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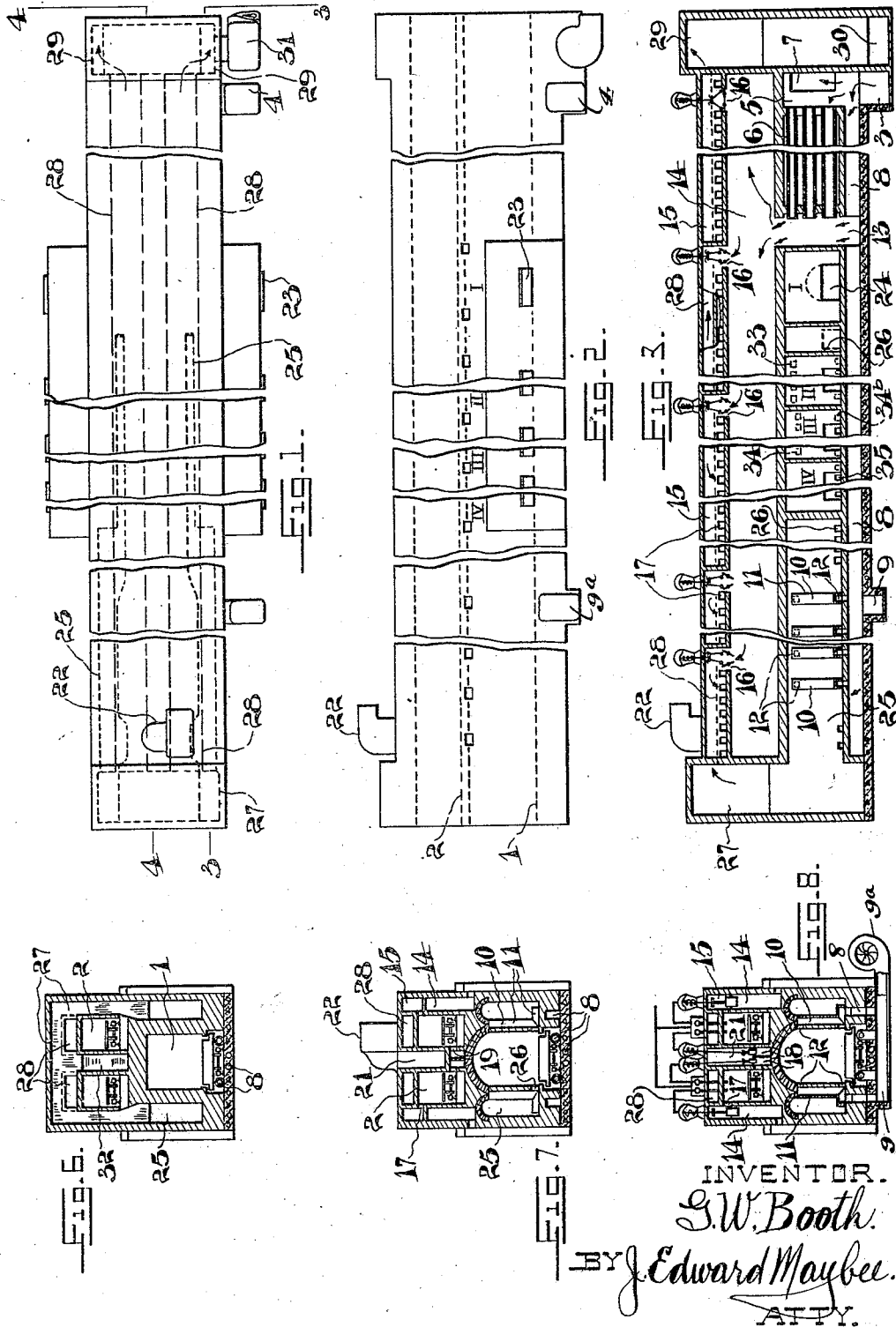
G. W. BOOTH

1,698,700

TUNNEL KILN

Filed March 28, 1927

2 Sheets-Sheet 1



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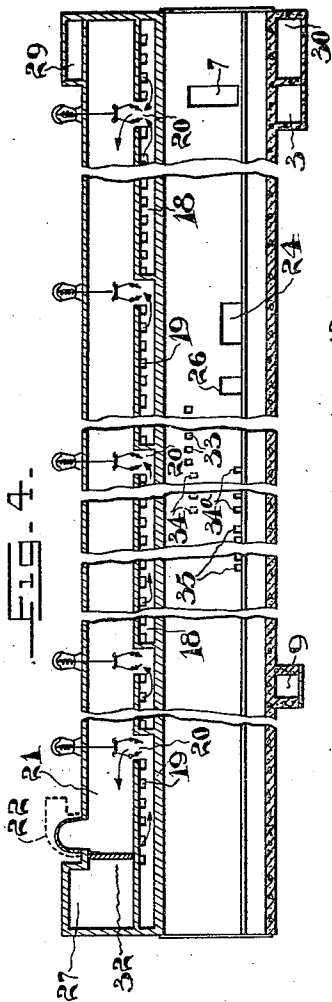
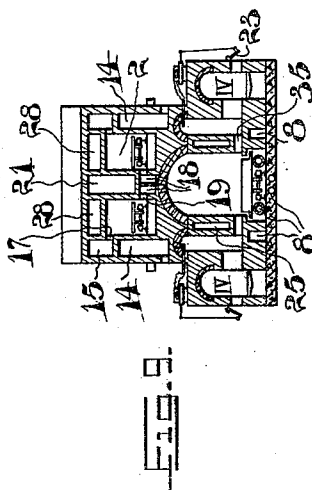
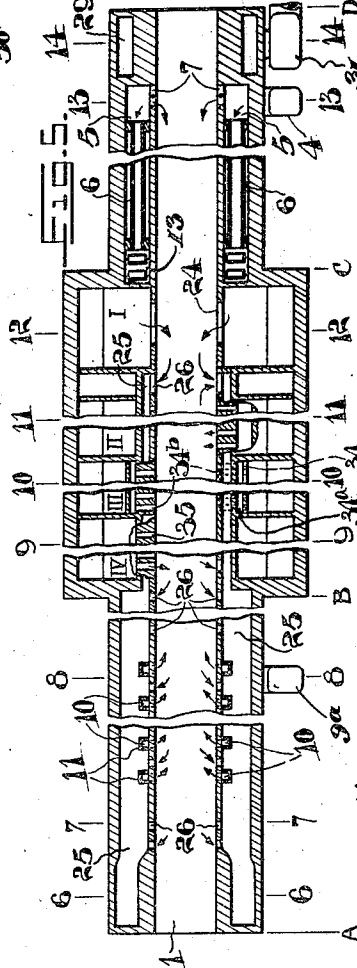
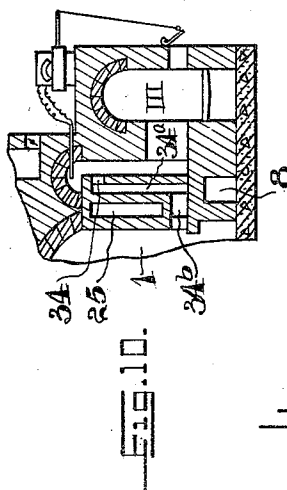
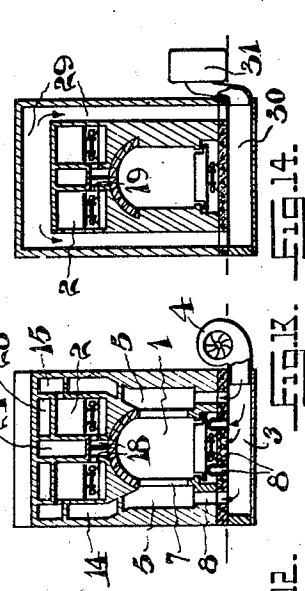
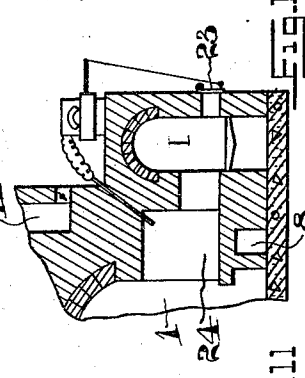
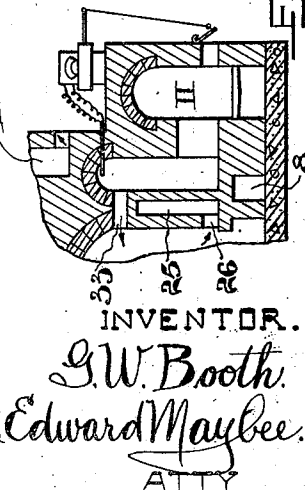
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G. W. BOOTH

TUNNEL KILN

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

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TUNNEL KILN.

Application filed March 28, 1927. Serial No. 179,074.

This invention relates to tunnel kilns for clay products of the type shown and described in my prior United States Patent 1,585,013, dated the 18th day of May, 1925, in which the drying of the ware is effected in a chamber or chambers extending lengthwise at the top of the kiln.

By such an arrangement a considerable saving of otherwise waste heat is effected. My present object is to devise an improved construction whereby still greater economies may be effected and whereby more perfect control may be had of the successive operations of drying, pre-heating, firing and cooling.

While many of the features of the invention lie in details of construction, as hereinafter described, one outstanding feature lies in the use of pressure fans to supply fresh air for cooling, drying and pre-heating purposes, so arranged that a slight air pressure may be maintained in the tunnel at each or either side of the firing zone whereby the zone of intense heat may be more or less restricted as described, or shifted in the tunnel towards or away from the cooling or the pre-heating zone. A further important feature is the arrangement whereby perfect control of the drying air at different parts of the length of the drying chamber is obtained and the moisture content of the ware thereby abstracted at such a rate that warping and checking of the ware is avoided. Further novel features of the construction are hereinafter described and illustrated in the accompanying drawings in which

Fig. 1 is a plan of a kiln constructed in accordance with my invention;

Fig. 2 a side elevation of the same;

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

Fig. 4 a longitudinal section on the line 4—4 in Fig. 1;

Fig. 5 a horizontal section of the kiln; and

Figs. 6 to 14 are transverse sections on the lines 6—6, 7—7, 8—8, 9—9, 10—10, 11—11, 12—12, 13—13 and 14—14 in Fig. 5.

In the drawings like numerals of reference indicate corresponding parts in the different figures.

1 is the tunnel of the kiln which, as usual, comprises pre-heating, firing and cooling zones. The pre-heating zone extends from A to B (see Fig. 5), the firing zone from B

to C and the cooling zone from C to D. On top of the tunnel of the kiln is arranged the drying chamber 2 extending substantially from end to end of the tunnel. Both the tunnel 1 and the drying chamber 2 will be arranged as usual for the passage of trucks carrying the ware to be fired.

In the drawings I have shown two drying chambers side by side, as this makes a convenient arrangement. It will be understood of course, that one only may be employed without departing from the spirit of my invention.

Air heating and drying system.

Adjacent the outer end of the cooling zone of the kiln is formed an air supply conduit 3 to which air may be supplied by means of a fan 4. This conduit extends transversely of the kiln and communicates at opposite ends with air passages 5 formed in the wall of the kiln at each side of the cooling zone. These passages extend from one end to the other of the cooling zone whereby there is a transfer of heat from the interior of the cooling zone to the air in the passages 5. To facilitate the heat transfer I may form the passages 5 of a series of metal tubes 6 in conductive contact at different points with the walls. The air supply conduit 3 also communicates with the interior of the cooling zone of the kiln through damper controlled openings 7. A proportion of the air supplied through the conduit 3 may thus be turned into the interior of the cooling zone of the kiln for a purpose which will hereinafter appear.

Extending under the bottom of the kiln are one or more longitudinal air passages 8, which extend past the firing zone of the kiln and communicate with a transverse air supply conduit 9 connected with the discharge outlet of a pressure fan 9^a. The passages 8 communicate with a plurality of vertical flues 10 extending up at both sides of the inner wall of the pre-heating zone of the kiln. These flues are separated by means of their metal walls 11 from the products of combustion flues hereinafter referred to.

Each flue 10 is provided with an upper and lower opening 12, which openings are formed in the inner wall of the pre-heating zone for admitting air from the flues 10 into the interior of the tunnel. Any desired number of these flues or openings may be closed

by suitable plugs (not shown) at any time to meet the needs of the case according to the qualities of the ware to be fired.

From the constructions described it follows that air under pressure may be introduced into the cooling zone, or the pre-heating zone, or both, by either fan 4 or 9^a so that the products of combustion in the firing zone may be held therein or allowed to travel somewhat towards either end of the kiln as may be required. It further follows that heated air is provided to pre-heat the ware passing through the pre-heating zone of the kiln and to assist in the oxidation of the ware therein. Hereinafter it will appear how the hot products of combustion are utilized to heat the walls of the pre-heating zone, and also to assist in heating the air passing through the flues 10.

The air which passes through the flues 8 under the tunnel serves to cool the space beneath the trucks passing through the zones of the kiln. The air heated in the air passages 5 extending along the sides of the cooling zone of the kiln is utilized in drying the ware passing through the drying chambers by means of the following constructions. At each side of the kiln the air passage 5 communicates with a vertical passage 13, which communicates at its lower end with one of the air passages 8 and, at its upper end, with a longitudinal air distributing passage 14 which extends substantially from end to end of the kiln. Dampers are provided at each end of each vertical passage 13. At each side, above the corresponding air distributing passage 14, is located an air passage 15 transversely divided into sections, each section communicating by means of a damper controlled opening 16 with the air distributing passage 14. Warm dry air may thus be introduced into each section according to circumstances. Each section communicates with the interior of the adjacent drying chamber by means of a longitudinal series of openings 17. These openings, it will be noted, are arranged along the top of the outer side wall of the drying chamber. Centrally of the kiln at or about the level of the lower parts of the drying chambers I provide moist air flues 18. While one flue might serve, I prefer to employ two as conditions in the two drying chambers may not be exactly the same. The lower part of each drying chamber communicates with one of the moist air flues by means of a longitudinal series of openings 19. The moist air flues are preferably divided into sections like the air passages 15, and each section communicates by means of a damper controlled opening 20 with the draw-off passage 21, which extends longitudinally of the kiln and adjacent the inlet end of the drying chamber is provided with a suction fan 22 whereby the moisture laden air may be drawn off.

From the constructions described it follows that perfect control may be obtained of the admission of drying air and the drawing-off of moist air at different points along the length of the drying chambers so that the rate of drying at different parts of the drying chamber may be accurately controlled to prevent warping and checking of the ware. While manually controlled dampers might be employed, I prefer to employ automatic temperature and humidity controllers, such as are well known in the art, and which are illustrated diagrammatically in the drawings.

The firing system and utilization of the waste heat of the products of combustion.

While any furnaces of known type may be employed, I prefer to employ the furnaces illustrated, which are preferably of different types at different points in the length of the firing zone to enable the firing to be carried as best suits the requirements of the ware to be fired. Four types of furnace are illustrated, which are best seen in Figs. 9, 10, 11 and 12 of the drawings.

The first furnace I in the series illustrated in Fig. 12 is of ordinary type, and is preferably provided with a draft damper 23 automatically controlled by an automatic temperature controller of known type. This furnace communicates directly with the interior of the kiln through an opening 24. At each side of the tunnel I form a flue 25 for the products of combustion communicating with the interior of the kiln by means of openings 26. The products of combustion entering the tunnel through the openings 24 may thus be drawn off through the flues 25 after traveling a greater or less distance through the tunnel and around the ware being fired. Preferably the series of openings 26 is extended substantially the full length of the pre-heating and firing zones of the kiln, as some wares are not injured by early contact with the products of combustion. At any time any of the openings 26 may be closed by suitable plugs. The flues 25 extend along each wall of the kiln in front of the furnaces II, III and IV and alongside the pre-heating zone to the inlet end of the kiln where they communicate with upwardly extending and transverse passages 27. The transverse portion of the passages 27 communicates with the flues 28 extending along the top of the drying chambers to the outlet end thereof. At this end the flues communicate with downwardly extending and transverse flues 29 communicating with a transverse flue 30, with which communicates the suction fan 31 by means of which the products of combustion may be drawn off. Under some conditions the moist air from the draw-off passage 21 may be allowed to pass off with the products of combustion. I therefore provide each draw-off passage with a damper controlled

communication 32 with the transverse passage 27. It will be noted that the hot products of combustion are utilized to heat the air passing through the flues 10, which air is supplied through either the air supply conduit 3, or the air supply conduit 9, or both.

The second furnace II communicates with the interior of the tunnel through the openings 33 over the flue 25.

10 The furnace III communicates with the interior of the kiln through the openings 34, passage 34^a and openings 34^b, while furnace number IV communicates with the interior of the tunnel through the openings 35. Any
15 one or any combination of the furnaces may be used as desired for different classes of ware.

With the furnaces arranged as described, hot products of combustion may be circulated in any desired manner through the ware to be fired.

All the furnaces are preferably provided with automatic damper controllers similar to that of furnace No. 1, and generally speaking
25 any of the openings or passages of the kiln may be provided with dampers, though not hereinbefore set forth.

It is obvious that the arrangement described not only gives me perfect control of the drying, pre-heating, firing, and cooling of the ware but results in economy in operation as otherwise waste heat is utilized to the greatest possible extent and perfect control of the combustion of the fuel is attained.

35 What I claim is:

1. The combination of a tunnel kiln; a separate drying chamber; a distributing air passage formed in the wall of the chamber extending longitudinally thereof; an air passage arranged adjacent the distributing passage divided into sections, each section communicating with the distributing passage and through a longitudinal series of openings with the interior of the drying chamber; a
40 moist air flue extending longitudinally of the kiln and communicating with the interior of the drying chamber at different points in its length; dampers controlling the communications between the distributing passage and the sections of the sectional passage; and
50 means for drawing air through the said passages, chamber and flue.

2. A kiln constructed as set forth in claim 1 in which the moist air flue is formed in separated sections and a draw off passage is provided in communication with each section by means of damper controlled openings.

3. The combination of a tunnel kiln; a separate drying chamber; an air passage formed in a wall of the chamber communicating with the interior of the chamber at different points in its length; a sectional moist air flue extending longitudinally of the kiln,

each section communicating with the interior 65 of the drying chamber through a longitudinal series of openings; a draw-off passage communicating with each section of the moist air flue; dampers controlling the communications between the draw-off passage and the sections of the moist air flue; and means for drawing air through the said passages, chamber and flue. 70

4. The combination of a tunnel kiln; a separate drying chamber; a distributing air passage formed in the wall of the chamber extending longitudinally thereof; an air passage arranged adjacent the distributing passage divided into sections, each section communicating with the distributing passage and with the interior of the drying chamber; a sectional moist air flue extending longitudinally of the kiln, each section communicating with the interior of the drying chamber; a draw-off passage communicating with each section of the moist air flue; dampers controlling the communications between the draw-off passage and the sections of the moist air flue; and means for drawing air through the said passages, chamber and flue. 75 80 85 90

5. The combination of a tunnel kiln; a separate drying chamber arranged at the top of the kiln whereby the chamber will be heated by conduction from the kiln; an air passage formed longitudinally in a wall of the chamber and adjacent the kiln, the passage having a series of openings communicating with the interior of the chamber; a moist air flue extending longitudinally of the kiln communicating with the interior of the chamber at different points in its length; means for drawing air through the said passage, chamber and flue; a furnace; passages for the products of combustion including a flue in the wall of the chamber paralleling the aforesaid air passage; and means for drawing the products of combustion through said passages and flue from the kiln. 95 100 105

6. The combination of a tunnel kiln; a separate drying chamber arranged at the top of the kiln whereby the chamber will be heated by conduction from the kiln; an air passage formed longitudinally in a wall of the chamber and adjacent the kiln, the passage having a series of openings communicating with the interior of the chamber; a moist air flue extending longitudinally of the kiln communicating with the interior of the chamber at different points in its length; means for drawing air through the said passage, chamber and flue; a furnace; passages for the products of combustion including a flue in the wall of the chamber paralleling the aforesaid air passage; means for drawing the products of combustion through said passages and flue from the kiln; and a damper controlled passage forming a communication between the moist air flue and the flue for the 110 115 120 125

products of combustion whereby the moist air may be carried off with the products of combustion when desired.

7. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with an air heating passage formed in the wall of the cooling zone of the furnace; an air supply conduit communicating with the air heating passage and the interior of the cooling zone of the kiln; means for controlling the proportion of air passing to each; a drying chamber; and means for leading the heated air into said drying chamber.

8. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with an air heating passage formed in the wall of the cooling zone of the kiln; an air supply conduit communicating with the air heating passage and the interior of the cooling zone of the kiln; means for controlling the proportion of air passing to each; a drying chamber; means for leading the heated air into said drying chamber; and a passage under the kiln communicating with the air conduit aforesaid and with the interior of the tunnel at the pre-heating zone.

9. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with an air heating passage formed in the wall of the cooling zone of the furnace; an air supply conduit communicating with the air heating passage and the interior of the cooling zone of the kiln; means for controlling the proportion of air passing to each; a drying chamber; means for leading the heated air into said drying chamber; a passage under the kiln communicating with the air conduit aforesaid and with the interior of the tunnel at the pre-heating zone; a flue through which the products of combustion from the firing zone are passed and which extends along the wall of the pre-heating zone; and means for effecting an exchange of heat between the said flue and the air from the last mentioned passage as it passes into the pre-heating zone of the kiln.

10. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a passage extending throughout the greater part of the length of the three zones; an air supply conduit communicating with said passage and the interior of the cooling zone of the furnace, the passage also communicating with the interior of the pre-heating zone of the kiln; and an air supply conduit communicating with said passage adjacent the pre-heating zone end of the same.

11. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with an air heating passage formed in the wall of the cooling zone of the furnace; a drying chamber; an air distributing passage communicating with the air heating passage adjacent the inner end of the cooling zone; means for leading air from the dis-

tributing passage to and through the drying chamber; and an air supply conduit communicating with the air heating passage and the interior of the cooling zone of the kiln adjacent its outlet end.

12. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a flue for the products of combustion extending along the wall of the pre-heating zone; a vertical flue extending up the side of and communicating with the pre-heating zone of the kiln and passing through the products of combustion flue; and an air supply conduit communicating with the vertical flue.

13. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a flue for the products of combustion extending along the wall of the pre-heating zone; vertical flues extending up the side of and communicating with the bottom and top of the pre-heating zone of the kiln, the said flues having metal walls separating them from the products of combustion flue; and an air supply conduit communicating with the vertical flues.

14. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a flue for the products of combustion located in the wall of the kiln and extending along both the firing and pre-heating zones; a furnace communicating with the interior of the tunnel at the firing zone adjacent the cooling zone, openings being formed from the interior of the tunnel into the flue at different points in the length of the firing zone; means for drawing gases from said flue; and means for introducing air under pressure into the interior of the tunnel at the pre-heating zone.

15. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a flue for the products of combustion located in the wall of the kiln and extending along both the firing and pre-heating zones; a furnace communicating with the interior of the tunnel adjacent the cooling zone, openings being formed from the interior of the tunnel into the flue at different points in the length of the firing zone and the pre-heating zone; means for drawing gases from said flue; and means for introducing air under pressure into the interior of the tunnel at the pre-heating zone.

16. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a flue for the products of combustion located in the wall of the kiln and extending along both the firing and pre-heating zones; a furnace communicating with the interior of the tunnel adjacent the cooling zone, openings being formed from the interior of the tunnel into the flue; a drying chamber; a flue for the products of combustion extending lengthwise of the chamber and communicating with the flue aforesaid; means for drawing the prod-

ucts of combustion from the drying chamber flue; means for pre-heating air; a passage for air extending along the wall of the drying chamber communicating with the interior of the chamber; a moist air flue also communicating with the interior of the chamber; means for drawing air from the moist air flue; and a damper controlled communication between the moist air flue and the drying chamber flue for products of combustion.

17. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with an air passage along the bottom of the tunnel extending from the cooling zone to the pre-heating zone and communicating with the interior of the tunnel at the pre-heating zone and the cooling zone; an air supply conduit connected with the passage; and means for controlling the flow therefrom to the said zones.

18. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with an air passage along the bottom of the tunnel extending from the cooling zone to the pre-heating zone and communicating with the interior of the tunnel both at the pre-heating zone and the cooling zone; air supply conduits connected with the passage adjacent opposite ends and means for controlling the flow therefrom to the said zones.

19. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a flue for the products of combustion located in the wall of the kiln and extending along both the firing and pre-heating zones; a furnace communicating with the interior of the tunnel at the firing zone adjacent the cooling zone, openings being formed from the interior of the tunnel into the flue at different points in the length of the firing zone; means for drawing gases from said flue; and means for introducing air under pressure into the interior of the tunnel at the cooling zone.

20. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a flue for the products of combustion located in the wall of the kiln and extending along both the firing and pre-heating zones; a furnace communicating with the interior of the tunnel adjacent the cooling zone, openings being formed from the interior of the tunnel into the flue at different points in the length of the firing zone adapted to be progressively closed to control the point of entry of products of combustion into the tunnel and the pre-heating zone; and means for drawing gases from said flue at a point remote from the furnace.

21. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a flue for the products of combustion located in the wall of the kiln and extending along both the firing and pre-heating zones; a furnace communicating with the interior of the tunnel adjacent the cooling zone, openings being formed from the interior of the tunnel into the flue at different points in the length of the firing zone and the pre-heating zone; means for drawing gases from said flue; and means for introducing air under pressure into the interior of the tunnel at the pre-heating zone and at the cooling zone.

22. A tunnel kiln comprising a pre-heating, a firing and a cooling zone in combination with a passage extending throughout the greater part of the length of the three zones and communicating with the interior of both the cooling and pre-heating zones; means for supplying air under pressure to said passage; and means for controlling the air passing from the passage into said zones to vary the relative proportion of air flowing to each.

Signed at Toronto this 3rd day of March, 1927.

GEORGE W. BOOTH.