July 26, 1966 F. O. HESS 3,262,484

INDUSTRIAL BURNER WITH RECUPERATIVE MEANS

Original Filed Nov. 24, 1961 2 Sheets-Sheet 1

FIG. 1

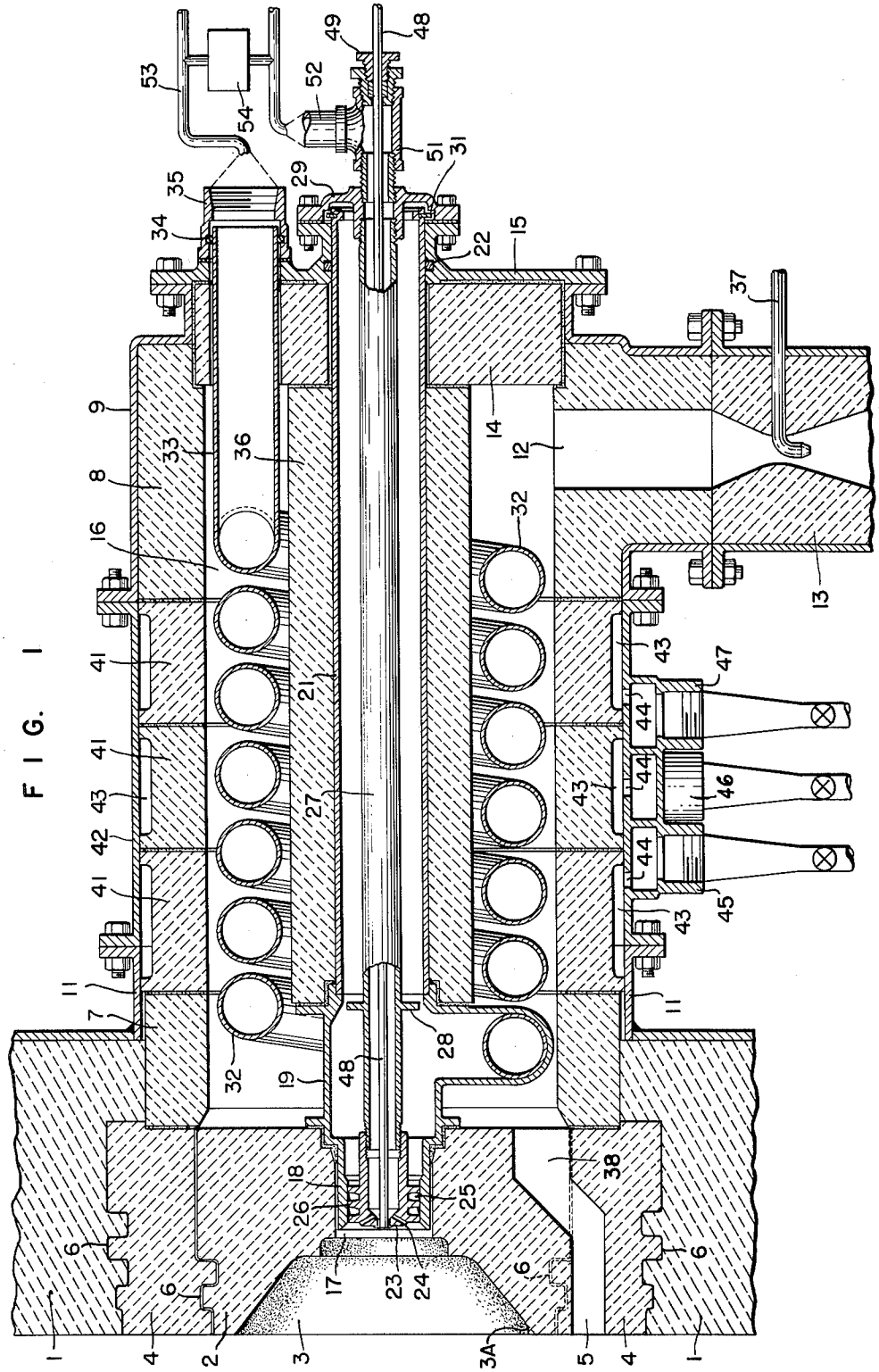

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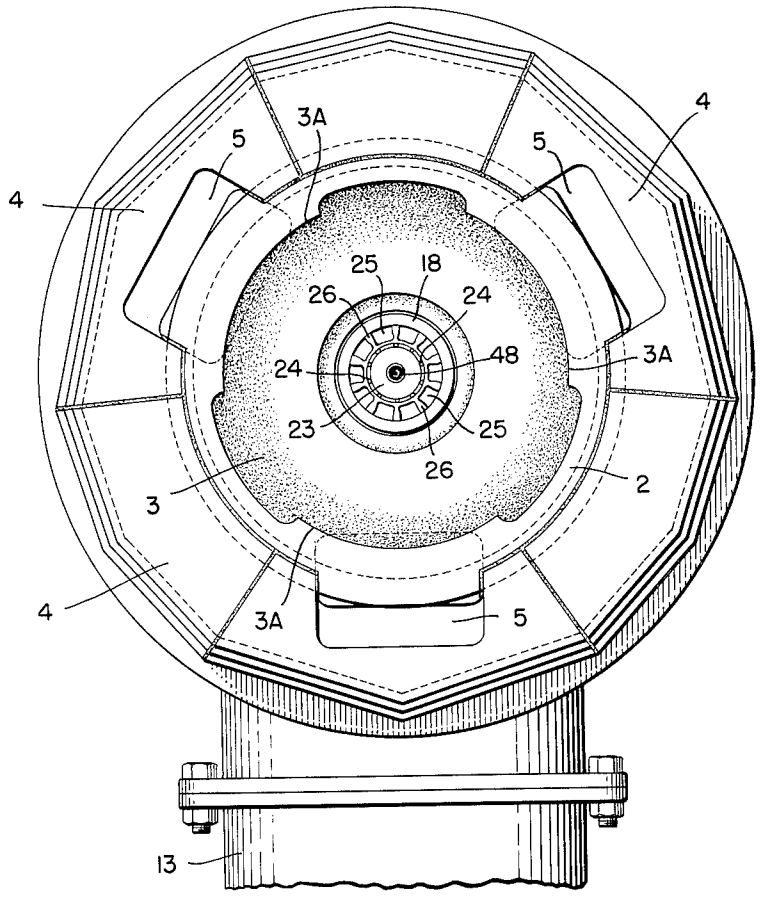
FIG. 2



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INDUSTRIAL BURNER WITH RECUPERATIVE MEANS

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9 Claims. (Cl. 158—7.6)

This is a continuation of application Serial No. 154,455 filed November 24, 1961.

The present invention relates to burners and more particularly to burners for industrial purposes in which the burner is provided with recuperative means to preheat the air being supplied thereto, and is designed to burn with a rich mixture to produce a protective atmosphere in a furnace.

It is frequently necessary in the heating of metal to provide a non-oxidizing atmosphere around it. In such an atmosphere steel can be heated without scale and other metals without oxidation. Prior to this time the metal has usually been heated in a muffle which was filled with the desired atmosphere, or directly by burners fired with a rich mixture of fuel and air. In the latter case the temperatures produced are relatively low compared with those that can be produced with a stoichiometric mixture of fuel and air.

It is an object of the present invention to provide a burner which will operate at a high temperature when burning a rich mixture of fuel and air.

It is a further object of the invention to provide a burner which will operate efficiently and at a high temperature with a rich mixture of fuel and air, and one in which a portion of the partially burned products of combustion are completely burned to preheat the air being supplied to the burner.

Another object of the invention is to provide a burner in which incompletely burned products of combustion are drawn into a chamber forming part of the burner and burned to preheat the air.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a section through the burner, and

FIG. 2 is a view from the left of FIG. 1.

In the heating of metal with a gas-air mixture of stoichiometric proportions, using a gas that requires nine parts of air to one of gas, for example, a relatively hot flame is produced, but the products of combustion will have an oxidizing effect on the metal when it reaches temperatures above about 1300° F. If the ratio of air to gas is changed to reduce the proportion of air, a non-oxidizing atmosphere is produced, but ordinarily the flame temperature is lowered, and as the ratio of air is increased, a point is reached where the mixture will not burn without the addition of supplemental heat. The present burner is intended to operate with a gas-air ratio that will not ordinarily burn with a hot flame, or at all, without substantial preheating of the air. The atmosphere produced by the products of combustion with such a rich mixture are such that steel can be heated to forging temperature without the formation of scale on its surface. The present burner will burn such a mixture at a temperature substantially equal to that obtained with stoichiometric proportions of fuel and air.

Referring to FIG. 1 there is shown at 1 a furnace wall in which the burner is inserted and of which the front of the burner forms a part. The portion of the burner in the furnace wall includes a refractory cup block 2 that has a cup-shaped depression 3 formed in the surface thereof facing the furnace interior. Surrounding this cup block to form the remainder of the burner block there is provided a ring comprised of a plurality of segments 4 that are cemented to the cup block and to each other. These segments are so formed that passages 5 extend through the block to the rear face thereof. It is noted that both the cup block and the segments 4 are provided with ridges 6 so that they will be held in axial alignment, and so that the entire burner block will be held accurately in position in the refractory of the furnace wall.

Extending rearwardly from the composite burner block through the remainder of the furnace wall there is a cylindrical refractory structure including two cylinders 7 and 8 of a dense refractory material that are separated by a plurality of rings 41 of a porous refractory. The rings and cylinders are held in position against the back of the burner block by means of a metal casing that is bolted to the furnace wall. To this end there is provided a cylindrical part 11 extending from the furnace casing. A first casing part 42, that surrounds rings 41, is bolted to a flange on 11, and a second casing part 9 is bolted to the other end of part 41. The various parts 7, 41 and 8 are cemented to each other, while cylinder 7 can be sealed, by a breakable cement, for example, to the back of the burner block. Cylinder 8 is provided with an exhaust opening 12 that connects with a stack 13. The back of cylinder 8 is closed by a refractory disc 14 that is cemented in place in the end of the cylinder, but which is also held in position by means of a metal cover 15. Cylinders 7, 41 and 8 form a recuperator chamber 16 in which are located the gas and air supply pipes through which fuel and air are supplied to the burner block.

The center of the cup block 2 is provided with an opening 17 that is concentric with the base of depression 3. A sleeve 18, which has an enlargement 19 on its rear end, is received in opening 17. Fastened to the rear end of the enlargement is a tube 21 that extends rearwardly through an opening in disc 14 and cover 15. The right end of this tube is sealed in gas tight fashion with respect to the cover by a seal ring 22 which will permit movement between the tube and the cover. A fuel and air distributor tip in the form of element 23 is snugly received in the sleeve 18. This element is provided with a plurality of radially extending gas passages 24 that are at such an angle to the axis of the member that they will discharge substantially parallel to the base of the depression 3. The exterior of element 23 is provided with a plurality of air passages 25 that are formed by helically extending ribs 26 projecting from the outer surface of element 23. Fuel gas is delivered to the passages 24 by means of a pipe 27, which pipe has a flange 28 extending radially from it for a purpose to be described. The right end of this pipe is threaded to a cap 29, which in turn is bolted to the cover 15. In this fashion the element 18 is positioned axially in opening 17. It is noted that a ring 31 is placed in the outer end of tube 21 to limit the movement of this tube with respect to pipe 27 and position sleeve 18 axially with respect to element 23.

Air is supplied to passages 25 by means of a helical tube 32 which surrounds the tube 21. This tube is made of a high temperature alloy, and has a relatively thin wall. The left end of tube 32 is fastened to the enlargement 19 so that the tube is in communication with the interior thereof. The outer or right end of tube 32 is indicated at 33 as extending into a cap 35 to which the air connection from a suitable source of supply can be made. A seal 34 is provided between

end 33 and cap 35 so that the tube can move relative thereto. If it is desired, an insulating refractory sleeve 36 can be placed around tube 21 inside the helix of tube 32 to help along with the space between pipe 27 and tube 21, to insulate pipe 27 from the heat. It is noted that the stack 13 is somewhat of the shape of a venturi, and is provided at or near its throat with the discharge nozzle of a pipe 37 for air under pressure.

Additional air is supplied to the recuperator chamber 16 through the porous refractory rings 41. In order to insure that the additional air is introduced evenly around the chamber, each ring is provided around its outer surface with a recessed portion 43 to act as a manifold. Each manifold is supplied with air through an opening 44 in casing part 42 from separate air supplies 45, 46 and 47, respectively, which in turn are supplied by pipes shown as having conventional valves therein.

Raw gas, unmixed with air, can be supplied to the furnace chamber through the burner, if it is needed. This is accomplished by a tube 48 that extends through pipe 27 with one end received in a hole in the end of element 23, and the other end held in place by a packing gland 49 in an extension 51 threaded into cap 29. The main supply of gas is introduced through a pipe 52 into the extension 51.

When the burner is operating, fuel gas and air are supplied, respectively, through pipe 52 and a pipe 53 leading to fitting 35 in a ratio that has been determined to be necessary for the type of work being heated, and which is controlled by a ratio controller 54. The burner will operate with a fuel air ratio from stoichiometric to a ratio in which there is an air deficiency greater than 50%. Since the burner is designed to be used with a deficiency of air, or what is commonly known as a rich mixture, it will be so described.

Air flows through coil 32, where it is preheated prior to entering part 19 on its way to passages 25. Flange 28 prevents the air from traveling back along pipe 27. From these passages air is discharged into the cup 3 to be thrown by centrifugal force along the surface thereof. Gas flowing through pipe 27 is discharged from ports 24 to flow along the surface of the cup to mix with the air and burn. The base of cup 3 is provided with a ridge, as best shown in the drawing, which creates enough turbulence in the flowing gas and air to produce a piloting action which will root the flames adjacent to the discharge ends of the gas and air ports. The burner will operate to heat the surface of the cup to incandescence and thereby direct radiant heat into the furnace. Heat is also produced by the hot products of combustion.

In most furnaces there is some furnace pressure because of expansion of the gases of combustion. Such pressure will cause some of the hot products of combustion to flow backwardly through passages 5 into the chamber 16 to be discharged through opening 12. Additional products of combustion can be drawn into chamber 16, and their flow controlled by the aspirating effect of air supplied through tube 37. It is noted that the outer edge of the cup 3, radially inward of passages 5, terminates in a substantially axial portion 3A. This portion directs the burning gases axially at this point into the furnace, and prevent them from short circuiting directly into passages 5.

Since there is a deficiency of air supplied to the burner, the products of combustion will have a large percentage of unburned gas in them. As this gas is flowing through chamber 16 air, supplied through pipes 45, 46 and 47 and flowing into chamber 16 through porous rings 41, will mix with the unburned gas and burn in the chamber. This secondary combustion taking place around tube 32 adds to the heat of the products of combustion for preheating the air supplied to the burner. Although it is possible to supply the air for secondary combustion through a single, wide, porous ring, a more even distribution of air can be obtained throughout the chamber with a plurality of rings, since the cement between rings 41 forms, in effect, separate compartments.

Only sufficient air to burn enough of the unburned gas in the products of combustion to obtain the desired preheat needs to be supplied through the porous rings. The volume of air can be regulated in any desired or conventional manner, such as a valve responsive to a ratio controller from the gas supply, or the temperature of the preheated air, for example, or manually. Because of the manifold sections 43, air will flow evenly into chamber 16 around its surface so that combustion can take place all around coil 32, thereby obtaining the maximum heating without hot spots.

The amount of preheat that can be obtained for the combustion air will vary with the amount of unburned gas in the products of combustion, determined by the air-gas ratio, and the volume of products of combustion drawn into chamber 16. The greater the deficiency of air from a stoichiometric mixture, the larger the percentage of unburned gas in the products of combustion. Therefore, the richer the mixture the smaller the percentage of products of combustion needed to obtain a given preheat temperature. The volume of products of combustion from the burner that is drawn back into the combustion chamber will vary with the furnace draft or pressure, and with the aspirating effect of the air flowing through pipe 37. This air can be controlled in a conventional manner by a valve adjusted manually or in response to any desired variable such as the temperature of the preheated air, for example. When using a fuel gas requiring an air-gas ratio of nine to one, with a fuel mixture of 4½ to 1, a preheat temperature of approximately 1300° F. for the combustion air can be obtained if 40% of the products of combustion are withdrawn through chamber 16, and the unburned fuel burned therein. This preheat temperature is sufficient to insure that combustion of such a rich mixture will take place, and at a temperature only one or two hundred degrees below that obtained with a stoichiometric mixture. Burners of this type can be used for heating steel directly to forging temperature with a complete absence of scale on its surface.

If additional gas is needed in the furnace chamber for some reason, it can be introduced through tube 48 extending axially through the burner.

From the above description it will be seen that the burner is a self-contained unit that can be supplied with any gas-air ratio to one having greater than 50% deficiency of air, thereby to produce in a furnace an atmosphere having desired protective characteristics. The feature of using a built-in recuperator for utilizing fuel that would otherwise be wasted to obtain the necessary preheat of the air does away with the necessity of auxiliary apparatus for this purpose. This self-contained, recuperative, atmosphere burner will reduce substantially the cost and complexity of metal heating equipment when it is necessary or desirable to produce scale free work.

An additional advantage that can be obtained with a burner of this type is the control of atmosphere and temperature distribution throughout a furnace. This can be accomplished by supplying different fuel-air ratios to different burners, by varying the volume of products of combustion that are withdrawn from different burners, and by varying the amount of the unburned gas in the products of combustion that is burnt. The versatility in the manner that the present burner can be operated permits the design and construction of superior furnaces.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit and scope of the invention set

worth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

What is claimed is:

1. An industrial gas burner comprising in combination: a burner block having a face and a back and being provided with an opening extending therethrough, structure attached to said block forming a chamber having a surrounding wall and an end wall with the back of said burner block acting as said end wall thereof, means including pipes through which fuel and air can be supplied to said burner block with said pipes terminating in discharge ports in said opening through which the gas and air are discharged to burn in front of said block, said pipes being at least partially located in said chamber and supported by said structure, means to withdraw products of combustion, including unburned fuel, from in front of said burner block and pass them through said chamber, said structure forming said chamber having a portion thereof which is provided with a portion having a multiplicity of small openings, a manifold surrounding said portion, and means to supply air to said chamber through said manifold and said portion of said surrounding wall in sufficient quantities to burn with said unburned fuel.

2. An industrial burner comprising in combination: a burner block having a front and a back and a central opening and a plurality of openings surrounding said central opening extending from the front to the back, means attached to said block forming a chamber having walls back of said block with the interior of the chamber being in communication with said plurality of openings, one wall of said chamber being provided with a plurality of ports around it, a pipe for a supply of gas extending to the back of said block and terminating in discharge ports located in said central opening, a pipe for a supply of air extending through said chamber to the back of said block and terminating in discharge ports located in said central opening, said discharge ports for gas and air being so directed that the gas and air will mix to be burned along the front of said block, means through which gas and a deficiency of air are supplied to said pipes to be burned in front of said block, means to place said chamber under reduced pressure thereby to withdraw products of combustion from the front of said block through said plurality of openings, means including a part around said chamber to cover said ports and form a manifold, and means to supply air to said manifold and through the ports in said wall into said chamber to burn with the unburned gas in said products of combustion.

3. The combination of claim 2 in which the ports in said wall are formed as a piece of porous refractory material.

4. An industrial burner comprising in combination: a burner block having a front and a back adapted to be placed in a furnace wall and having a central opening and a plurality of openings surrounding said central opening, a supply pipe for gas and a supply pipe for air extending from back of said block to and terminating in said central opening, the terminal ends of said pipes being provided with ports so shaped that the gas and air will mix as they are discharged therefrom and burn across the front of said block, means forming a chamber attached to said block surrounding said pipes leading to said block, said chamber having as a portion thereof a wall having a plurality of small openings therein, a casing surrounding said portion of said wall and spaced therefrom to form a manifold, means to supply gas and air in proportions with a deficiency of air through said pipes to be discharged through said central opening and burned in front of said block, means to place said chamber under a reduced pressure thereby to withdraw a portion of the products of combustion through said plurality of openings in said burner block into said chamber, and means to force air into said manifold and through said portion of said wall into said chamber to burn therein with the unburned gas in the products of combustion.

5. In an industrial burner, a burner block provided with a central opening and a plurality of openings around said central opening, a supply pipe for gas extending from the back of said burner block to said central opening, a supply pipe for air extending from back of said burner block to said central opening, said pipes being provided with discharge ports in said central opening to direct the gas and air into mixing engagement, means attached to said block forming a chamber around said supply pipes with the interior of said chamber being in communication with the back of said plurality of openings whereby products of combustion can flow through said plurality of openings into said chamber, means to place said chamber under a reduced pressure thereby to draw a portion of said products of combustion through said chamber, said means forming said chamber including a portion having ports therein, means surrounding the portion of the chamber having ports therein to form a manifold communicating with the ports and means to blow air into said manifold and through said ports into said chamber.

6. The combination of claim 5 in which said portion having ports therein is formed of a porous refractory.

7. An industrial burner adapted to be inserted in a furnace wall comprising structure having a front face forming a portion of a furnace wall and a back surface, said structure being provided with a first opening extending from said front face to said back surface, and another opening extending from said front surface to said back wall, means attached to said structure with the back surface of said structure forming one wall of said chamber, an element received in said first opening that is provided with a first group and a second group of discharge ports, said groups of ports being designed to direct gas and air across said front face, a gas pipe extending through said chamber and terminating at said element in communication with one of said groups of ports, an air pipe surrounding said gas pipe in said chamber and terminating in said element in communication with said other group of ports, means to withdraw products of combustion from in front of said front face through said other opening into and through said chamber, said means forming said chamber including a portion thereof formed with a plurality of small passages, means to supply air to said chamber through said small passages, and a manifold surrounding said portion of said chamber through which air is supplied to said passages.

8. An industrial gas burner adapted to be inserted in and form part of a furnace wall including structure having a front face forming part of said wall and a back face, said structure being provided with a first opening extending between said faces, a second opening extending between said faces, means forming a chamber attached to said structure with the back face of said structure acting as one wall of said chamber, a gas pipe extending through said chamber and terminating in said first opening, an air pipe extending through said chamber and terminating in said first opening with the air pipe surrounding the gas pipe, means to retard heat flow between said pipes, an element in said first opening connected to said pipes, said element being provided with ports to direct air and gas across said front face, means to draw products of combustion from beyond said front face through said second opening to and through said chamber, said means forming said chamber including a portion surrounding said air pipe through which air can flow into said chamber to mix with the products of combustion therein and means to force air into said chamber through said portion.

9. An industrial burner adapted to be placed in a furnace wall comprising structure forming a refractory

chamber having end walls separated by a side wall, one of said end walls being provided with a central opening and a plurality of openings surrounding said central opening, the outer face of said end wall around said central opening being a surface along which combustion takes place, a gas pipe and an air pipe in said chamber, one end of each of said pipes terminating in said central opening of said one end wall, the other end of each of said pipes extending through the other end wall, means at said end of said pipes terminating in said opening including groups of ports through which gas and air are discharged across said surface, means to place said chamber under a reduced pressure thereby to withdraw products of combustion from beyond said surface through said plurality of openings to and through said chamber, said side wall including a section having a plurality of small openings through which air can be passed from the outside to the interior of said chamber, a part covering and spaced from said section to form a manifold on the exterior of said side wall and means to force air into said manifold and through said section to mix with products of combustion in said chamber.

References Cited by the Examiner

UNITED STATES PATENTS

2,992,676 7/1961 Henwood ---------- 158—113

FOREIGN PATENTS

719,944 4/1942 Germany.

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