A. ROBERTS.
ART OF HEATING WALLS.
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Fig. 3.

Fig. 4.

Witness:

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by

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ART OF HEATING WALLS.


To all whom it may concern:

Be it known that I, ARThUR ROBERTS, a citizen of the United States, residing at EvanSTon, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in the Art of Heating Walls, of which the following is a specification.

This invention has to do with the heating of walls for such structures as coke ovens, distillate ovens, retorts, kilns and the like, and has reference to the method by which the heating is accomplished, as well as to the structure itself, although the features of the invention are very well adapted to the heating of walls for coke ovens, distillate ovens and similar structures. It will presently appear that they are not limited to these particular uses. Nevertheless, since said features are of especial benefit when used in coke ovens and distillate ovens and the like, and since the advantages to be secured from their practice are peculiarly beneficial when used in such structures, I shall hereafter speak of their use in connection with the art which includes such structures.

The natural law of combustion, where a fuel gas capable of generating a flame of, say, 3000°F. temperature is used, is uncontrollable to the operator in heating a wall unless there is a rate of transmission throughout the wall as rapid as the heat is generated. Consequently in the past this type of combustion has not been considered feasible in the operation of coke ovens and the like. By my method this type of combustion is made possible and practical and is controllable according to the will of the operator.

At the initial points along the wall, gas is introduced and with it the air required for totally consuming it during the time it is in the wall. Only a part of the total amount of gas introduced at the initial point, say as illustrative 60%, and 100% of the air. As there is plenty of oxygen present in the 100% of air, the 60% of gas burns with great rapidity, generating all the heat capable of generation from the fuel gas consumed, but being intermingled with and surrounded by the molecules of excess air as a tempering agent so that only a part of its heat comes into contact with the walls at any one point, thereby enabling the operator to obtain the maximum heat generation and at the same time get a temperature appropriate to meet the said requirements according to the heat desired for maximum operation. At a point or points farther along in the wall proceeding from the top of the oven downward, the balance of the gas or say 40% is introduced into a zone at the end or at the point where the combustion of the initial gas has begun to cease, and which would permit a gradual cooling to take place. According to the practice of the past, it has been impossible to avail of the benefits of intense combustion of the short flame because if the burning of the initial gas took place, say, in a zone 6 feet in height, and the gases travel a total of 12 feet, the temperature of the lower 6 feet of the wall would be less than in that zone where the initial combustion or flame was being generated; consequently the wall would not have a uniform temperature throughout each foot of surface exposed. But by the introduction of the second-
ary gas, according to my method, a new and intense flame is caused to begin where the initial flame begins to weaken, cease, making thereby a series of continuous short, intense flames, and therefore, by necessity, according to the natural law of combustion, producing a uniform generation of heat against all points of contact in the wall, compelling a uniform distribution and absorption of heat in any given zone, the products of combustion being continuously built up by the most intense combustion possible and kept at the same temperature that they had in the zone where the initial flame was generated and the same temperature is brought in contact with the lower zone. If the surface is large enough it is not necessary to confine the introduction of the gas to two stages; it might be any number.

By the above method it is possible to fill the heating wall with combustible gases in the process of combustion and expose the entire surface to these gases during the combustion period, thereby exposing the entire surface to the flame temperature. As a given gas has a given flame temperature, which is constant, the wall to which this flame is exposed being in contact throughout its entire surface with this flame, an equivalent uniform form temperature will be thereby imparted to the wall surface.

By this method the necessity of carrying either excess air, products of combustion, or other inert gases as a dilutant, is obviated. Regardless of the problem only the required amount of gas and air is introduced, the fuel gas being introduced in the combustion chamber fractionally.

Two things transpire by this method:

First, by the introduction of only a fraction of the gas, by way of illustration say, 60% of the fuel gas is introduced at the initial point and 100% of air, the rate of combustion is not slowed down; consequently, the efficiency or combustion is maintained, but on account of the excess air being present at this point, the flame temperature is tempered and kept within a controllable range. Second, when the combustion has ceased with that part of the primary fuel gas introduced at the initial point, then the secondary gas is introduced and the combustion is completed, the flame generation being maintained throughout all points of contact of the wall by the efficient means of the short intense combustion, and as the air arriving at this point is partially diluted with the products of combustion from the primary zone, the flame at this point is again tempered and not allowed to go beyond a controllable point, and as the result this zone is maintained at the flame temperature, the same as the primary zone.

Consequently, the distinguishing features of this method make it possible to maintain uniform temperatures over large surfaces without the use of either excess air or gas as has been the practice in the past, and at the same time allow the maximum procurable temperature to be maintained on a wall, at the will of the operator. This also obviates the necessity of the long flame or slow combustion in order to get a wide diffusion of the heat by the wide distribution of the flame and the necessity of using some diluting agent by which no work is obtained.

I will point out at this time that this arrangement results in the generation of a maximum temperature in the combustion gases because there is always present a sufficient amount of air or oxygen to completely burn the combustible gas introduced, and, furthermore, the gas and air will unite chemically in the most advantageous manner, and under the most favorable conditions, because there is present no unnecessary inert gas serving to separate the molecules of the gas and air so as to interfere with the act of combustion. Each time an additional amount of combustible gas is introduced, the combustion is reinforced or renewed under the most advantageous condition, the molecules of gas and air being in as close association or relationship as may be possible. Therefore, the maximum temperature is secured, resulting in the most favorable condition for prosecuting the heating system, and at the same the most uniform temperature is secured over the entire area of the wall. These results cannot be secured with any other method of heating or construction with which I am familiar.

In carrying into effect the features of the present invention I provide a construction or arrangement which allows the introduction of all the air and a means for introducing the fuel gas in stages to provide a universal flame with relation to the surface to be heated by means of a series of continuous short flames, the full quantity of air being introduced along with a partial quantity of fuel gas at the beginning edge of this wall, the additional quantities of fuel gases being introduced from time to time during this single passage or travel from one edge to the other. Such an arrangement is to be distinguished from an arrangement in which the full amount of the air and gas for one continuous pass of the wall is initially introduced, depending on the velocities and inert gas to slow down the combustion to a long slow flame that the sluggish flame may be drawn through a one way passage of the wall, then repeating the operation in a return passage and so continuing back and forth from one side to the other until the flames have been covered throughout the wall. In the present case a large number of burners or points of introduction of full quantities of air and partial quantities of gas are
located adjacent to one edge of the wall, and
the heating gases travel as a single sheet or
wide flame universally over all portions of
the wall in one direction as one flame to the
5 discharge edge thereof, the additional quan-
tities of gas being introduced at various
points as desired throughout the face of said
wall so as to reinforce the combustion at
those points and in those amounts necessary
to maintain a series of short flames at all
portions of the wall so that every point of
the wall is in contact with the flame gener-
ation of heat which of necessity produces a
uniform temperature in all portions of the
wall.

In the practical carrying into effect of the
features of this invention, I provide
secondary, tertiary, etc., ducts, through
which the additional portions of gas are
introduced into the body of the wall, said
ducts reaching down into the body of the
wall and communicating with the heating
passages therein. These auxiliary ducts
are of course adjacent to the temperature
25 of the wall, since they are in or adjacent
to the wall, and if there should be any
deposition of carbon on the surface of these
ducts, the same may be readily removed by
passing air through the ducts, to thereby
burn out the carbon so deposited. The
burning out of carbon in this manner will
result in the generation of heat, and this
heat will be introduced into the wall so as
to assist the heating action to that extent,
35 thereby preventing any loss of heat on ac-
count of the deposition of the carbon.

Other objects and uses of the invention
will appear from a detailed description of
the same, which consists in the features of
construction and combinations of parts
hereinafter described and claimed, as well as
the process or method of heating.

Referring to the drawings:

Figure 1 shows a cross section through
a pair of adjacent coke ovens with their retorts and heating walls. This section is
taken at such a point that it shows one of
the passages through which the additional quantity of combustible gas is introduced;

Fig. 2 is a cross section similar to that of
Fig. 1, with the exception that it is taken at a different position so that it reveals one
of the air risers. Figs. 1 and 2 may be
considered as being taken on the lines 1—1
and 2—2 of Fig. 4 respectively;

Fig. 3 is a fragmentary longitudinal sec-
tion through one of the heating walls, being
taken on the line 3—3 of Fig. 1 looking in
the direction of the arrows;

Fig. 4 is a fragmentary longitudinal sec-
tion through the intermediate wall between
the heating walls, being taken on the line
4—4 of Fig. 1 looking in the direction of
the arrows;

Fig. 5 is a fragmentary plan view of the
top of a bench of ovens, showing one ar-
angement of piping for supplying the air
and gas;

Fig. 6 is a side view of one of the notched
blocks used in building up the wall; and
Fig. 7 is a plan view corresponding to
Fig. 6.

Bearing in mind the matters hereinbefore
explained, and with the knowledge that I
have herein illustrated the application of the
75 features of invention to a particular con-
struction simply by way of illustration and
not as a matter of limitation, I will describe
the construction shown in the drawing.
Here are illustrated two adjacent retorts or
80 carbonizing chambers 8 and 9. Each of
these is provided with heating walls 10 and
11. Between the heating walls of adjacent
retorts there are provided the intermediate
walls 12, which serve to accommodate pas-
sages or flues.

The particular construction adopted for
the various heating walls is a matter of
convenience in any particular case, and the
features of the present invention do not
90 relate to any particular construction of
heating wall. However, as a matter of con-
venience in illustration, and also because it
has been found to be a satisfactory con-
nstruction, I have shown the heating walls as
95 built up from notched blocks laid in layers
or courses, of such form that the notches
provide a meshwork of horizontally and
vertically extending passages 13 on the in-
terior of the wall. The particular notched
block illustrated is shown in detail in Figs.
6 and 7, and includes the side recesses 14 and
15, and the top notch or recess 16.

The top surface of the central portion 17
of the block is of tapered or notch-shaped
100 construction, as is well shown in Figs. 6
and 7. I will not herein particularly con-
cern myself further with the details of con-
struction of the heating walls, beyond
pointing out that certain of the blocks
shown at 18 in Fig. 3 are not fully recessed,
with the result that there is provided a
vertical partition extending up through the
wall to the course of blocks 19, thereby pre-
venting the full or free interchange of gases
lengthwise of the wall. Similarly the
blocks 20 serve to provide, in effect, another
vertical partition extending from the
course 21 to the course 22 shown in Fig. 3.

Along one edge of each heating wall there
is provided a series of burners 23 through
which fuel gas is introduced into said edge
of the heating wall from a manifold or
manifolds 24 by way of the individual
burner connections 25. A valve 26 may be
provided in each of these individual burner
connections, so that the gas supply to the
different burners may be independently
controlled.

Intermediate the burner connections 25
130
are the air chambers 27, the lower ends of which deliver air from combustion through the nozzles 28. The air delivered to each of these nozzles can be controlled by a damper 29 in the lower portion of the corresponding chamber 27. Each of the nozzles 28 delivers its air into a relatively large air chamber 30, whereas each of the gas burners 23 delivers its gas into a relatively small gas chamber 31. From the chambers 30 and 31 the air and gas respectively find their way into the upper portion of the heating wall and its passages. Examination of Fig. 3 will reveal the fact that the passages 30 are very much larger than the passages 31. This arrangement is desirable for the reason that several times as much air as gas by volume is necessary in order to support the perfect combustion, and, therefore, the passages 30 should be several times the cross sectional area of the passages 31 in order to maintain the same rate or velocity of flow of the air and the gas in said passages.

The air reaches the chambers 27 from the cross connections 32 which are best shown in Fig. 2. The central portion of each of these cross connections communicates with a vertical riser 33 within the body of the intermediate wall 12, the air for the risers 33 coming from the foundation of the structure where it may be preheated if that be desired. I will not further refer in detail to the construction of these risers and the arrangement within the foundation of the structure, inasmuch as these constructions may be of any suitable form which may be found desirable.

The major portion of the air, or in most cases, the entire volume or body of it, is delivered in the first instance through the passages 30 in the upper portion of the wall. Only a portion of the gas, however, is delivered through the passages 31, for example, 60% of the total amount. This means that there is an excess or surplus of air during the beginning of the burning process. Intermediate the various risers 33 are the gas downcomers 34 and 35 best shown in Figs. 1 and 4. These deliver an additional quantity of gas into the central portions of the heating walls through the openings or nozzles 36 which are best illustrated in Figs. 1 and 3. These nozzles face alternately to the walls 10 and 11, inasmuch as the additional fuel gases for both of said walls are supplied from nozzles within a single intermediate wall 12.

Ordinarily the intermediate walls 12 are slightly thinner than the space between the two adjacent heating walls, so as to permit of a slight amount of movement in the expansion of the walls when the structure is initially heated.

The nozzles or openings 36 are conveniently formed in one of the courses of the notched block, and the passages or downcomers 34 and 35 should register nicely with said nozzles and should provide substantially gas-tight connections with them. Otherwise there will be a certain amount of wastage of fuel gas, and, furthermore, the best results will not be secured. In order to insure a substantially gas-tight connection at this point, I have illustrated in Fig. 1 an arrangement in which the course 75 of blocks 37 is slightly thicker than the other courses of blocks in the intermediate wall 12, so as to insure a contact of at least the blocks of the course 37 with the faces of the heating walls. This arrangement is well illustrated in Fig. 1.

The gas for the nozzles 36 and downcomers 34 and 35 may be drawn from any suitable source. A convenient arrangement, however, is that illustrated in Figs. 1 and 2, in which a special manifold 38 is provided for this gas. During the ordinary run of the structure, the additional or reinforcement fuel gas is supplied to the manifold 38, and this supply is continued until it may become desirable to introduce a supply of air into the passages 34 and 35. Although the supply of fuel gas to the manifold 38 is discontinuous or intermittent, still the heating effect from the nozzles 36 will be substantially constant because the combustion of carbon in the passages 34 and 35 will generate heat during the introduction of air.

In Fig. 5 is shown a convenient arrangement for supplying the air and gas intermittently, the same including the air connection 39 and the gas connection 40 leading to the manifold 38 and provided with the valves 41 and 42, respectively. It is to be observed that while I have, in the drawings and description, mentioned only one specific or particular construction, the same being one in which there is only a single renewal or reinforcement of the combustion, still this arrangement is shown and described only by way of illustration, for it is evident that additional renewals or reinforcements of combustion may be secured by subsequent introductions of additional quantities of the gas.

I claim:

1. A heating wall having on its interior a meshwork of interconnected passages extending in zigzag fashion from its upper to its lower portion, whereby gases traveling downwardly therethrough may freely equalize within the wall, a series of burners for directing fuel gas into the upper portions of said passages, a series of air connections for delivering a full quantity of air into said passages adjacent to the burners, there being gas passages extending downwardly and communicating with orifices for the delivery of additional quantities of gas.
to the interior of the wall during the travel of the heating mixture therethrough to thereby reinforce the combustion by the consumption of the additional fuel gas in the presence of excess air traveling through the wall, the heating mixture being free to equalize position on the interior of the wall and thereby insure intimate mixture of gas so introduced with such excess of air, substantially as described.

3. A heating wall having on its portion of the wall a mesh-work of interconnected passages extending in zigzag fashion from one edge to an opposite edge, whereby gas traveling therethrough may freely equalize within the wall, a series of burners for directing fuel gas into the beginning portions of said passages, a series of air connections for delivering an excess quantity of air into said passages near their beginning portions, there being gas passages extending downwardly and communicating with orifices for delivering additional quantities of gas to the interior of the wall during the travel of the heating mixture therethrough to thereby reinforce the combustion by the consumption of the additional fuel gas in the presence of excess air traveling through the wall, the heating mixture being free to equalize position on the interior of the wall thereby generate a primary increment of heat, thereafter causing said mixture to travel in zigzag fashion in contact with the wall always in the same general direction from one edge toward another, which consists in reinforcing the heating action during such travel and only after a number of successive reversals of direction by the introduction of a secondary quantity of gas into said mixture for the purpose of uniting with unconsumed air of the mixture and reinforcing the heat thereby.

6. The method of substantially uniformly heating a wall or the like, which consists in first directing a mixture of air and gas overly rich in air in association with the wall to thereby generate a primary increment of heat, thereafter causing said mixture to travel in zigzag fashion in contact with the wall always in the same general direction from one edge toward another, and which consists in reinforcing the heating action during such travel and only after a number of successive reversals of direction by the introduction of a secondary quantity of gas into said mixture for the purpose of uniting with unconsumed air of the mixture and reinforcing the heat thereby.

7. A heating wall having on its interior a mesh-work of interconnected passages extending in zigzag fashion the entire distance of a portion of the wall, whereby the gases traveling therethrough may freely equalize within such portion of the wall, connections for delivering a full quantity of air into said passages adjacent to one edge, connections for delivering additional quantities of fuel gas into said passages adjacent to the first mentioned connections, and other connections for delivering additional quantities of fuel gas into said passages during the travel of the burning mixture therethrough to reinforce the combustion by the consumption of such additional quantities of fuel gas in the presence of unconsumed air traveling through the passages, substantially as described.

8. A heating wall having on its interior a series of interconnected passages extending...
ing in zig-zag fashion through its body, a series of connections for the delivery of constituents of combustion into the wall above said passages, and a series of combustion chambers between the connections aforesaid and the interconnected passages aforesaid, said combustion chambers having openings extending between them permitting the interchange of constituents of combustion between them and lengthwise of the wall, substantially as described.

9. A heating wall having on its interior a series of passages extending through a portion of its body in zig-zag fashion, a series of connections for the delivery of constituents of combustion into the wall adjacent to said connections, and a series of combustion chambers between the connections aforesaid and the zig-zag passages aforesaid, said combustion chambers having openings extending between them permitting the interchange of constituents of combustion between them and lengthwise of the wall, substantially as described.

10. A heating wall having on its interior a series of passages extending through a portion of its body in zig-zag fashion, connections for delivering a full quantity of air and a partial quantity of fuel gas into said passages adjacent to the beginning portions of said zig-zag passages, connections for delivering a further portion of fuel gas to points adjacent to said zig-zag passages in the central portion of the wall, and a series of gas openings into the zig-zag passages in the central portion of the wall, said gas openings being elongated in the direction of gas flow through the wall and having their floors slanting downwardly in the direction of gas flow from them into the zig-zag passages, whereby the fuel gas delivered through them enters the zig-zag passages in the normal direction of gas movement through said zig-zag passages and is compelled to mix with the gases moving through said zig-zag passages, substantially as described.

11. A heating wall having on its interior a series of passages extending through a portion of its body in zig-zag fashion, connections for delivering constituents of combustion into said passages adjacent to one edge of the wall, and a series of openings for delivering a constituent of combustion into the zig-zag passages in the central portion of the wall, said openings being elongated in the direction of gas flow through the wall and having their floors slanting into the zig-zag passages in the normal direction of gas flow through the zig-zag passages, whereby the constituent of combustion introduced through said openings moves into the zig-zag passages in such way as to freely mingle with the gases flowing through said zig-zag passages, substantially as described.

12. A heating wall having on its interior a series of passages extending through a portion of its body in zig-zag fashion, connections for delivering air and gas for combustion into said passages adjacent to the beginning portions thereof, and connections for delivering a further portion of gas into said passages adjacent to their central portions and including gas openings elongated in the direction of gas travel through the wall, whereby the fuel gas delivered through them enters the zig-zag passages in the normal direction of gas movement through the zig-zag passages and is compelled to mix with the gases moving through said zig-zag passages, substantially as described.

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