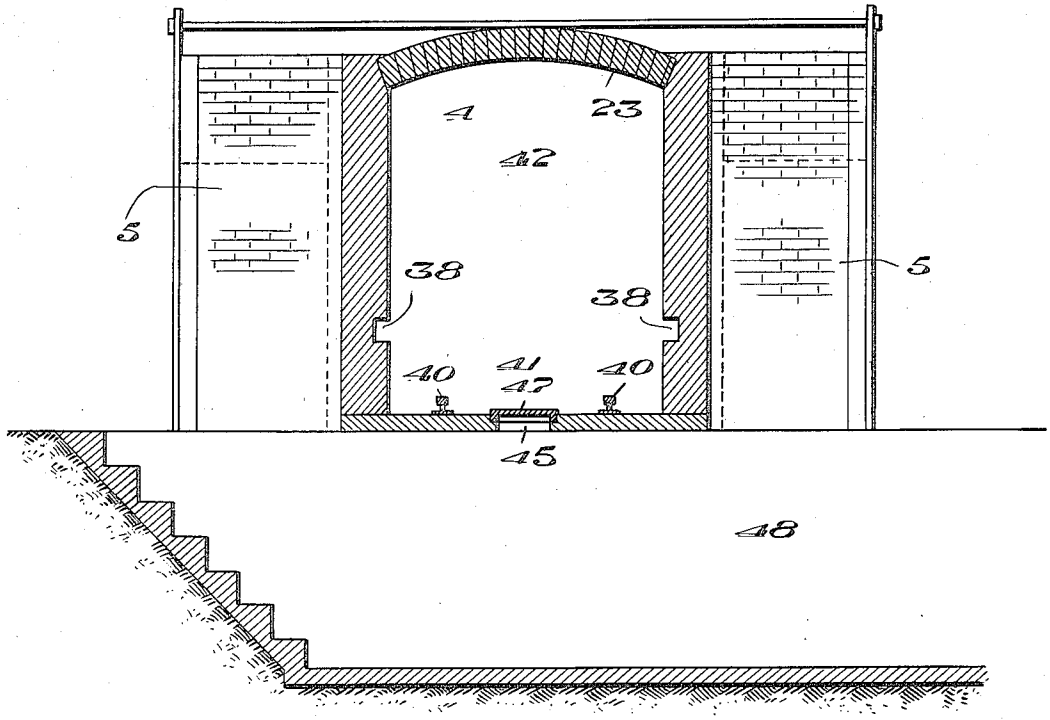
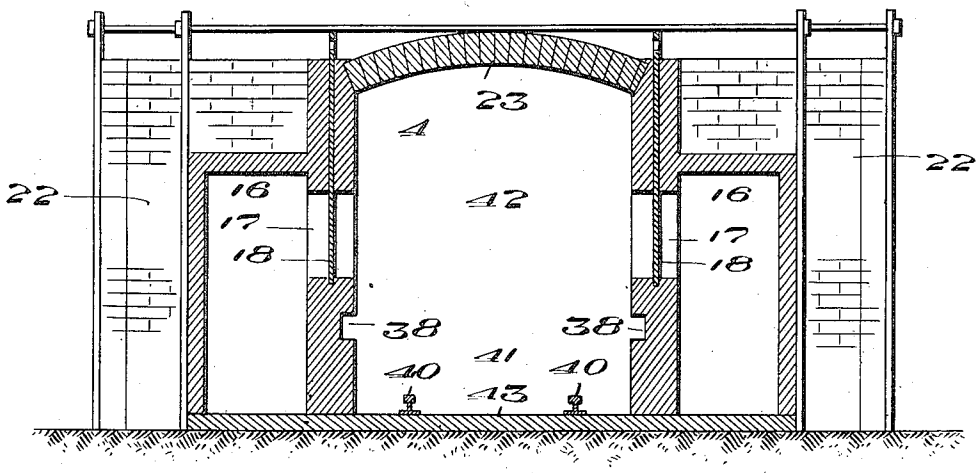


Fig. 4.



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4 SHEETS—SHEET 3.

Fig. 5.

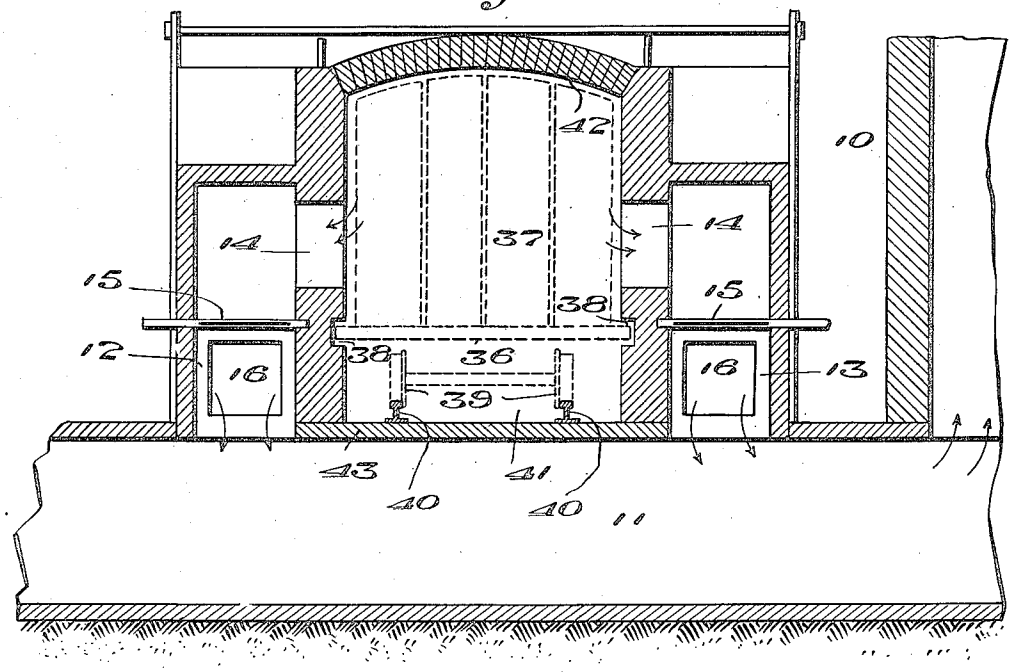
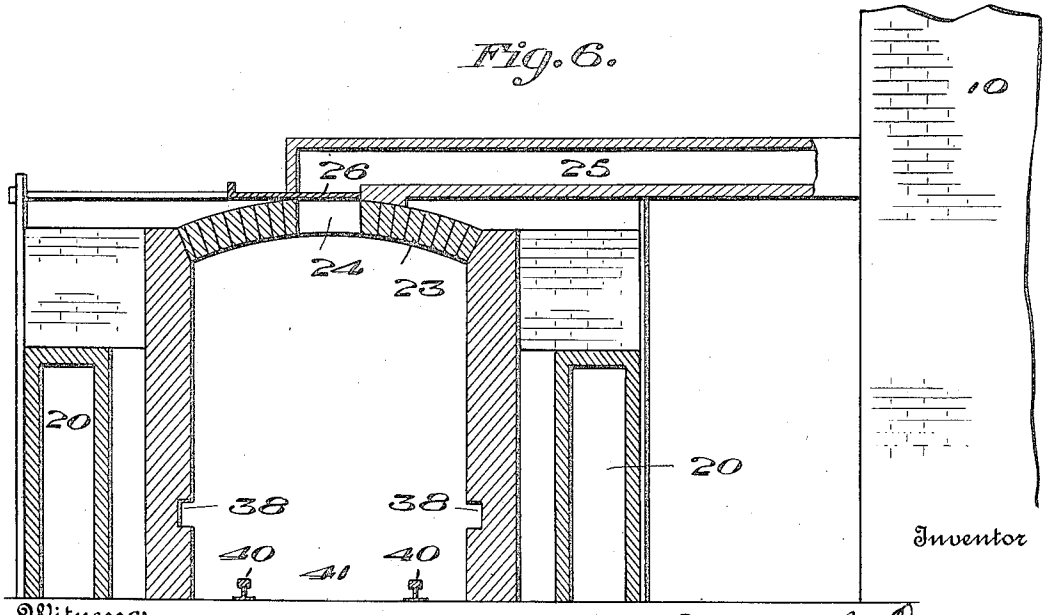


Fig. 6.



Witnesses

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4 SHEETS—SHEET 4.

Fig. 7.

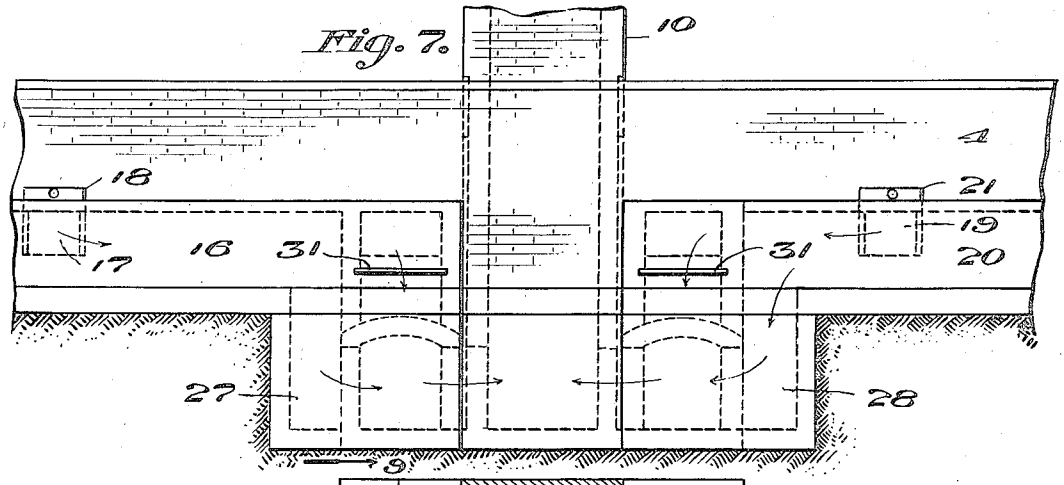


Fig. 8.

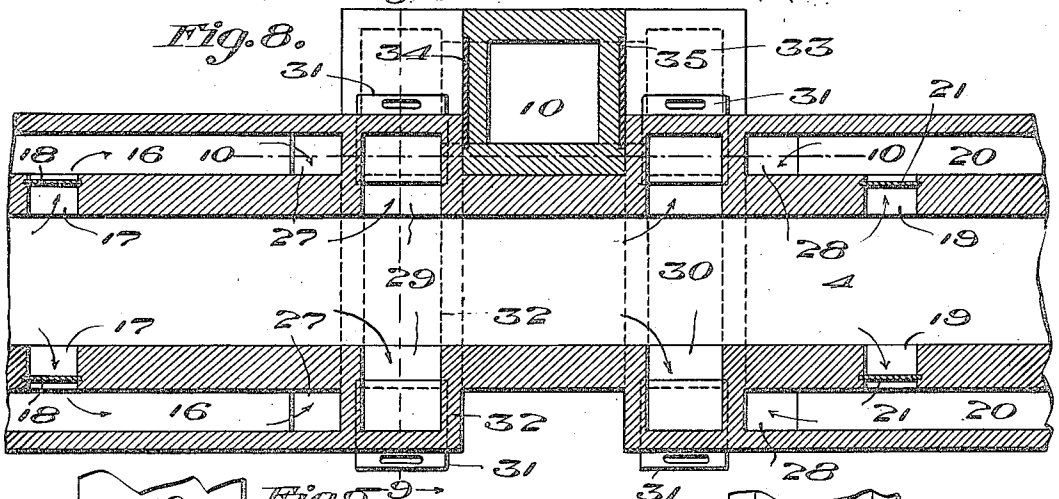


Fig. 9.

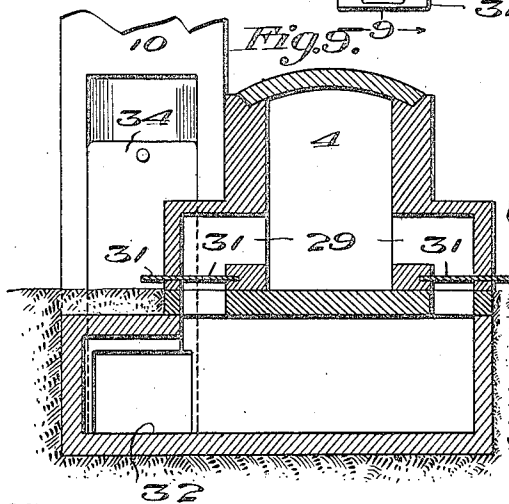
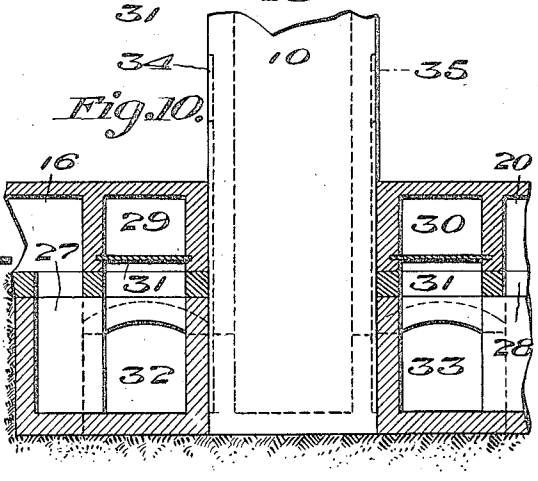


Fig. 10.



Witnesses

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UNITED STATES PATENT OFFICE.

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CONTROLLABLE DRAFT FOR TUNNEL-KILNS.

1,289,889. Specification of Letters Patent. Patented Dec. 31, 1918.

Application filed March 3, 1917. Serial No. 152,444.

To all whom it may concern:

Be it known that I, JOHN B. OWENS, a citizen of the United States, residing at Metuchen, county of Middlesex, and State of New Jersey, have invented certain new and useful Improvements in Controllable Drafts for Tunnel-Kilns, of which the following is a specification.

This invention relates to tunnel kilns and has for its object the provision of a controllable draft therefor.

The molding of a piece of pottery, tile, or brick requires the presence of a certain quantity of water in the raw material. The next step is to slowly dry the molded article until all suspended moisture is eliminated so that the central portion of the piece will become dry before the outer surface commences to harden. If the outer surface hardens before the moisture is eliminated from the central portion of the piece, a crack necessarily develops to liberate steam generated inside the piece. Another critical point is reached at the temperature when what is commonly known at "water of combination" is liberated. To raise the piece to either of these critical temperatures too rapidly, invariably results in damage or total loss of the article.

In a tunnel kiln the exact temperatures therein at the critical points above mentioned, may vary somewhat according to the nature of the material being burned and its rate of progress through the tunnel. Thin material, such as floor tile, can be heated much more rapidly than brick or heavy pieces of pottery which may contain more suspended moisture than tile and require more time for heating the mass.

Weather conditions, rate of production, and other considerations may render it necessary from time to time to change the rate at which heat is applied to or withdrawn from the kiln in order that uniform conditions may be maintained inside the kiln at different points of the length thereof.

The nearest to an ideal condition would be a constant rate of firing and a uniform travel through the kiln of the material to be burned. The maintenance of fire at a constant degree of intensity and constant rate of fuel consumption contributes to thermal efficiency and economy of labor and supervision. A certain minimum temperature is the lowest at which a given ware can be finished and there is a maximum temperature going beyond which will result in overburning and damage.

The economy of operation of a tunnel kiln depends largely upon the extent to which the heat contained in the products of combustion from the furnace can be absorbed before these products of combustion reach the stack or other draft inducing means. If the material is conveyed through the tunnel with sufficient rapidity to absorb a maximum amount of the heat liberated from the furnace, too rapid heating of the ware may result, with consequences as previously described.

To obtain the desired graduation of heat at different points at its length, a tunnel kiln might be built of a length sufficient to give the desired stack temperature at the proper rate of progress of the ware within the tunnel. Great length of a tunnel kiln increases the cost of installation and raises the investment to a point where there is no economy. Moreover, the greater the length of the tunnel, the more complicated becomes the problem of driving the means for conveying the ware therethrough. A further disadvantage inhering in a tunnel of excessive length would arise when a material different from that which the kiln was designed to treat, was introduced, inasmuch as the sole means for regulation of the heat would be regulation at the furnace itself. It is not practicable to change the rate of travel of the conveyer, once its rate has been determined, nor to locate the point of maximum temperature where more rapid heating could be effected after passing the point of critical temperature, because the kiln could then only be used for one class of ware and, furthermore, the furnace might have to be located so near the stack or draft inducing means as to reduce the thermal efficiency of the kiln below the point dictated by commercial requirements.

If the introduction of heat at different points along the tunnel is resorted to in order to secure the desired distribution, serious stack losses and inconvenience in operation result and such method is particularly impracticable where the fuel is wood or coal.

The successful operation of any kiln for

burning ceramic ware, or material made from clays, once the required heat has been attained in the furnace, depends largely upon the rate at which the material being burned is brought up to its maximum heat, also upon the rate of cooling. Heat control is necessary also in annealing, hardening, and metallurgical operations, as well as in certain processes in the manufacture of glass ware.

The foregoing enumeration of conditions met with in practice in the operation of tunnel kilns, clearly shows the advantages of a kiln which can be standardized to handle a variety of ware without necessitating changes in the construction of the kiln when a change is made from the burning of one class of ware to another class, and which enables the kiln to be of comparatively short length so that the first cost of construction is comparatively low and the space required is not so great as to prevent the use of the kiln in industrial operations in those localities where space is costly.

The kiln constituting the present invention possesses the advantages just enumerated, is simple in construction and operation, and may be successfully operated without expert labor or supervision. The desired objects are accomplished entirely by manipulation of the draft, the furnace or source of heat of the kiln being maintained at the temperature which is required for the finishing of the material to be heated or burned. At different points of the length of the tunnel, between the furnace or source of heat and the stack or draft inducing means, the tunnel is provided with openings, controlled by dampers, leading into a flue or flues connecting with the stack whereby heat may be taken off from the tunnel at whatever point or points may be found necessary to obtain the proper temperature range.

As, for instance, set forth in my applications Serial Nos. 142674 and 142675 the heat taken off in this manner may be absorbed by a waste heat boiler, sanitary incinerator, or other means, in its passage to the stack.

I do not consider, however, that regulation by draft manipulation as thus generally set forth, would fulfil the objects of my invention in all of its aspects, because the temperature of the stack itself is often above the first critical temperature and if enough heat be taken from the tunnel at a point or points between the furnace and the stack, to reduce the temperature of the tunnel at a point opposite the stack below the temperature of the stack itself, the thermal efficiency of the kiln would be seriously impaired, unless indeed, a comparatively elaborate system of heat absorbing devices, such as waste heat boilers, or similar apparatus, is installed. Furthermore, the graduation of heat simply by allowing the escape thereof from the tunnel at different points might not be regulated closely enough or graduated with sufficient evenness to obtain the desired results.

To obtain the desired even graduation of heat in the tunnel through a wide range of temperatures and to maintain maximum thermal efficiency, the kiln is also provided with means whereby heat may be drawn from one or more points of the entry portion of the kiln beyond the flue connecting the stack or draft means with the tunnel so that heating of the ware will commence immediately at the entrance of the kiln and gradually increase from that point on, as the ware travels in the kiln. By forcing sufficient draft beyond the main outlet or outlets to the stack, toward the entrance end of the kiln to render possible the comparatively slow heating of the ware until the first critical temperature has been passed, the thermal efficiency of the kiln is greatly increased and the rapidity of production is enhanced.

I may provide, as shown in one form of the kiln disclosed in the drawings and hereinafter described, additional main draft flues and regulating dampers for the purpose of increasing the pull of the draft toward the entrance end of the kiln, thus, in effect, increasing the capacity of the stack by the elimination of counter currents in the connection from the kiln to the stack. A double draft outlet from the entry end of the kiln is thus provided.

In tunnel kilns it has been customary to provide a sand seal to shut off the heat in the tunnel so that it will not have access to the under parts of the appliances, for instance cars, which carry the ware being burnt. Such cars are usually provided with a protecting platform of refractory material. The integrity of sand seals is difficult to maintain.

My kiln may be provided with means by which a sufficiently low temperature may be maintained below the platforms of the cars to prevent injury to the trucks and other mechanical parts, whereas the space above the car platforms will be maintained at the temperature required for burning the ware. This eliminates the necessity of a sand seal and simplifies both the construction and operation of the kiln. To accomplish this object I provide means by which inert air is maintained below the car platforms as an insulator from the heat above said platforms and supplements the insulating action of the protective platforms. The inertness of the air in the space below the platforms is occasioned by sealing that space from the outside air and preventing it from having direct connection with the draft outlet to the stack except by air leakage through the space between the tunnel walls and the edges of the refractory car platforms, and the spaces between the cars. When it is de-

sired to take advantage of the air leakage referred to and to circulate enough air under the car platforms to cool the working parts of the cars, communication between the space below the car platforms and the outside air is established by operating dampers controlling inlet openings whose number may vary according to requirements. The air leakage in question, while not interfering with conditions to be maintained above the car platforms, will have sufficient cooling effect to prevent the accumulation of injurious heat below the car platforms. In my Patent No. 1278991, Sept. 17, 1918, I have set forth and claimed those features of the present invention which relate to the method of, and means for, sealing the space below the car platforms from the space above them by an air curtain and to the balancing of the draft by air leakage.

When I refer to car platforms, I have reference to any conveyer support or platform on which the ware is carried; cars are commonly employed for that purpose, but other conveying means could be used.

Control of the rate of cooling in my tunnel kiln after the maximum burning temperature has been attained is of importance as well as control of the rate of rise to maximum temperature. The rate of cooling is not controlled directly by the draft although regulation of the draft has a certain effect which is taken into consideration.

The embodiments of the invention shown in the drawings and hereinafter described are to be considered as illustrative, rather than restrictive, of the scope of the invention, as other forms may be resorted to without changing the essential principles thereof.

In the accompanying drawings:

Figure 1 is a half plan, half sectional view, of a kiln, certain parts being broken away, and others shown in dotted lines;

Fig. 2 a side elevation with certain parts in section;

Fig. 3 an enlarged detail section on line 3—3 Fig. 1;

Fig. 4 a similar view on line 4—4;

Fig. 5 a like view on line 5—5;

Fig. 6 a corresponding view on line 6—6;

Fig. 7 a detail side elevation of a portion of the kiln showing a modification having a double draft outlet;

Fig. 8 a horizontal section thereof.

Fig. 9 a section on line 9—9 Fig. 8; and

Fig. 10, a section on line 10—10, Fig. 8.

The kiln has an air-lock 1 whose doors are shown at 2 and 3. After the ware has passed from the lock 1 under the door 3, it is in the kiln proper 4 and is heated until it reaches a point opposite the furnaces 5. The ware is cooled as it passes beyond the furnaces 5 into the cooling zone 6, thence into the air-lock 7 having doors 8 and 9 and finally out of the end of the kiln, the direction of travel being shown by the arrow in Fig. 1.

The stack 10 may be located immediately adjacent the kiln or at a point removed therefrom.

When referring to the "stack" in the following description and claims, I am to be understood as including any means for inducing draft and that term may comprehend a plain stack, a fan, or a combined fan and stack, or, any means for inducing draft. Referring first to Figs. 1, 2 and 5, the stack communicates with the kiln proper 4 by a flue or duct 11, and down flues 12 and 13 which are joined to the kiln by ports or openings 14. Dampers 15 of the slide, butterfly, or any other type, control communication between the ports 14 and the main flue 11. The regulation of these dampers enables the main draft from the kiln through the ports 14 to be changed, as desired, irrespective of the controls now to be described.

Extending alongside the kiln on its opposite sides are flues 16 which open into the main draft flue 11 below the dampers 15 so that there is no interference with regulation by the dampers 15 of the main draft. At intervals the opposite sides of the kiln are provided with outlets or ports 17 at points between the main draft outlets 14 and the furnaces 5. The size and number of these outlets 17 may vary according to conditions. Each outlet is controlled by a damper 18 of any desired type, enabling the regulation of the draft to be carried on at any point or points desired.

My invention does not solely comprehend the provision of these additional outlets 17 opening into the flues 16, but as I have pointed out previously, it comprises draft outlets 19, of any desired number, leading from that portion of the kiln proper 4 which is located in advance of the main draft outlets 14 and between said outlets and the entry portion of the kiln, said outlets 19 leading to flues 20 which communicate with the down flues 12 below the dampers 15. Any suitable dampers 21 are provided for the outlets 19 so that any desired control thereof may be obtained. As previously explained, the even graduation of heat in the tunnel through a wide range of temperatures is obtained, not alone by the use of the outlet 17 and dampers 18, but by drawing the heat beyond the main draft outlets 14, that is, into the entry portion of the kiln where the ware is first subject to the heat after leaving the air lock 1. In consequence, heating of the ware begins immediately it enters the kiln and is graduated from that point on, the regulation or graduation of the heat being accomplished by proper setting of the dampers 21, as well as the dampers 15 and 18.

A radical distinction exists in this construction and decided advantages are ob-

tained over a kiln having a stack which draws directly on the end of the kiln and is only provided with regulable outlets because it is necessary to maintain a certain temperature in the stack for uniform draft conditions. In my kiln, by forcing sufficient draft beyond the main stack outlets 14 into the entry portion of the kiln, comparatively slow heating of the material is had until the first critical temperature has been passed and the thermal efficiency of the kiln is greatly increased and rapidity of production is promoted.

Waste heat taken from the kiln may be utilized as a heating medium for heat absorbing instrumentalities such as steam boilers 22 as explained more fully in my application, Serial No. 142675. It is possible to utilize waste heat taken from points between the tunnel and the stack in other lower temperature waste heat absorption systems, such as driers, sanitary incinerators, heating systems for buildings and the like. In my application Serial No. 142674 I have set forth a sanitary incinerator and a method for incineration in that connection. These waste heat appliances do not affect the principles of draft control, but they are mentioned because they contribute to the over-all thermal efficiency of the plant in connection with the system of heat control.

Referring to Fig. 6 there may be provided in the arch 23 of the kiln one or more openings 24 which are connected in any suitable manner by a flue or flues 25 with the stack 10. A damper 26 controls the draft through the opening 24 and flue 25, in each instance. These outlets each have draft control similar to the outlets 17 and 19.

By adjusting the dampers 15, the draft may be forced beyond the main outlets 14, through the outlets 19 into the flues 20 until the required temperature has been reached at the entrance of the kiln and the necessary graduation of the temperature obtained between the entrance and the main draft outlets 14.

In Figs. 7, 8, 9, 10, there is shown a modified construction and arrangement of flues and dampers whereby a stronger pull of the draft toward the entrance end of the kiln may be obtained. The effect obtained is practically equivalent to an increase in the stack capacity by the elimination of counter currents in the connection from the kiln to the stack. The outlets 17 and 19 and their dampers are the same as in Fig. 1, and open into the respective flues 16 and 20 which have diving flues 27 and 28 connecting the flues 16 and 20, respectively, to the stack 10. In addition to the outlets 17 and 19 there are provided outlets 29 and 30 which are provided with horizontal dampers 31 to control the draft from the body 4 of the kiln into the stack 10 independently of the other outlets. The outlets 29 and 30 communicate with the same trunk flues 32 and 33 with which the diving flues 27 and 28 communicate. Stack cut-off dampers 34 and 35 control communication between the trunks 32 and 33 and the stack 10. By opening or closing the damper 34 the draft from the flues 16 and outlets 29 may be regulated independently of the regulation of the draft from the entrance end of the kiln body 4 into the stack 10 by way of the outlets 19 and 30, and vice versa.

Referring to Fig. 5, it will be seen that the outlets 14 (and likewise outlets 17, 19, 29 and 30) are located above the refractory platform 36 of the car which carries the ware 37 and that the edges of said platform travel in channels 38 in the walls of the tunnel. The wheels 39 run on rails 40. The mechanical parts of the car or conveyer are, therefore, located in a space 41 below the platform 38, said space being filled with inert air which acts as an insulator from the heat in the upper portion 42 of the tunnel. The inertness of the air in the space 41 is due to the fact that this space is sealed from the outside air and has no direct connection with any draft outlet, except by leakage around the edges of the platform 36 where they loosely project into the channels 38.

In the floor 43 of the kiln there are provided openings 44 and 45 (Figs. 1 and 3) which are controlled by dampers 46 and 47, respectively. Usually one or two of these openings is sufficient, but their number may be increased according to the requirements under which the kiln is to be operated. Outside air may be supplied to the openings in any preferred manner, a convenient plan being the provision of inspection tunnels 48, 49, Figs. 1, 2, 3. These tunnels 48, 49 may communicate with several kilns. By suitable adjustment of the dampers 46, 47, it is possible to maintain a circulation of air from the space below the protecting platform 36 upwardly through the points of leakage from the space 41 to the space 42 at a rate which will not interfere with conditions to be maintained above the platform 36, but which will have sufficient cooling effect to prevent the accumulation of injurious heat in the space 41 below the platform. In that connection, it is to be noted that however well the mechanical parts below the platform 36 may be insulated by the said platform and the inert air space 41, it might be possible to accumulate injurious heat in the space 41 under extreme conditions, if it were not possible to renew the supply of air either at intervals or continuously, at the proper rate.

By thus dividing the tunnel into upper and lower strata, comprising an upper section in which burning operations are conducted at high temperature, and a lower

section containing the mechanical parts for carrying the ware, the temperature in the lower section being maintained at a sufficiently low point not to injure said mechanical carrying parts, a balanced condition exists between the upper and lower sections which prevents downward draft from the higher to the lower temperature and renders possible the admission from below of sufficient cool air to maintain the low temperature required in the lower section. This balancing of the draft renders unnecessary the provision of sand seals or means to hermetically seal the upper section from the lower zone.

The controllable draft for regulating the temperature at the entry end of the kiln, includes not only the regulation of particular temperatures, but also the regulation of velocity of the draft.

In an application, Serial No. 109511, filed July 15, 1916, I have disclosed and claimed inspection tunnels and channels, openings, and dampers for the control of the air admitted to the bottom of the tunnel; and in my Patent No. 1246148, dated Nov. 13, 1917, I have claimed certain improvements thereon.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. A tunnel kiln having a continuous open interior throughout its active length from the point where the ware enters to that where it leaves the active length of the kiln and normally closed at its entry portion, a main draft outlet connecting with the kiln at a point inwardly of the normally closed entry portion of the active length thereof, and a controllable draft outlet for the active entry portion of the kiln between the main draft outlet and the point where the ware enters the kiln, and means whereby direct draft may be caused to pass through the active length of the kiln and out through the draft outlets aforesaid.

2. A tunnel kiln having a continuous open interior throughout its active length from the point where the ware enters to that where it leaves the active length of the kiln and normally closed at its entry portion, a main draft outlet connecting with the kiln at a point inwardly of the normally closed entry portion of the active length thereof, a controllable draft outlet for the active entry portion of the kiln between the main draft outlet and the point where the ware enters the kiln, and another controllable draft outlet connecting with the body of the kiln inwardly of the length of the kiln beyond the main draft outlet aforesaid, and means whereby direct draft may be caused to pass through the active length of the kiln and out through the draft outlets aforesaid.

3. A tunnel kiln having a continuous open interior throughout its active length from the point where the ware enters to that where it leaves the active length of the kiln and normally closed at its entry portion, a main draft outlet connecting with the kiln at a point inwardly of the normally closed entry portion of the active length thereof, a plurality of draft outlets for the active entry portion of the kiln between the main draft outlet and the point where the ware enters the kiln, dampers for the respective ones of the plurality of draft outlets whereby the draft through the different ones may be independently controlled, and means whereby direct draft may be caused to pass through the active length of the kiln and out through the draft outlets aforesaid.

4. A tunnel kiln having a continuous open interior throughout its active length from the point where the ware enters to that where it leaves the active length of the kiln and normally closed at its entry portion, a controllable main draft outlet connecting with the kiln at a point inwardly of the normally closed entry portion of the active length thereof, a plurality of draft outlets for the active entry portion of the kiln between the main draft outlet and the point where the ware enters the kiln, dampers for the respective ones of the plurality of draft outlets, whereby the draft through the different ones may be independently controlled, a plurality of draft outlets connecting with the body of the kiln inwardly of the length of the kiln beyond the main draft outlet aforesaid, dampers for the respective ones of the draft outlets last-named, whereby they may be independently controlled, and means whereby direct draft may be caused to pass through the active length of the kiln and out through the draft outlets aforesaid.

5. A direct draft tunnel kiln having a continuous open interior throughout its active length from the point where the ware enters to that where it leaves the active length of the kiln and normally closed at its entry portion, said kiln being provided with a main draft outlet, and means for controllably forcing or surging the heat by direct draft into the normally closed entry portion of the kiln beyond the main draft outlet, whereby the ware may be subjected to a predetermined gradual heating effect when it enters the kiln.

In testimony whereof, I hereunto affix my signature.

JOHN B. OWENS.