J. B. OWENS.

MUFFLE KILN.

APPLICATION FILED APR. 1, 1918.

1,289,890.

Patented Dec. 31, 1918.

4 SHEETS—SHEET 1.

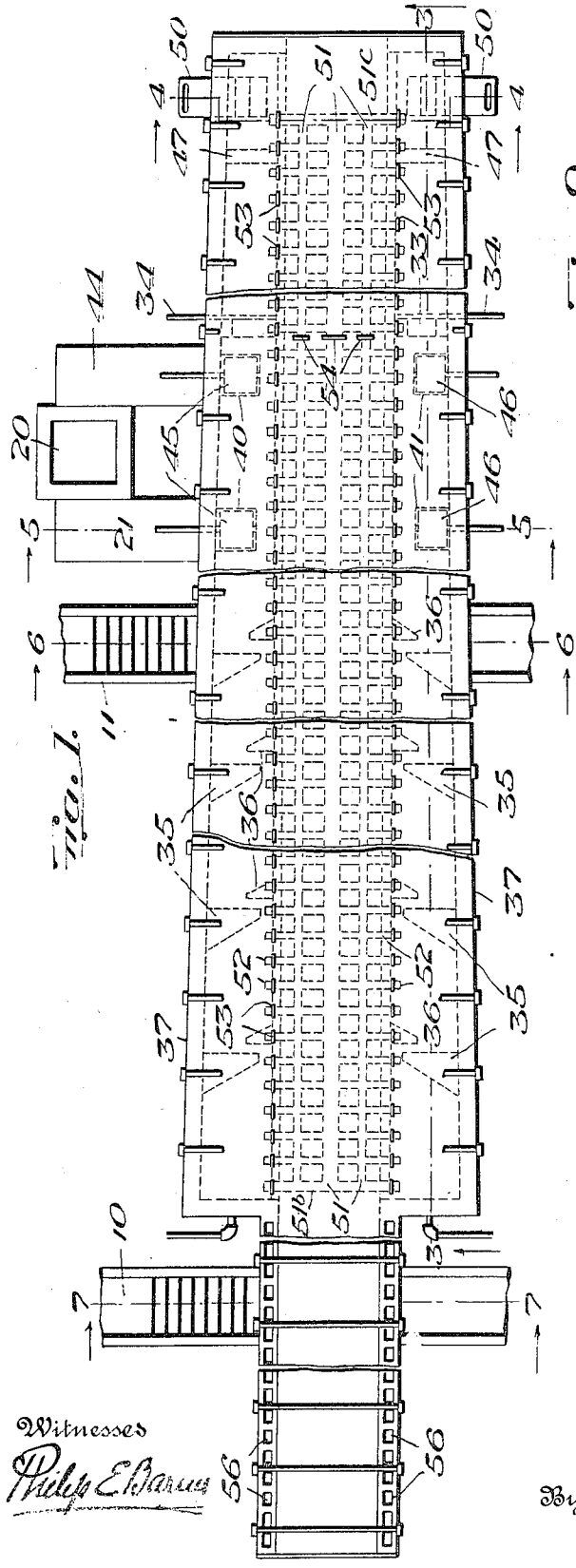


Fig. 1.

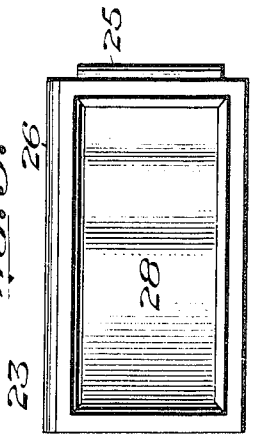


Fig. 9.

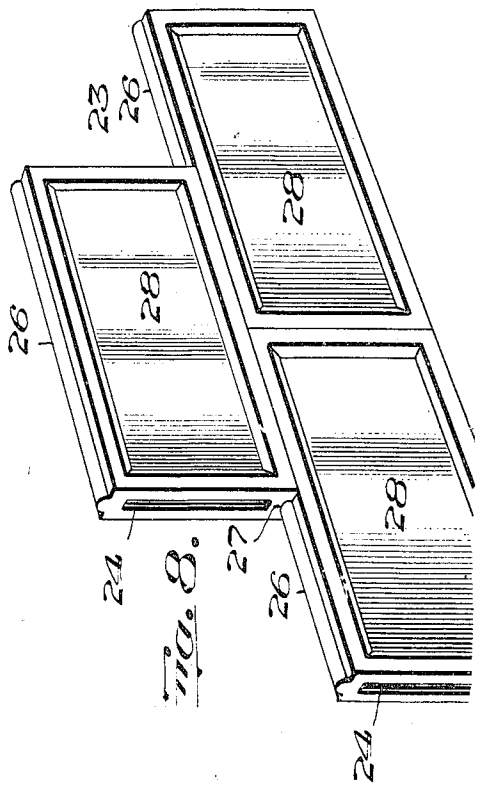


Fig. 8.

Witnesses

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4 SHEETS—SHEET 2.

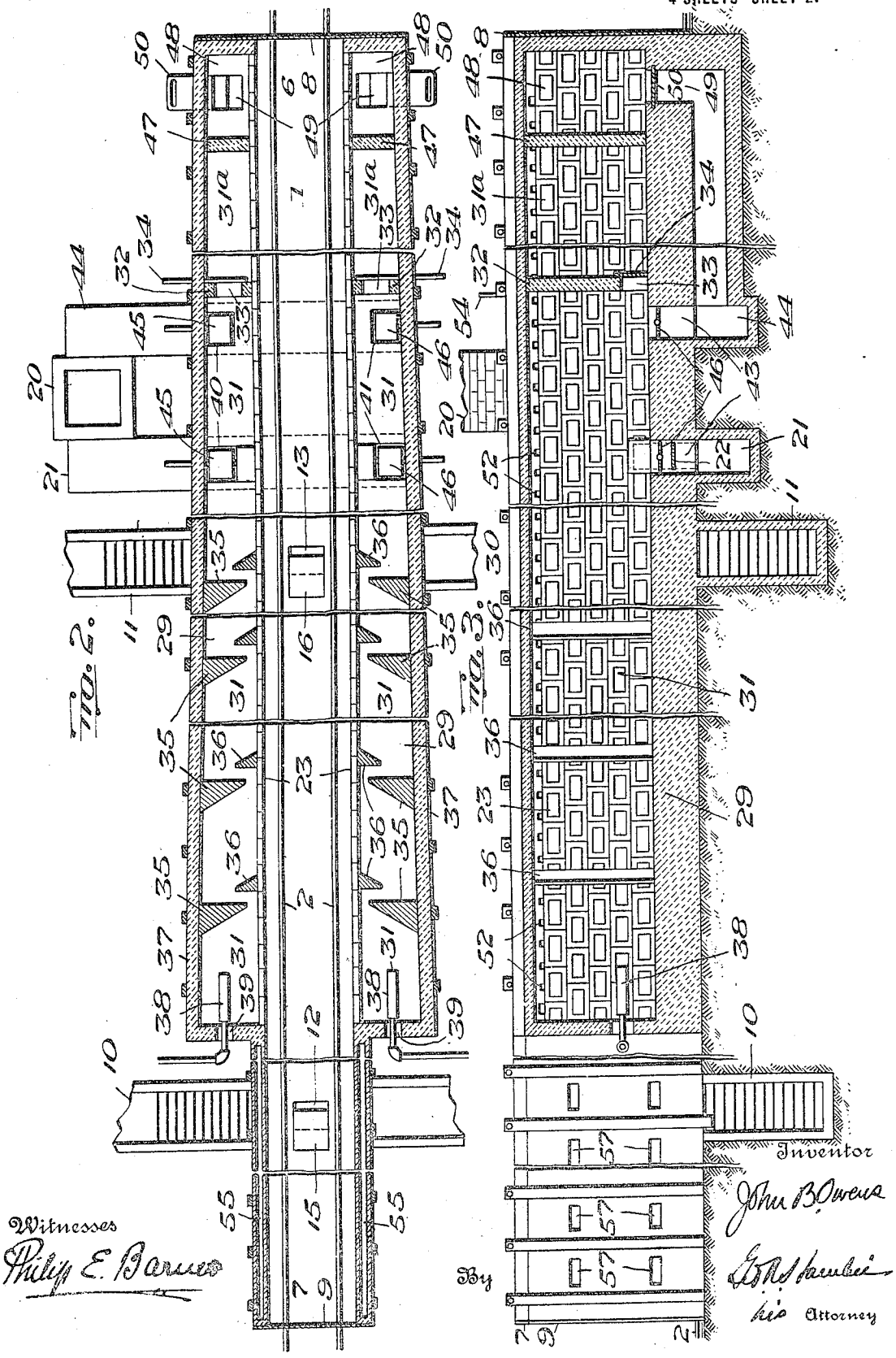


FIG. 2.

FIG. 3.

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4 SHEETS—SHEET 3.

Fig. 4.

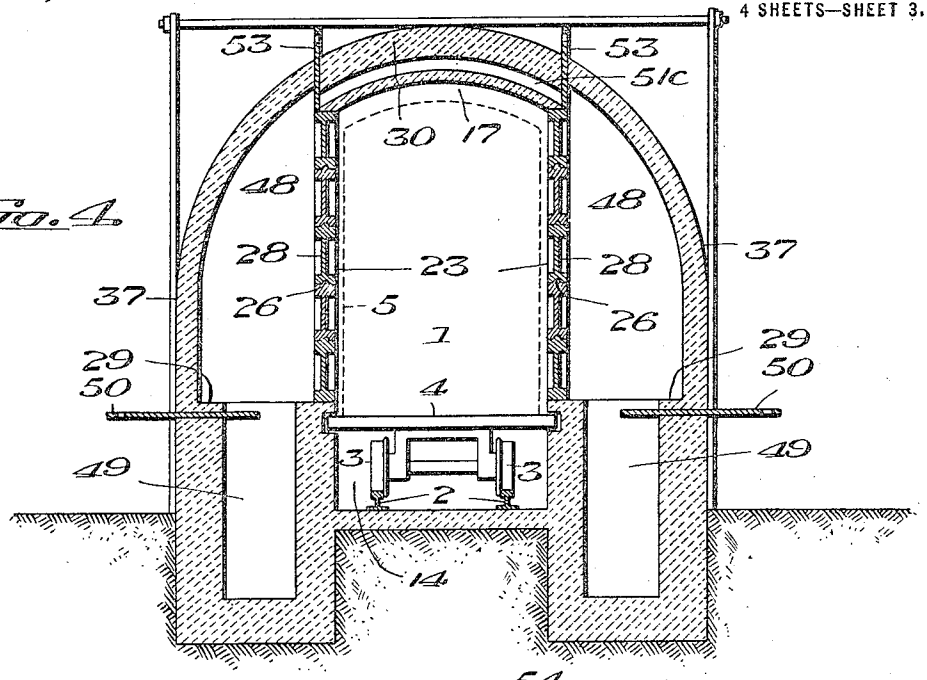
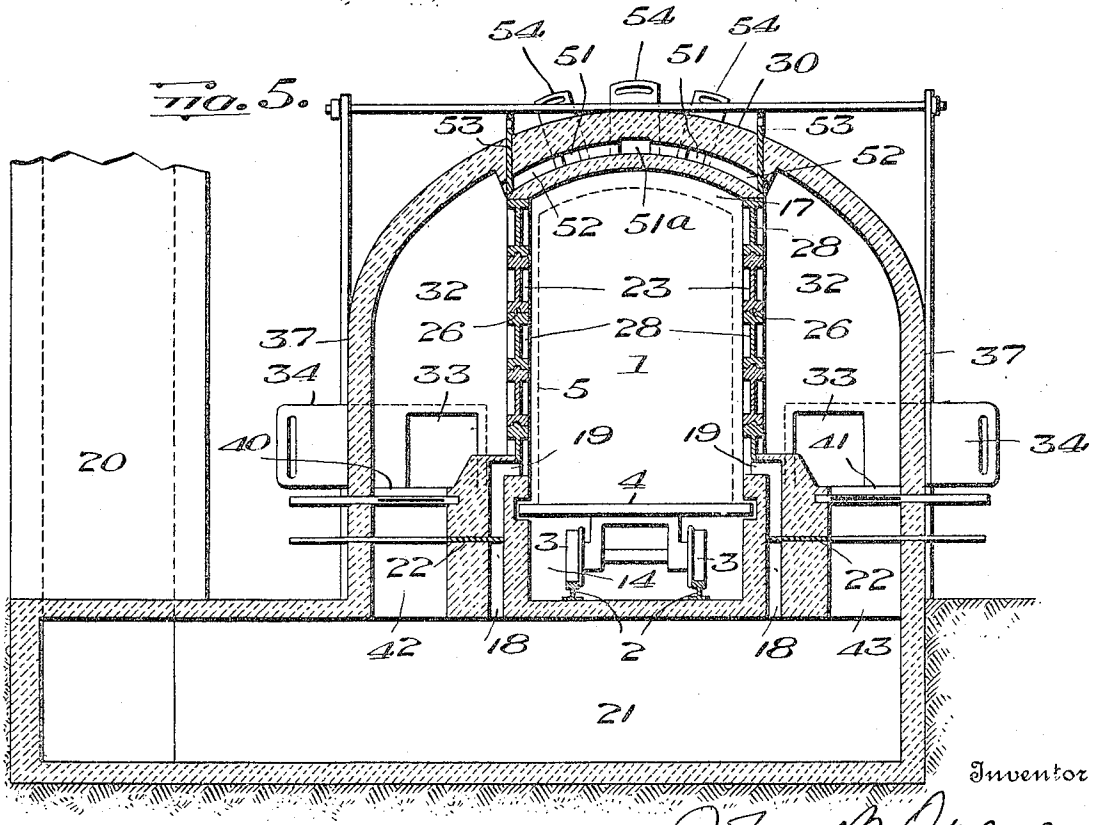


Fig. 5.



Witnesses

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4 SHEETS—SHEET 4.

Fig. 6.

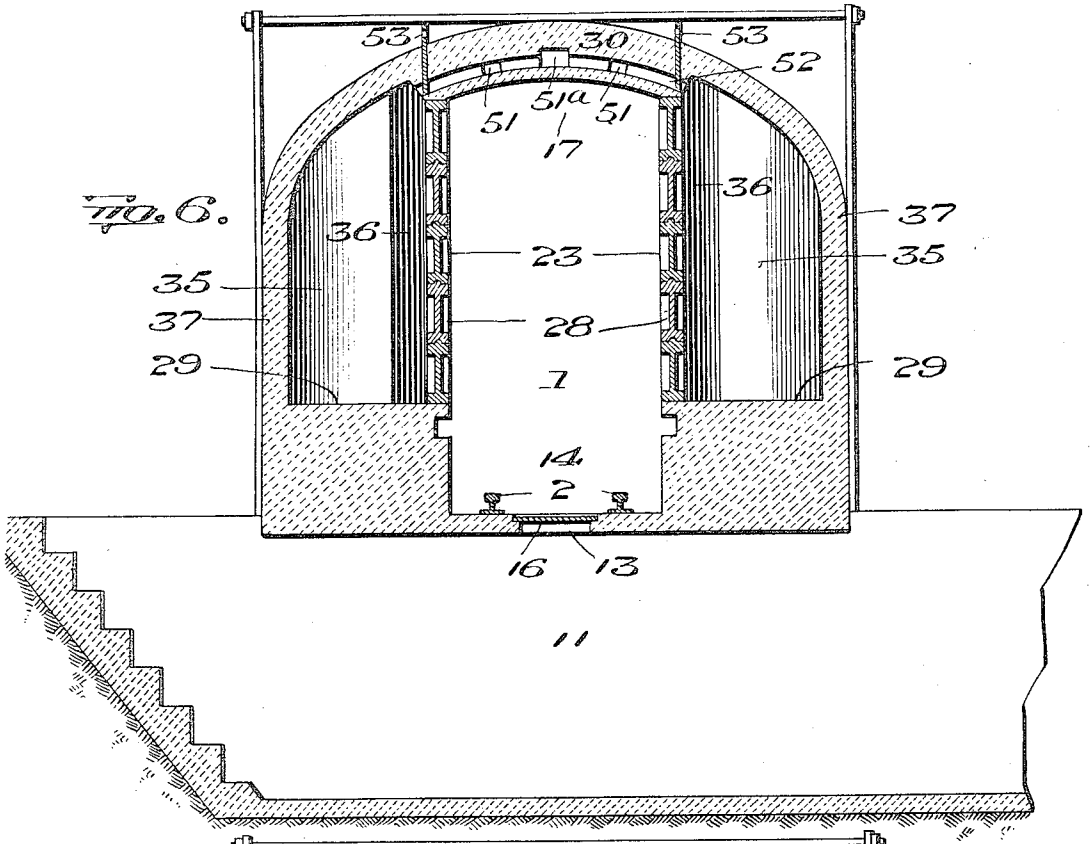
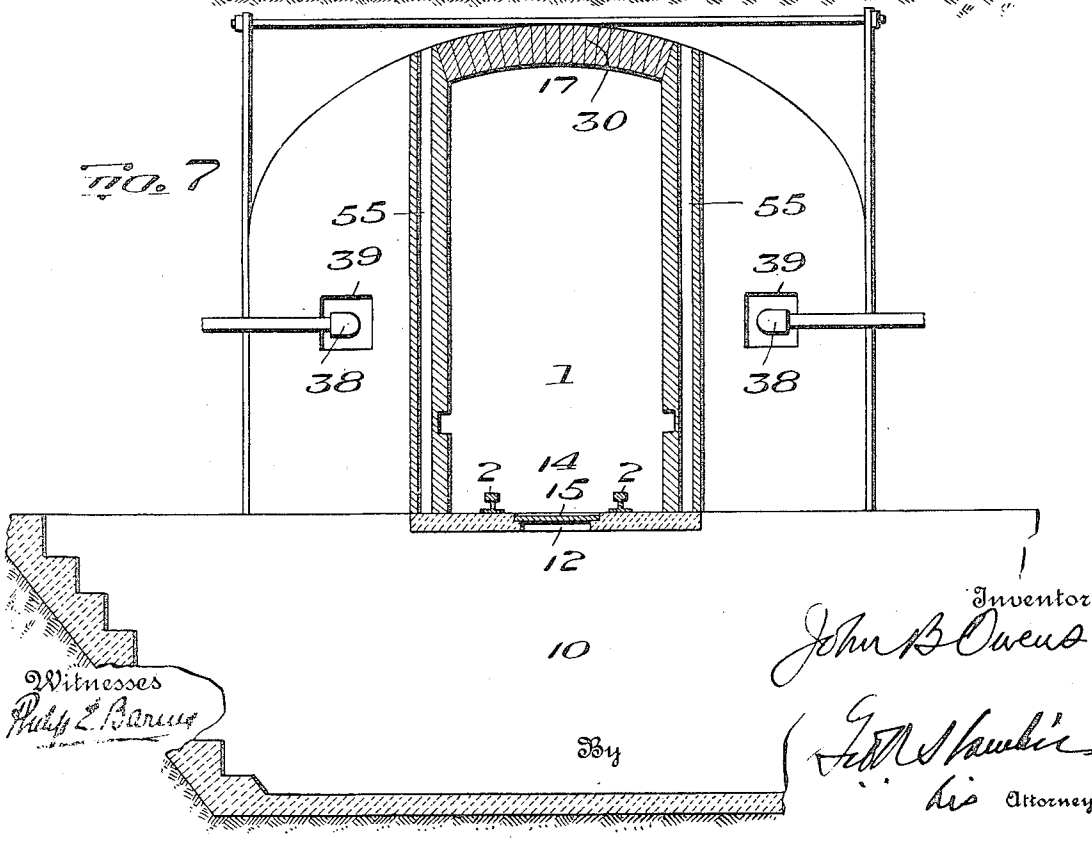


Fig. 7



Witnesses

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JOHN B. OWENS, OF METUCHEN, NEW JERSEY.

MUFFLE-KILN.

1,289,890. Specification of Letters Patent. Patented Dec. 31, 1918.

Application filed April 1, 1918. Serial No. 225,926.

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 Muffle-Kilns, of which the following is a specification.

This invention relates to continuous muffle kilns, such as are adapted for the firing of all kinds of clay products, including brick, tile, pottery, the enameling of steel or other metal-ware, the firing of carbons, and the annealing of iron, glass, and the like. The term "ware," hereinafter used, is intended to include the foregoing enumeration, and all other products, goods, articles, or material which the kiln is adapted to treat.

My object is to provide improvements in a continuous muffle kiln whereby a variety of regulations of the heat and the paths it may travel, may be attained so that circulation of the heat and the resulting treatment of the ware can be varied according to the nature of the operation being conducted.

Another object is to provide for the cooling of the ware conveying means, such as the cars usually employed, and the taking off of excess heat from the tunnel, independently of the circulation and control of the heat radiated through the muffle walls into the tunnel.

My improved kiln has muffle walls and combustion chambers so constructed and arranged as to enable the heat derived from combustion to be made available the full length of the side walls and the crown of the kiln from the fire zone to the entrance end of the kiln whereby the heat is radiated into the tunnel containing the ware conveying means in a manner rendering it most effective.

My kiln has a tunnel into one end of which ware to be burned or fired is introduced, thence traveling along by means of a suitable conveyer and emerging at the opposite end of the tunnel, as usual in continuous tunnel kilns. The kiln is, in effect, divided into a preheating zone extending for a certain distance where the ware enters, a burning or firing zone where the ware is fully burned or fired, and a cooling zone in which it is cooled before it is taken out of the exit end of the tunnel. Extending along both sides of the tunnel are combustion chambers which run from the point of initial combustion to points near the entry end of the kiln. Muffle walls separate the combustion chambers from the tunnel. These walls are of novel construction, comprising tongue and groove brick which may be of any size, the tops and bottoms of which have a tongue and groove, respectively, and being grooved at one end and tongued at the other. While size is not essential, it is preferable to use brick which are eight by twelve inches, or of proportionate dimensions. The top, bottom, and ends, in such a brick may be about three inches wide, while the remainder of the brick is in the form of a panel. If of refractory material, other than carborundum the panel portion would be about three-quarters of an inch in thickness, but if of carborundum, one-half inch in thickness will suffice. These brick or tile are placed on edge with the tongues and grooves interlocking at the tops and ends and sealed along their edges by some suitable material such as soluble glass. A muffle wall of this character has great strength, small tendency to warp, and permits a very high degree of heat radiation from the combustion chambers into the tunnel.

At intervals along the length of the combustion chambers there are baffles which sufficiently retard the heat to insure utilization of its full value if such is desired, while enabling the kiln to be built of relatively short length without decrease in efficiency.

While, in effect, the combustion chambers extend from the point of initial combustion nearly to the entrance end of the kiln, end baffles or partitions are provided beyond the stack take-offs or outlets which divide the combustion chambers into main and secondary ones, the latter being opposite the preheating zone. Dampers control the openings in these end baffles and enable the heat derived from combustion to be admitted directly into the secondary combustion chambers, or cut off therefrom. One or more outlets connect the main combustion chambers with the stack; dampers are provided by which the draft may be regulated.

Extending the full length of the burning zone and preheating zone in the crown of the kiln are ducts, of which the central one is preferably the largest, the others being smaller. Lateral ducts or channels connect the crown ducts with the combustion chambers on opposite sides of the tunnel. In some operations the heat should travel the

full length of the crown in the ducts therein, while in other operations it should not flow directly to the entrance end of the kiln in the crown ducts. I provide dampers controlling the crown ducts so that both conditions may be met. Dampers are provided for the transverse or lateral ducts which communicate with the combustion chambers, enabling any desired regulation of the volume and direction of travel of the heat to be obtained.

In the firing of some products, it is desirable that the heat generated at the point of gas ignition should be taken off in its entirety when it first reaches the stack. In other firing operations it may be found desirable to take off the heat from the combustion chambers and not from the crown flues; in such a case, the improved arrangement of flues or ducts in the crown enables the dampers to be set so that the heat will travel to the entry end of the kiln, then dive down through the lateral ducts into the secondary combustion chambers, thence passing therethrough to the stack. There are return flues leading to the stack from the crown flues at the entrance end of the kiln, dampers being provided therefor. Heat made to travel to the entry end of the kiln in the crown flues can be caused to dive down into the return flues and thus be carried back to the stack.

Should the product being treated necessitate it, or the better operation of the kiln require it, the heat in the main combustion chambers, as well as that in the crown flues, can be carried along through the crown flues to the entrance end of the kiln and made to dive down the lateral crown flues into the secondary combustion chambers, or, to enter the return flues, and thence pass back to the stack. To effect this operation, the main stack dampers which control the outlets from the main combustion chambers to the stack, may be partially or wholly closed.

My novel system of combustion chambers, longitudinal and transverse crown flues, and dampers, permit the heat to rise from the combustion chambers into the crown flues, or, to dive back into the combustion chambers, or, to pass along the full length of the crown flues, or, only a part of the length of said flues, that is, to the region of the stack. The kiln is, therefore, adapted for regulation enabling it to fire or treat various wares and products demanding different temperatures and modes of treatment.

To keep the ware conveying means, such as the cars commonly used, cool when passing through the kiln, I provide air inlet means, subject to damper control, preferably located under the cooling zone and at a suitable point under the burning zone and to maintain a semi-inert air space below the car platforms and an air curtain around the edges of said car platforms. At suitable points, such as in the general region of the stack, flues or ducts are provided which lead from the interior of the tunnel to the stack either by way of a separate trunk flue, or, by connection to the main stack flues from the combustion chambers. These take-off flues preferably open into the tunnel at points just above the car platforms so that the excess heat in the tunnel will be taken off into the stack, under suitable damper control, and, in connection with the leakage from the semi-inert space below the car platforms, cause a draft which will relieve the tunnel of excess heat and will also maintain the air curtain past the edges of the car platforms, thus keeping the car platforms and running gear relatively cool and entirely eliminating a sand seal which would otherwise be necessary for this purpose. The dampered air inlets into the bottom of the tunnel at the cooling zone and firing zone, described above, are preferably fed by air from cross tunnels located under the kiln and which may also be used for inspection purposes, enabling an operative to project his head and shoulders through these inlets to view the bottom of the tunnel and under parts of the cars.

I am aware that modifications may be resorted to in carrying out my invention without departing from the essential principles thereof. The embodiment of the invention hereinafter described and which is shown in the accompanying drawings is to be considered as illustrative, rather than restrictive, of the scope of the invention.

In the accompanying drawings:

Figure 1 is a plan view of the complete kiln, broken across at several parts;

Fig. 2, a horizontal section through the same;

Fig. 3, a vertical longitudinal section on the line 3—3, Fig. 1;

Fig. 4, a cross section on the line 4—4, Fig. 1;

Fig. 5, a cross section on the line 5—5, Fig. 1;

Fig. 6, a cross section on the line 6—6, Fig. 1;

Fig. 7, a cross section on the line 7—7, Fig. 1;

Fig. 8, a detail perspective view of the bricks or tiles used for the muffle walls and

Fig. 9, a detail front view of one of the bricks or tiles.

The kiln has a tunnel 1 provided with a track 2 on which the wheels 3 of the cars 4 travel when carrying the ware 5, Figs. 4 and 5, through the kiln. The kiln has a preheating zone, burning zone and cooling zone, as indicated in Fig. 2, through which the cars successively pass when conveying the ware from the entry end 6 to the exit 7 of the kiln; doors 8 and 9, respectively, close the ends 6 and 7 and are only opened to

admit and discharge cars. Extending crosswise beneath the cooling zone is an inspection and air inlet tunnel 10 provided with suitable steps to enable an operative to enter beneath the tunnel 1. A similar inspection and air inlet tunnel 11 extends beneath the burning zone. In the bottom of the tunnel 1 there are provided air inlets 12 and 13 communicating with the respective tunnels 10 and 11 for the admission of air to the space 14 below the car platforms 4. Suitable dampers 15 and 16 control the air inlets 12 and 13. These dampers are intended to be set to regularly admit a certain quantity of outside air into the space 14, or, they may be closed at times and opened when it is necessary to admit additional air into the space 14. The space 14 constitutes a semi-inert air space in which the running gear of the cars 4 travels. Air leakage past the edges of the car platforms 4 into the upper space 17 of the tunnel constitutes an insulating air curtain around the edges of the car platforms, protecting them against burning from the high temperature in the burning space 17 and the maintenance of the semi-inert airspace 14 below the platforms prevents injury to the running gear of the cars and insures the maintenance of a relatively low temperature in the space 14. The inlets 12 and 13 are of sufficient size to admit the head and shoulders of an operative who may thus inspect the semi-inert air space 14 and determine the condition of the running gear of the cars. To provide the requisite circulation or air leakage from the semi-inert air space 14 into the high temperature or burning space 17 for the maintenance of the air curtain around the edges of the car platforms 4, and to take off the excess heat radiated into the tunnel, there are provided ducts or flues 18, Fig. 5, which preferably connect with the space 17 as at 19 in the general region of the juncture of the burning zone and preheating zone. These ducts or channels connect with the stack 20 by means of one of the main take-off stack flues 21 extending beneath the kiln, as shown in Figs. 3 and 5, or a separate flue can connect the flues 18 to the stack 20. Dampers 22 control the take-off flues 18. The flues 18 communicate with the space 17 just above the car platforms 4 so that the heat will have accomplished its most effective work on the ware 5 before the excess heat is taken off to the flue 21. The flues 18 provide the requisite movement of the heat lengthwise of the tunnel in the space 17, in addition to providing a suitable draft to accomplish air leakage from the semi-inert space 14 into the space 17, past the edges of the car platforms. Not only does this arrangement of air leakage and draft dispense with the necessity of providing sand seals for the car platforms, but, also, the draft accomplishes movement of the heat in the space 17, along the length of the tunnel, and insures the utilization of a high percentage of the heat units.

It will be understood in referring to the movement of the heat in the space 17, that there is no direct combustion within the tunnel 1 and that the heat referred to is that which is radiated through the muffle walls 23.

The muffle walls 23, 23 run from the cooling zone to the entrance end of the kiln and are composed of bricks or tiles of the construction shown in Figs. 8 and 9. The bricks or tiles are relatively thick at their top, bottom and ends, say three inches in a brick which is eight inches by twelve inches. One end has a groove 24 and the other end a tongue or rib 25, the groove being blind at the top and bottom. A strong interlocking connection is provided at the ends of the bricks. Extending the full length of the top of each brick is a tongue or rib 26 which fits in a corresponding groove 27 in the bottom of the brick immediately thereabove, as shown in Fig. 8. A suitable heat resisting binder, such as soluble glass, secures the tongues in the grooves at the tops, bottoms and ends of the tile. The tile are laid with their joints broken. The tile or brick, except at the tops, bottoms and ends are relatively thin, say three-quarters of an inch in thickness in the panel portion 28, for an eight inches by twelve inches size, if made of refractory material other than carborundum; if of carborundum, the thickness need be no more than one-half inch. The walls thus provided are supported on the benches or lateral portions 29 of the kiln and they support the crown 30. Great strength, lightness, and adaptability to freely radiate heat into the tunnel 1 results from the improved muffle wall construction

Extending the full length of the burning zone and preheating zone on the opposite sides of the tunnel, and having walls 23 as the inner walls thereof, are the combustion chambers 31, a portion of which (those parts which are opposite the preheating zone) may be considered as secondary combustion chambers 31^a. The remaining lengths of the combustion chambers, that is, those parts which extend from the cooling zone to the preheating zone, may be considered as main combustion chambers. In effect, the combustion chambers run the full length of the kiln, except opposite the cooling zone, but as the treatment of different wares or products may require different paths, and directions of travel, for the heat, I preferably provide end baffles 32 having openings 33, Figs. 2 and 5, and controlling dampers 34 by means of which the secondary combustion chambers 31^a may be thrown into communication with the main combustion chambers 31, or, may

be cut off from direct communication therewith through the openings 33. The end baffles 32 are located in the region of the stack 20.

At intervals of the length of the main combustion chambers 31 there are provided baffles, comprising the overlapping parts 35, 36, arranged in pairs, Fig. 2. The longer baffles project nearly across the combustion chambers 31 from the outer walls 37 of the kiln toward the muffle walls 23. The shorter baffles 36 project from the muffle walls 23 toward the outer walls 37 in overlapped relation to the baffles 35, Figs. 2 and 6. To prevent warping of these baffles by the heat to which they are subject, they are preferably built with inclined faces on the baffles 35 and both baffles 35 and 36 are of general triangular form in cross sectional shape, as shown in Fig. 2.

Any form of heat producing means may be used in connection with the kiln. Oil burners 38, Figs. 2 and 7, are shown as entering the ends of the combustion chambers through air admission holes 39. The flame and heat derived from the burners 38 travel in the direction of the length of the combustion chambers 31 (and into the secondary combustion chambers 31^a, if they are in communication with chambers 31) and is baffled or retarded in its travel so that the heat is radiated through the muffle walls 23 into the space 17. The highest temperature obtained in the space 17 is at the burner ends of the combustion chambers, being graduated downwardly in temperature from those points on toward the entry end 6 of the kiln. The baffles 35, 36 are effective in obtaining a maximum thermal value in graduated temperature conditions. Draft to the stack 20 is obtained through main draft outlets 40, 41 for the respective combustion chambers 31. I have shown two main draft outlets for each main combustion chamber 31, but one outlet will suffice. The outlets 40, 41 communicate with down flues 42, 43, Figs. 3 and 5, leading to respective flues or ducts 21 and 44 which conect with the stack 20. Dampers 45, 46 for the respective outlets 40, 41, enable the draft into the stack 20 from the main combustion chambers 31 to be entirely cut off, fully opened up, or choked down in any desired manner according to the circulation and path of travel of the heat which may be desired. For instance, if it is desired to surge the heat from the combustion chambers 31 into the secondary combustion chambers 31^a through the openings 33, this can be accomplished by suitably choking the outlets 40, 41 and opening the damper 34.

The secondary combustion chambers 31^a are blind at their forward ends, by virtue of walls or partitions 47, Figs. 2, 3, 4, which provide, in connection with the end of the kiln, chambers 48 whose bottoms are in communication with flues 49 which may lead direct to the stack 20 or into one or the other of the cross flues 21, 44; the latter arrangement is shown. Dampers 50 control the circulation from the chambers 48 to the flues 49.

To obtain the effect of a combustion chamber over the crown 30 and resultant radiation down through the crown of the tunnel, to supplement the radiation through the muffle walls, I provide the longitudinal ducts or heat flues 51 and the lateral flues 52 which connect the longitudinal flues with the combustion chambers 31, 31^a on both sides of the tunnel. To obtain the greatest draft in the center of the crown 30, the central longitudinal ducts or flues 51^a may be larger, preferably twice as large as the companion longitudinal flues 51. The longitudinal flues or ducts 51 are blind at the extreme end 51^b of the burning zone and blind at 51^c just inward from the entrance 6 of the kiln. These ducts or flues run the full length of the crown 30 as seen in Fig. 1, and they all communicate with the transverse ducts 52. The transverse ducts, where they open into the respective combustion chambers 31, 31^a on opposite sides of the tunnel, have dampers 53, Figs. 1, 4 and 6. These dampers permit any desired transverse ducts to be opened, while others are closed, or any or all of them be shut off or partially opened, permitting full regulation of the volume or direction of travel of the heat derived from the combustion chambers 31, 31^a.

Some operations demand a full supply of heat in the ducts 51, 51^a, 52 over the preheating zone, while others require that the heat be cut off from, or choked down as it enters, the ducts above the preheating zone. Dampers 54, Fig. 1, control communication between those sections of the longitudinal ducts 51, 51^a over the burning zone and those over the preheating zone, for the foregoing purpose.

The walls of the cooling zone are hollow as shown at 55, Fig. 2, and have ports 56 at their top, Fig. 1. Ports 57, Fig. 3, communicate with the hollow spaces 55 and admit cooling outside air to said spaces, said air rising and voiding through the ports 56, as proposed in certain of my earlier applications.

Operation: The ware on the cars enters at 6 and progresses through the tunnel 1, passing first through the preheating zone and then the burning zone and cooling zone and out through the exit 7. The doors 8 and 9 are kept closed except when cars are being introduced or taken out from the tunnel. The heat from the combustion chambers 31 is always radiated through the muffle walls 23. If the dampers 34 are opened and dampers 40, 41 closed, or nearly so, the secondary combustion chambers 31^a are then in di-

rect communication with the chambers 31, and the heat will surge into the chambers 31ª and be directly radiated through the muffle walls 23 to the goods in the preheating zone. If, however, the dampers 34 are closed and the path of travel of the heat in the ducts 51, 51ª over the preheating zone is changed, while there will be direct radiation through the muffle walls opposite the secondary combustion chambers 31ª, the path of travel of the heat into said chambers 31ª would not be direct. The arrangement and control of the crown ducts 51, 51ª and the provision of the openings 32 and 49 and the dampers 34 and 50 enables the heat to be forced in different ways in relation to the preheating zone. The provision of the dampers 53 and 54 enables the heat to be made to travel in different ways in relation to the burning zone.

For instance, in the firing of certain products it may be preferable that the heat generated at the points of gas ignition (near the burners 38) should be taken off in its entirety when it first reaches the stack. Other wares may render it desirable to take the heat off from the side combustion chambers 31, 31ª and not from the crown flues 51, 51ª. For example, the heat in the crown flues 51, 51ª can be made to travel the full length of the kiln to the entrance end thereof and then caused to dive down through the transverse flues 52 into the secondary combustion chambers 31ª and back through the openings 33 and down through the ports 40, 41, back to the stack 20. On the other hand, other products may require the opening of the dampers 34, the surging of the heat along the full length of the combustion chambers 31, 31ª, the rise of the heat through the transverse flues 52 into the longitudinal flues 51, 51ª, and the travel of the heat along the entire length of the crown 30, the full heat volume being then admitted to the chambers 48 and taken through the flues 49 back to the stack. Again, some of the dampers 53 may be so arranged that the heat will rise in certain of the flues 52 and travel along the flues 51, 51ª and then dive down through other flues 52 and pass again into the combustion chambers.

The foregoing operations which may be conducted with my kiln are stated as illustrative, and not restrictive, of the draft and heat manipulation possible with the arrangement of combustion chambers, flues and dampers which are provided. Provision is made for controlling the volume and direction of travel, as well as velocity of the draft to meet conditions required by a wide variety of wares or products which are to be treated by the kiln.

What I claim is:

1. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, and continuous combustion chambers extending horizontally alongside said muffle walls.

2. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, continuous combustion chambers extending horizontally alongside said muffle walls, and upright baffles arranged at intervals of the length of said combustion chambers, adapted to baffle the flow of the heat alongside said chambers.

3. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, and baffles arranged in overlapping pairs the members of which project part way across the respective combustion chambers from the muffle and outside walls thereof, said pairs of baffles being arranged at intervals of the length of said combustion chambers.

4. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, and main and secondary combustion chambers extending alongside said muffle walls which are provided with means for placing them in communication with each other or cutting them off from each other.

5. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, controllable draft outlets for taking off the heat from said combustion chambers, and controllable means located beyond the draft outlets of the combustion chambers whereby the combustion chambers may be sub-divided into main and secondary chambers which can be placed in communication with each other or shut off from intercommunication.

6. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, controllable draft outlets for taking off the heat from said combustion chambers, controllable means located beyond the draft outlets of the combustion chambers whereby the combustion chambers may be subdivided into main and secondary chambers which can be placed in communication with each other or shut off from intercommunication, and baffles located at intervals of the length of the main combustion chambers.

7. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers ex-

tending alongside said muffle walls, and heat conveying conduits extending lengthwise of the crown of the tunnel which are in communication with the combustion chambers.

8. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, heat conveying conduits extending lengthwise of the crown of the tunnel, which are in communication with the combustion chambers at intervals of the length thereof, and means for controlling the flow of heat through said conduits.

9. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, heat conveying conduits extending lengthwise of the crown of the tunnel which are in communication with the combustion chambers at intervals of the length of said combustion chambers, and means for controlling communication between different parts of the lengths of said conduits.

10. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, heat conveying conduits extending lengthwise of the crown of the tunnel which are in communication with the combustion chambers, and means for controlling communication between different parts of the lengths of said conduits.

11. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, and a network of longitudinally and transversely extending communicating heat conveying ducts in the crown of the tunnel, said transversely extending ducts communicating with the combustion chambers at intervals of the length of the latter.

12. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, a net-work of longitudinally and transversely extending communicating heat conveying ducts in the crown of the tunnel, said transversely extending ducts communicating with the combustion chambers at intervals of the length of the latter, and dampers controlling the communication between the transversely extending ducts and the combustion chambers.

13. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, a network of longitudinally and transversely extending communicating heat conveying ducts in the crown of the tunnel, said transversely extending ducts communicating with the combustion chambers at intervals of the length of the latter, dampers controlling the flow between sections of the longitudinally extending ducts, and other dampers controlling the communication between transversely extending ducts and the combustion chambers.

14. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, means for subdividing the combustion chambers into sections, longitudinally extending heat-conveying ducts or conduits in the crown of the tunnel, and transverse heat conducting conduits which join the longitudinal conduits or ducts to the sections of the combustion chambers.

15. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, means for subdividing the combustion chambers into sections, longitudinally extending heat conveying ducts or conduits in the crown of the tunnel, transverse heat conducting conduits which join the longitudinal conduits or ducts to the sections of the combustion chambers, and means for controlling the flow in the ducts or conduits in the crown of the tunnel.

16. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, means for subdividing the combustion chambers into sections, longitudinally extending heat conveying ducts or conduits in the crown of the tunnel, transverse heat conducting conduits which join the longitudinal conduits or ducts to the sections of the combustion chambers, and independent draft outlets for the respective sections of the combustion chambers.

17. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, means for subdividing the combustion chambers into sections, longitudinally extending heat conveying ducts or conduits in the crown of the tunnel, transverse heat conducting conduits which join the longitudinal conduits or ducts to the sections of the combustion chambers, independent draft outlets for

the respective sections of the combustion chambers, dampers controlling communication between the transverse ducts or conduits and the respective sections of the combustion chambers at intervals of the lengths of the latter, and dampers controlling communication between different sections of the longitudinally extending ducts or conduits.

18. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel comprising numerous relatively thin panels with intervening thickened portions throughout the extent of said walls, and combustion chambers outside said muffle walls.

19. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel which consist of brick or tile having interlocking horizontal and vertical marginal portions and substantially uniformly relatively thin panel-like bodies, and combustion chambers extending alongside said muffle walls.

20. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel which consist of brick or tile having one of their horizontal edges provided with a tongue and the opposite horizontal edge with a groove and one vertical edge provided with a tongue and the other vertical edge with a groove, the respective bricks or tiles having their tongues and grooves interlocked, the bodies of the bricks or tiles being substantially uniformly relatively thin, and combustion chambers extending alongside said muffle walls.

21. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, ware conveying means for the tunnel which substantially subdivides said tunnel into an upper section in which the ware is located, and a lower section in which the temperature is maintained low enough to prevent injury to the ware conveying means, the said upper and lower sections being sealed from each other except for air leakage from the lower section into the upper section, means for admitting air to the lower section, and means for taking off heated air from the upper section, whereby a semi-inert air space is maintained below the ware conveying means and heat flow is maintained in the upper section of the tunnel.

22. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, said tunnel having an upper section in which high temperature may be maintained, a lower section containing semi-inert air in which a low temperature may be maintained and means permitting air leakage from the lower section into the upper section, said sections being otherwise sealed from each other.

23. A continuous muffle kiln comprising a tunnel for receiving the ware or products to be treated, muffle walls constituting the sides of said tunnel, combustion chambers extending alongside said muffle walls, said tunnel having an upper section in which high temperature may be maintained, a lower section containing semi-inert air in which a low temperature may be maintained, means permitting air leakage from the lower section into the upper section, said sections being otherwise sealed from each other, and means for taking off heated air from the upper section, whereby the semi-inert air space is maintained in the lower section and air circulation is had in said lower section and heat circulation in the upper section.

In testimony whereof, I hereunto affix my signature.

JOHN B. OWENS.