G. H. BENJAMIN.

CONTINUOUS TUNNEL KILN.

APPLICATION FILED MAY 24, 1916. RENEWED NOV. 10, 1917.

1,268,204.

Patented June 4, 1918.

4 SHEETS—SHEET 1.

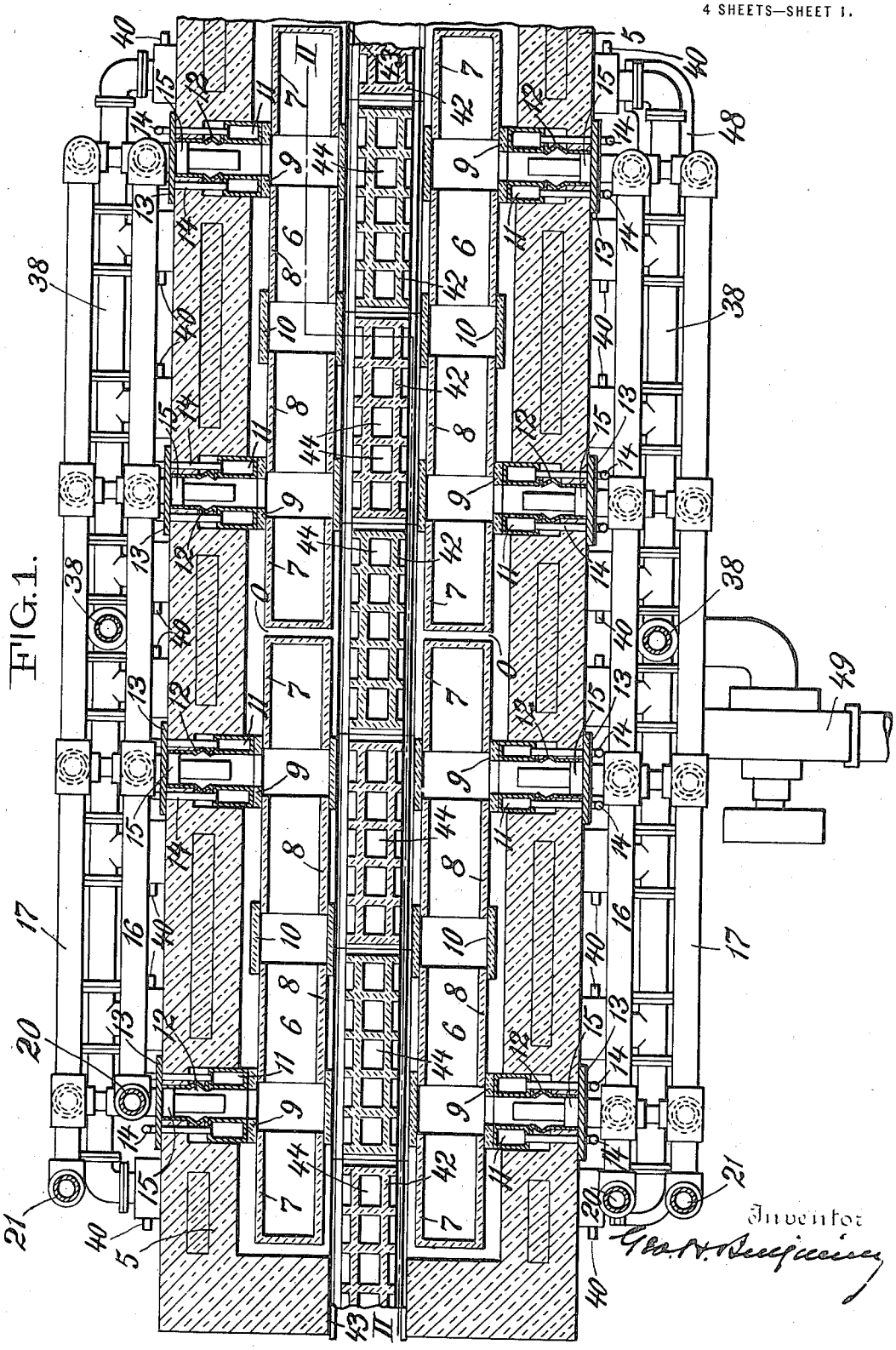


FIG. 1.

Inventor

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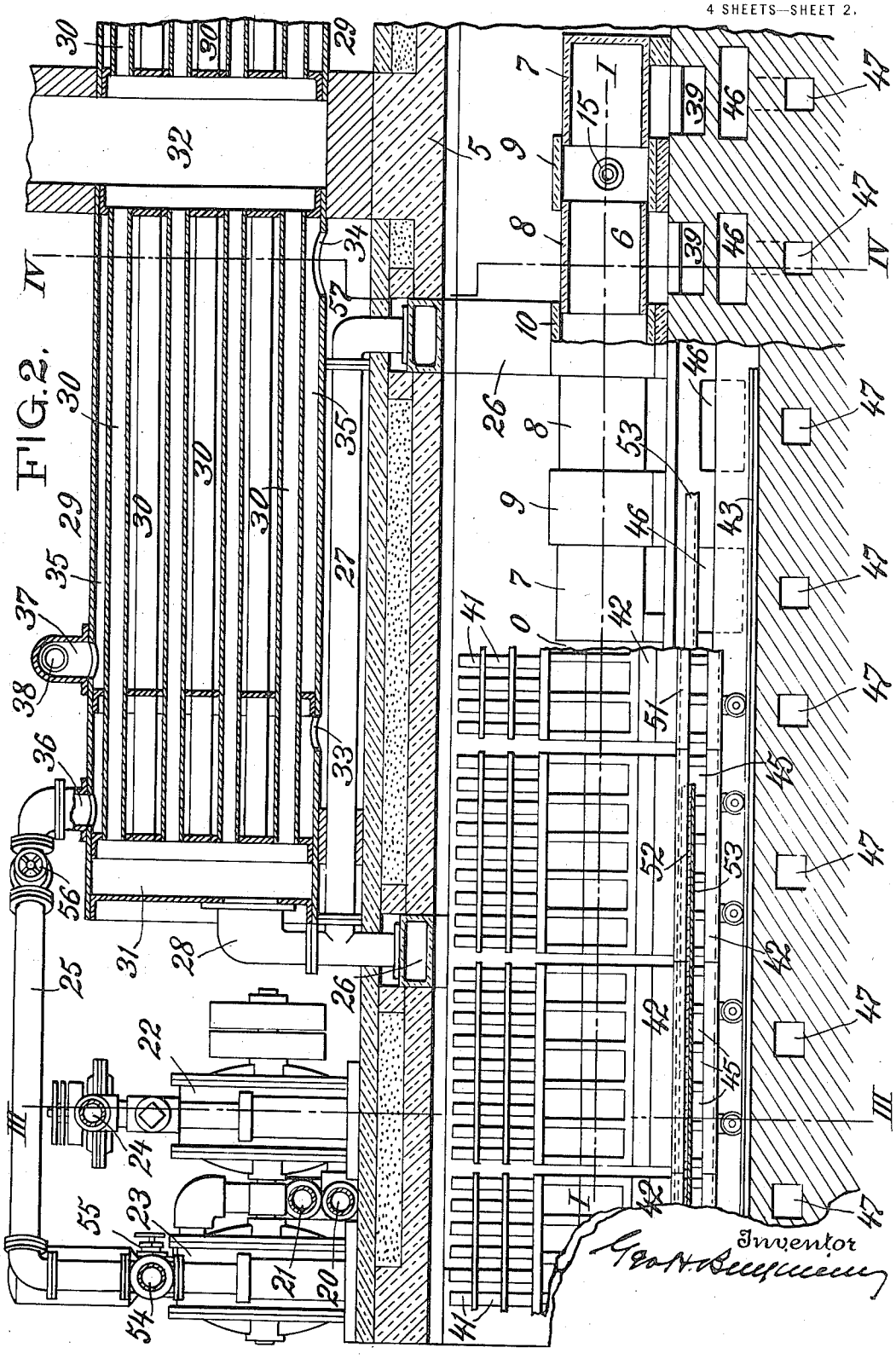
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4 SHEETS—SHEET 2.

FIG. 2.



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4 SHEETS—SHEET 3.

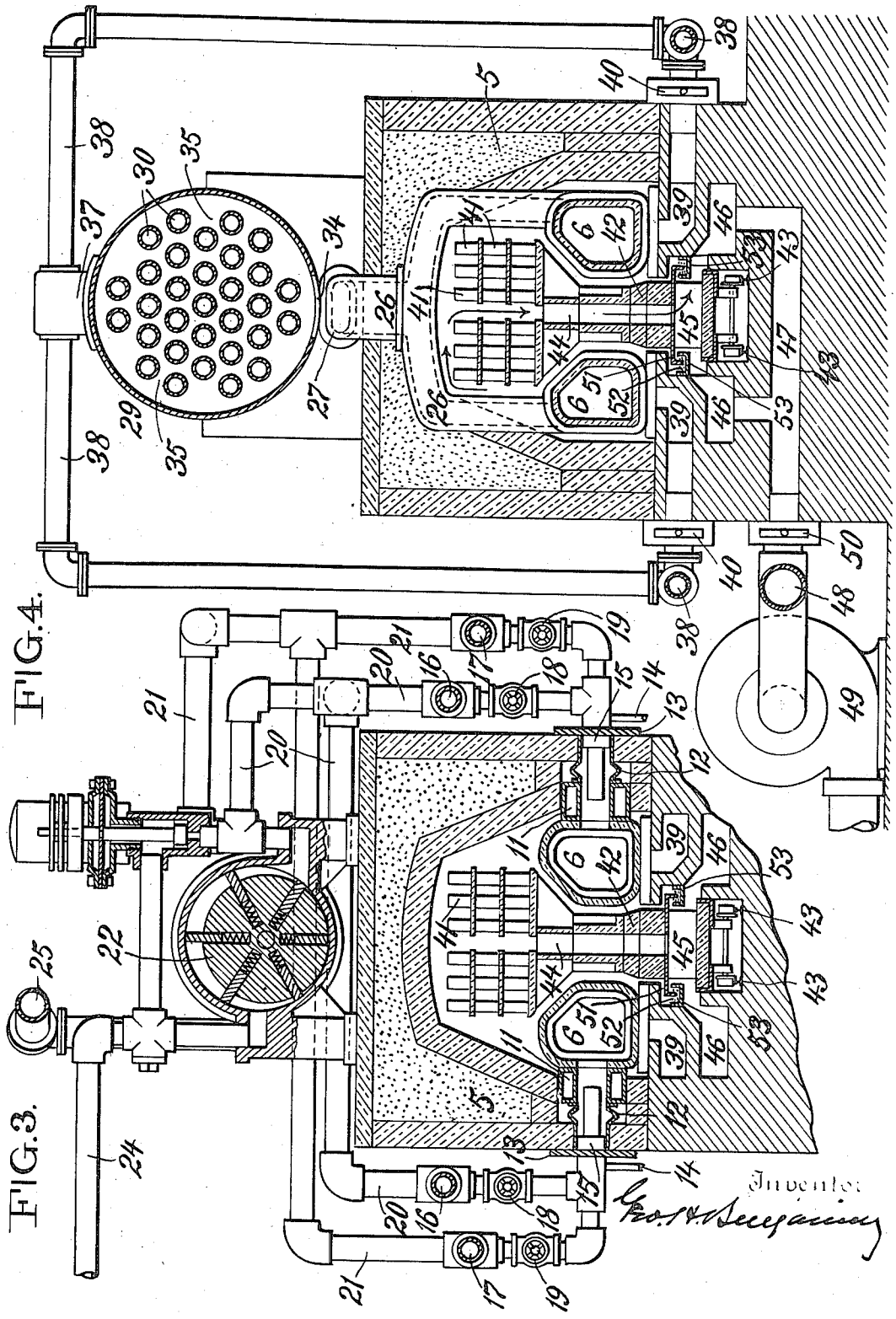


FIG. 4.

FIG. 3.

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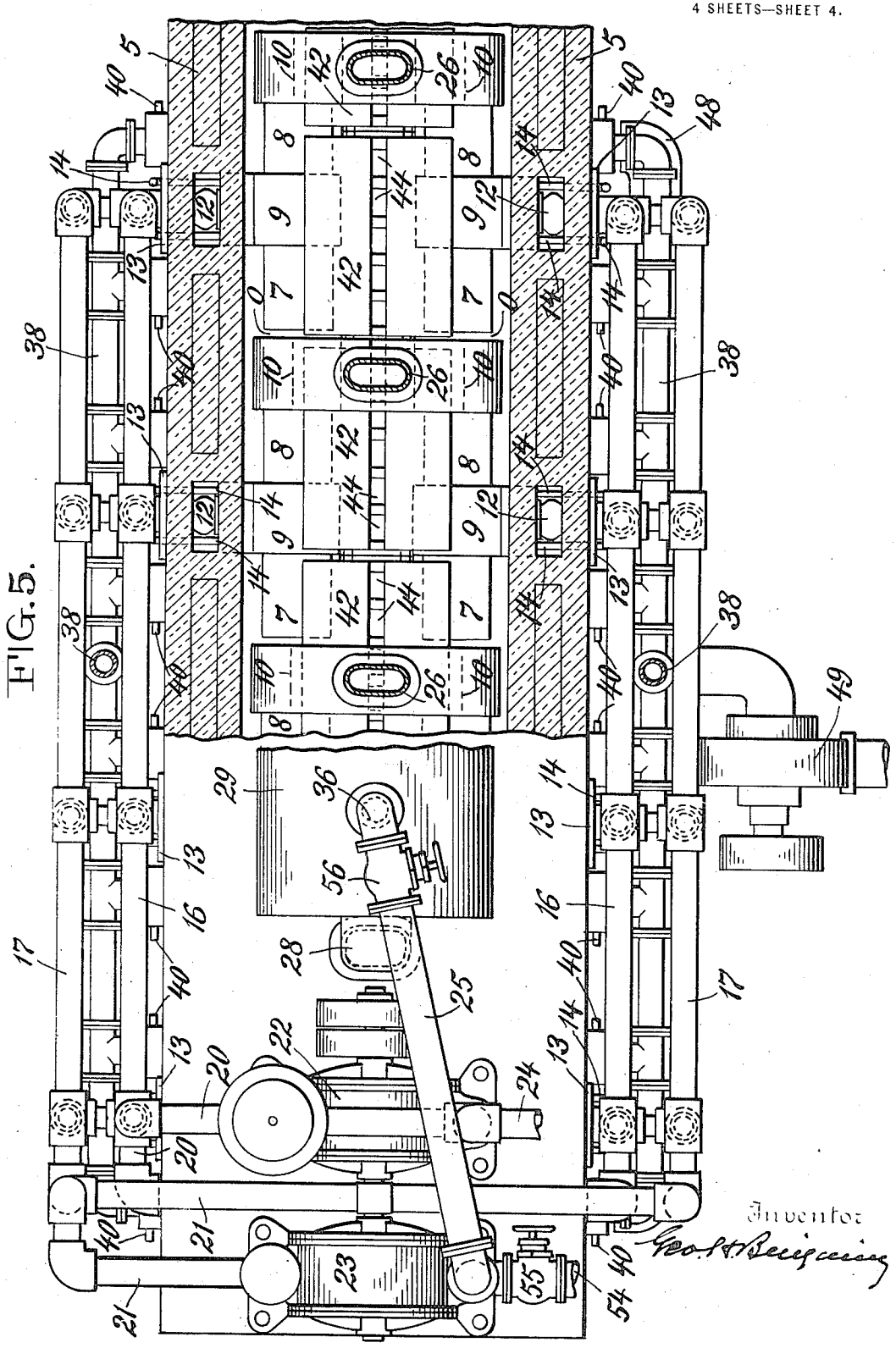
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4 SHEETS—SHEET 4.

FIG. 5.



UNITED STATES PATENT OFFICE.

GEORGE HILLARD BENJAMIN, OF NEW YORK, N. Y.

CONTINUOUS TUNNEL-KILN.

1,268,204. Specification of Letters Patent. Patented June 4, 1918.

Application filed May 24, 1916, Serial No. 99,540. Renewed November 10, 1917. Serial No. 201,223.

To all whom it may concern:

Be it known that I, GEORGE HILLARD BENJAMIN, a citizen of the United States, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Continuous Tunnel-Kilns, of which the following is a specification.

My invention relates to improvements in continuous tunnel kilns, more especially adapted for use in the manufacture of tiles, pottery and the like.

My invention relates to certain improved features of construction which may be enumerated as follows:

1. Improved method of constructing the heating chambers, by reason of which the chambers may freely expand and contract with less liability of injury to the chambers than has heretofore been the case.

2. Improved method of heating the chambers, by reason of which perfect combustion takes place within the chambers and free transmission of heat to the interior of the kiln; as also control of the temperature at any part of the kiln.

3. Improved method of circulating the heated air in the kiln, around and through the material under treatment, whereby the rate of absorption of moisture is materially increased.

4. Improved construction whereby the outgoing products of combustion from the heating chambers are utilized to primarily heat the moisture-absorbing air which circulates around the material under treatment, as also the air used in effecting combustion in connection with a fuel gas in the heating chambers.

The accompanying drawings will serve to illustrate my invention, in which Figure 1 is a horizontal section on the line I—I of Fig. 2. Fig. 2 is a sectional elevation on the line II—II of Fig. 1. Fig. 3 is a transverse section on the line III—III of Fig. 2. Fig. 4 is a transverse section on the line IV—IV of Fig. 2. Fig. 5 is a plan view, partially in section, showing a modified construction of the combustion chambers and the flues for carrying off the products of combustion.

In the drawings, 5 indicates the body of the kiln which may be of any suitable construction. As the kiln is a long piece of apparatus, only sufficient length is illustrated in Figs. 1, 2 and 5 to show its general construction. Located within the kiln and on each side thereof, and separated from the walls, are heating chambers 6. As illustrated in Fig. 1, the heating chambers each consist of the end portions 7, central portions 8, burner portions 9, and a chimney portion 10. As illustrated in Fig. 5, of an end portion 7, a central portion 8, a burner portion 9, and a chimney portion 10. In the construction illustrated in Fig. 1, two burner portions 9 are shown as interposed between an end portion 7 and central portion 8 at one end, and an end portion 7 and central portion 8 at the other end, with the chimney portion 10 in the center; whereas in the construction shown in Fig. 5, but a single burner portion 9 is shown as interposed between an end portion 7 and a central portion 8, with a chimney portion at one end. As the kiln is of considerable length, the sections of the heating chambers 6 are repeated along the whole length of the kiln, sufficient space being left between the ends of the sections to permit expansion and contraction, such space being indicated at 0 in Figs. 1 and 5.

Located with the walls of the kiln are annular sleeves 11 which bear on their inner end, against the burner portions 9 of the heating chambers 6. Connected to the outer end of each of the annular sleeves, is a metallic corrugated sleeve 12 connected to a plate 13 on the outer wall of the kiln. 14 indicates pipes through which a cooling fluid may be caused to circulate in the cavity of the annular sleeves 11. 15 represents gas and air burners having their forward ends projecting into annular sleeves 11. The rear end of these burners is connected to a gas supply pipe 16 and to an air supply pipe 17, the supply to each of the burners being controlled by a valve 18 in a pipe connected to pipe 16, and a valve 19 in a pipe connect to pipe 17. Pipes 16 and 17 are respectively connected by pipes 20 and 21 to the eduction orifice of gas pump 22 and air pump 23. The gas pump is connected to a source of gas supply through pipe 24, and the air pump 23 to a source of hot air through the pipe 25. In practice I prefer that the gas shall be delivered at a pressure of one pound to the square inch, and the air at a pressure of one and one quarter pounds to the square inch. I, however, do not limit myself to such respective pressures.

The construction of the gas and air burn-

ers, pumps, air heater and communicating parts, is substantially the same as shown in my prior Patent No. 948,538 dated Feb. 8, 1910, to which reference is made for a full description, both as to construction and method of operation.

In Fig. 1 two burners are shown as connected with each heating chamber 6; in Fig. 5, one burner. I wish it understood that I do not limit myself to the number of burners.

The products of combustion are carried out of the heating chambers through vertical flues 26, which communicate with a pipe 27, and thence through pipe 28 to an air heater 29 containing a series of flues 30, connected at the left hand end to a space 31, and at the right hand end to a chimney stack 32. Located in the bottom of the air heater, are two openings 33—34 through which air enters the heater and passes around the flues 30, through the spaces 35, thence to the air exhaust orifices 36—37. The opening 36 communicates with the pipe 25 leading to air pump 23. The opening 37 communicates with pipes 38 which communicate with a series of flues 39 adapted to discharge air under the heating chambers 6. The supply of air to each flue 39 is controlled by a valve 40 in one of a series of pipes which are connected to a pipe 38. The air discharged under the heating chambers 6 from the pipes 38, passes over the material under treatment 41, which is mounted on a truck 42 itself mounted on rails 43 situated in a cavity below the bottom of the kiln. The truck 42 has formed in it a vertical air passage 44, which communicates with a horizontal air passage 45 in communication with a series of flues 46—47, which communicate with a pipe 48 connected to the induction orifice of an exhaust pump 49. Passage of air from flues 46—47 is controlled by valves 50.

To prevent the air introduced through the flues 39 from flowing to the passage 45 and the flues 46—47 to the exhaust pump, I provide an air shield, which consists of a plate 51 having downwardly turned ends which move through a body of sand 52 located in the troughs 53. Any other form of shield may be substituted. I have described the air fed to the air pump 23 as heated by passage through the heater 29. It will sometimes be desirable to introduce cold air or tempered air, and to permit this, I provide a pipe 54 communicating with the atmosphere, in which is a valve 55, as also a valve 56 in pipe 25. By opening the valve 55 and closing the valve 56, air at the temperature of the atmosphere may be drawn into the pump 23 and be discharged by the pump into the body of the kiln.

It will be seen from the above description, that the air entering through the flues 39 is discharged under the chamber 6, is heated in passing over the chamber 6, then passes to the top of the kiln, then through the material 41 on the truck 42, down the vertical air passage 44 to the horizontal passage 45, flues 46, flue 47, to exhaust pump 49, there being a complete circuit of air. The exhaust from pump 49 can, if desired, be delivered to the flue 57 under the heater 29 and in which the air orifices 33—34 in the bottom of the heater are located, so that the air can be caused to pass through the material in the kiln and then through the heater to increase the heat of the air and back again, the circuit being repeated as often as is desired. The advantage of this construction over that heretofore used, is that the circulation is positive.

It has heretofore been suggested to cause circulation to take place over the material in the kiln by heating the air through radiation from the heating chambers, then causing the air to flow in a downward direction by chilling the air through contact with the material under treatment, and repeating the circulatory movement. In practice, however, such circulation is not readily effected, and for the reason that the heated air, when it comes in contact with the material under treatment, absorbs moisture, with the effect that the specific gravity of the air and moisture is less than the original specific gravity of the air, and consequently, the moist air does not flow in a downward direction to be again heated and moved to the top of the kiln.

I have not described in this specification, the details of construction illustrated in the drawings, as the constructive features may be modified in many particulars, as will be fully understood by those skilled in the art to whom this invention is directed.

Having thus described my invention, I claim:

1. A tunnel oven of the type described, comprising a main chamber, a plurality of heating chambers in which combustion may be effected without discharging the products of combustion into the main chamber and arranged longitudinally in line on each side of the main chamber, means for feeding gas and air under pressure into each of said heating chambers, and means for conveying the products of combustion from each of said heating chambers.

2. A tunnel oven of the type described, comprising a main chamber, a plurality of heating chambers in which combustion may be effected without discharging the products of combustion into the main chamber and arranged in spaced relation and longitudinally in line on each side of the main chamber, means for feeding gas and air under pressure into each of said heating chambers, and means for conveying the

products of combustion from each of said heating chambers.

3. A tunnel oven of the type described, comprising a main chamber, a plurality of heating chambers adapted to heat by radiation from combustion within said chambers, each chamber formed of a series of movable sections, and such chambers arranged longitudinally in line on each side of the main chamber, means for feeding gas and air under pressure into each of said heating chambers, and means for conveying the products of combustion from each of said heating chambers.

4. A tunnel oven of the type described, comprising a main chamber, a plurality of heating chambers adapted to heat by radiation from combustion within said chambers and arranged longitudinally in line on each side of the main chamber, means for feeding gas and air under pressure into each of said heating chambers, means for conveying the material to be treated through the main chamber, and means for causing heated air to move over the material in the main chamber.

5. A tunnel oven of the type described, comprising a main chamber, a plurality of heating chambers arranged longitudinally and in spaced relation on each side of the main chamber, means for feeding gas and air under pressure into each of said heating chambers, means for conveying the products of combustion from each of said chambers, an air heater through which the products of combustion pass, means for conveying the material to be treated through the main chamber, and means for causing the heated air to be positively moved over said heating chambers and through the material under treatment in the main chamber.

6. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers arranged longitudinally in line on each side of the main chamber, means for feeding gas and heated air under pressure into each of said heating chambers, and means for conveying the products of combustion from each of said heating chambers.

7. A tunnel oven of the type described, comprising a main chamber, a plurality of heating chambers, each of said heating chambers consisting of a series of movable sections, means for feeding gas and air under pressure into the opposite ends of said chambers, means for conveying the products of combustion from the central portion of said chambers, together with means for regulating the velocity of flow of the gas and air in accordance with the rate of combustion.

8. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers, gas and air burners for each heating chamber, together with means for delivering gas and air at said burners at such pressures as will cause the velocity of flow to correspond to the speed of combustion.

9. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers, said heating chambers arranged in line and in two groups on opposite sides of the main chamber and of such size as to permit free development of flame therein, gas and air burners for such heating chambers, together with means for delivering gas and air at said burners at pressures substantially in the ratio of one to one and one quarter pounds to the square inch respectively.

10. A tunnel oven of the type described, comprising a main chamber, a series of sectional independent substantially closed heating chambers arranged in line on each side of said main chamber and separated therefrom, gas and air burners communicating with each of said heating chambers, means for feeding gas and air under pressure to said burners, and means for conveying away the products of combustion from said heating chambers.

11. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers, means for feeding gas and air into said heating chambers, means for conveying the products of combustion from said heating chambers without passing through the main chamber, an air heater through which the products of combustion pass, means for conveying the air from the air heater through and around the material in the main chamber under treatment, and means for exhausting the air from the main chamber.

12. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers, means for conveying combustible gases to the interior of the heating chambers, means for conveying the products of combustion from said chambers, a heater through which the products of combustion pass, means for conveying hot air from the air heater to the main chamber, and means for causing the hot air to positively pass through and out of the main chamber.

13. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers, gas and air burners for each of said heating chambers, means for conveying the products of combustion from the heating chambers, an air heater heated by the products of combustion, means for conveying the hot air from the air heater respectively to the main chamber and to the gas and air burners, and means for causing the air fed to the main chamber to positively move through the ma-

terial in the main chamber and out of the main chamber.

14. A tunnel oven of the type described, comprising a main chamber, a plurality of heating chambers, a series of flues through which hot air may be introduced under the heating chambers, a series of flues through which the hot air may be drawn from the main chamber, and means for causing a positive movement of the hot air in the main chamber, around the heating chambers and out of the main chamber.

15. A tunnel oven of the type described, comprising a main chamber, a plurality of heating chambers located on opposite sides of the main chamber, a truck for conveying the materials to be treated mounted on a trackway and adapted to be moved between the heating chambers, hot air flues adapted to deliver hot air under and around the heating chambers, a centrally located flue in the truck, air exit flues arranged along the air entrance flues, and an air screen carried by the truck and interposed between the air entrance and the air exit flues.

16. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers arranged on each side of the main chamber, gas and air burners for each of said heating chambers, expansible sleeves located in the walls of the main chamber and interposed between the exterior of the main chamber and one of the walls of the heating chambers, together with means for circulating a cooling medium through said expansible sleeves.

17. A tunnel oven of the type described, comprising a main chamber, a plurality of heating chambers, means for heating said heating chambers, means for causing air to circulate through said main chamber, and around the heating chambers and the material under treatment in the main chamber, and means for increasing the heat of the circulating air at one point of its circulation and exterior to the main chamber.

18. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers arranged in line and in pairs on opposite sides of the main chamber and along its length, means for introducing combustible gases into said heating chambers, and means for withdrawing the products of combustion from said heating chambers.

19. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers arranged in pairs on opposite sides of the main chamber and along its length, means for introducing combustible gases at two or more points along each heating chamber, and means for withdrawing the products of combustion from said heating chambers.

20. A tunnel oven of the type described, comprising a main chamber, a plurality of substantially closed heating chambers arranged in line and in pairs on opposite sides of the main chamber and along its length, means for setting free heat in the interior of the chambers, means for regulating the temperature radiated from the exterior walls of said chambers, and means for conveying the products of combustion from the interior of the chambers.

In testimony whereof, I affix my signature, in the presence of two witnesses.

GEORGE HILLARD BENJAMIN.

Witnesses:
HELEN E. HOELSCH,
HARRY TERHUNE.