(No Model.) 2 Sheets—Sheet 1.

R. F. NENNINGER.

APPARATUS FOR PRODUCING HIGHLY HEATED GAS.

No. 432,281. Patented July 15, 1890.

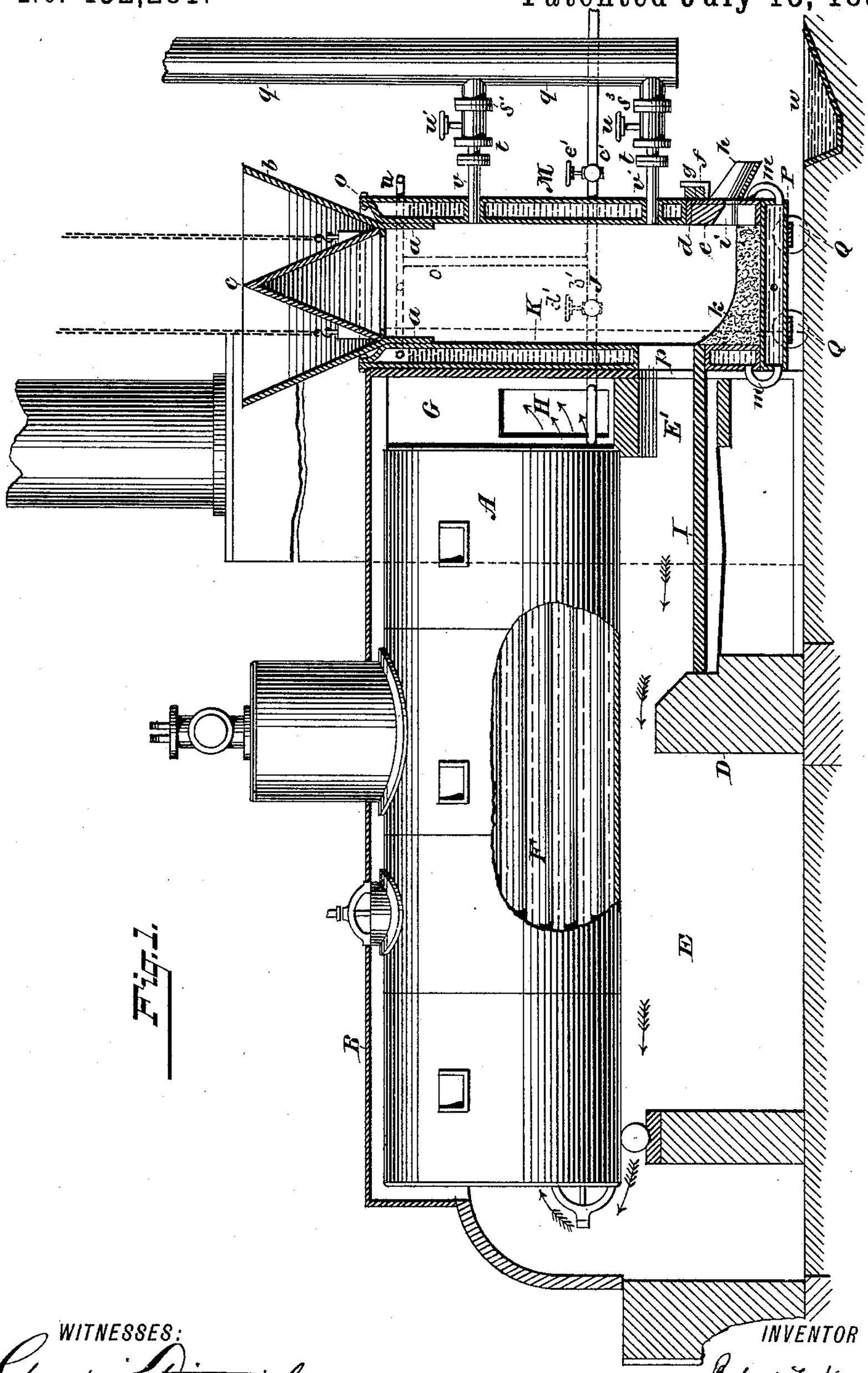

Fig. 1.

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

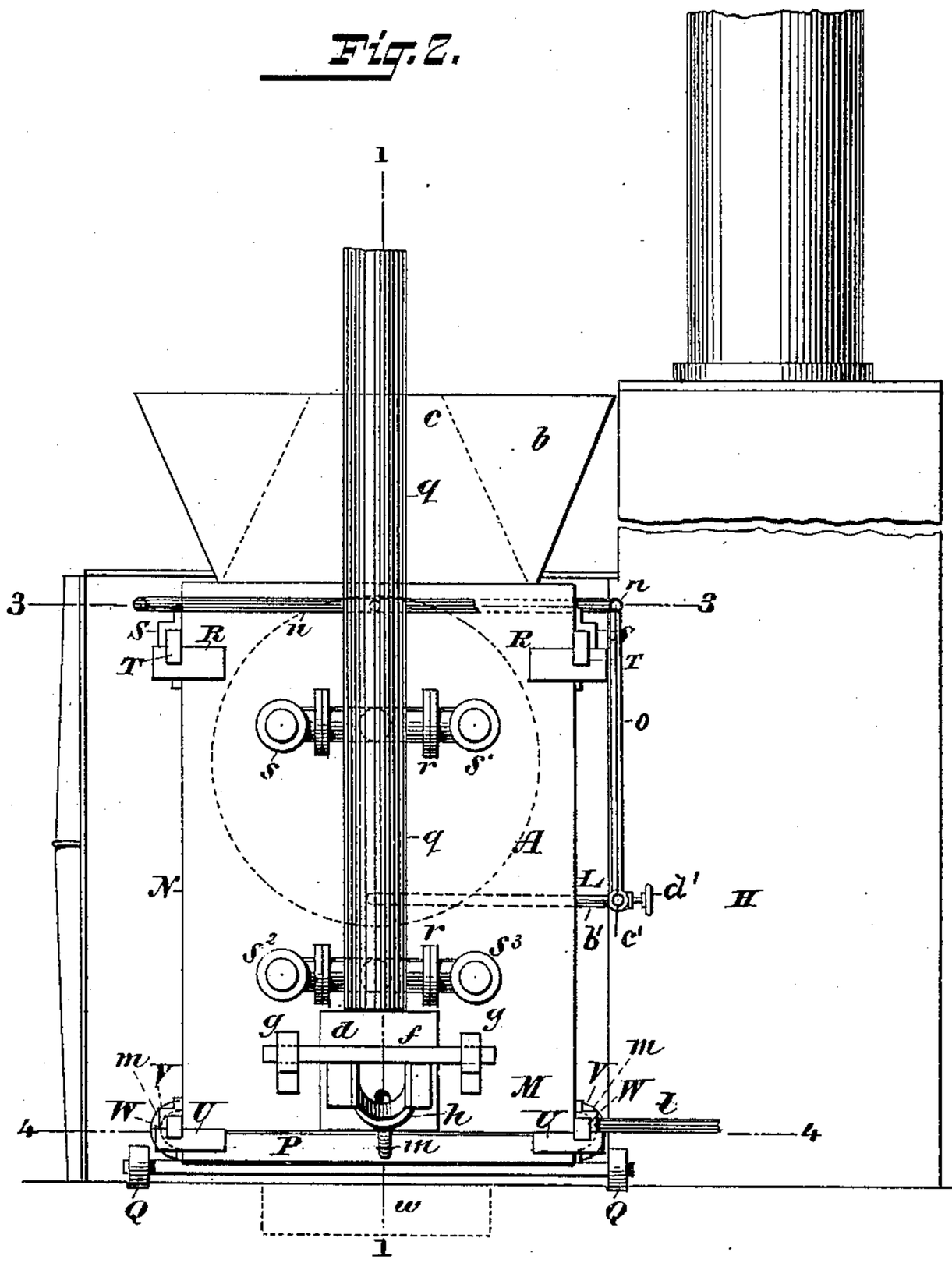


Fig. 3.

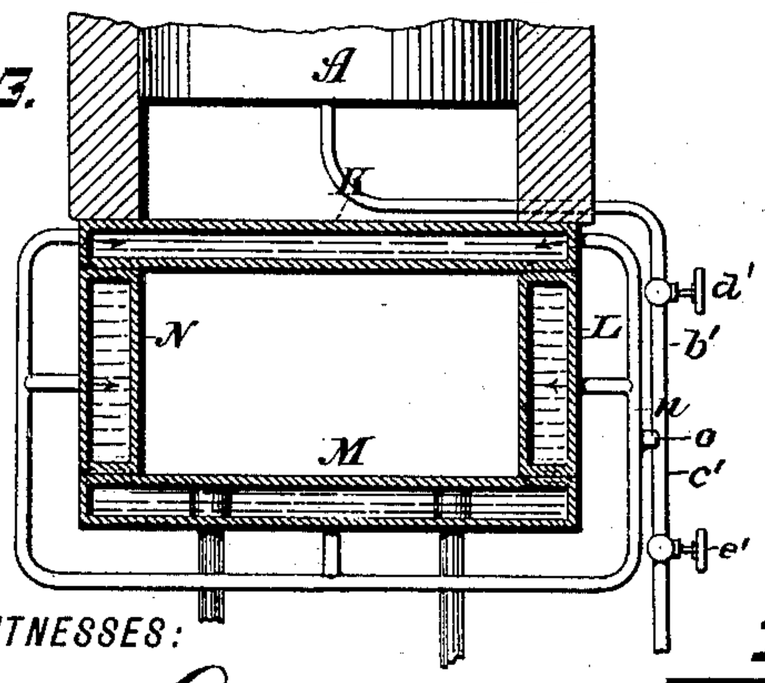


Fig. 4.

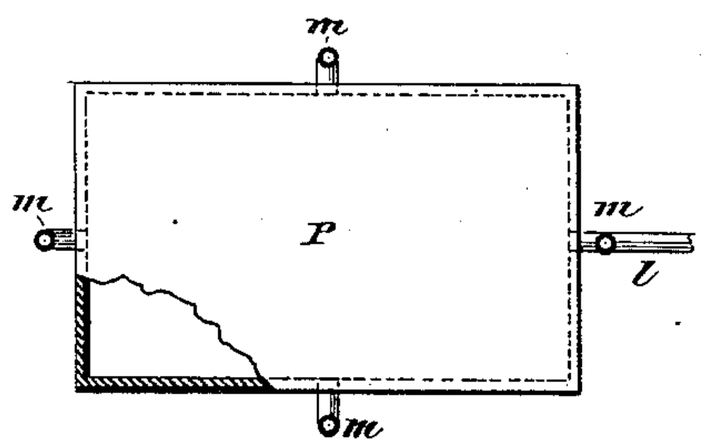
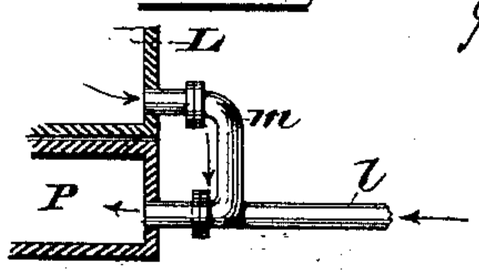


Fig. 5.



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UNITED STATES PATENT OFFICE.

ROBERT F. NENNINGER, OF NEWARK, NEW JERSEY, ASSIGNOR TO THE NEW JERSEY FURNACE AND SMELTING COMPANY, OF NEW JERSEY.

APPARATUS FOR PRODUCING HIGHLY-HEATED GAS.

SPECIFICATION forming part of Letters Patent No. 432,281, dated July 15, 1890.

Application filed December 10, 1889. Serial No. 333,227. (No model.)

To all whom it may concern:

Be it known that I, ROBERT F. NENNINGER, of Newark, Essex county, New Jersey, have invented a new and useful Improvement in Apparatus for Producing Highly-Heated Gas for Heating Purposes, &c., of which the following is a specification.

It is well known that in an ordinary boiler-grate complete combustion of the carbon, or, in other words, its entire conversion in combination with the oxygen of the air into carbonic acid, is impracticable, and that instead a large proportion of carbonic oxide is produced, which is only partially converted into carbonic acid in the flame-chamber. In order to meet this difficulty, various devices have been been contrived for directing a current of air into said chamber—such, for example, as hollow grate-bars, or even pipes leading from blowers directly into said flame-space. The principal difficulty in such cases is that the incoming air-currents are comparatively cool and that the resulting temperature of the mixed gases is not sufficiently high to result in the desired combination and consequent production of carbonic acid, so that the net result is simply a cooling of the products of combustion.

By my device complete combustion of the fuel, and consequent utilization of all its combustible portion, is produced in a separate apparatus from which a current of intensely-heated carbonic acid is delivered. In the application of my invention to a steam-boiler (here shown) the current enters at once into the fire-box, and then sweeps under and through the boiler. In this current there are mingled no uncombined gases and equally no uncombined carbon. Consequently the products of combustion are smokeless, and the immense mass of carbon which ordinarily passes into the chimney in the form of smoke is here completely utilized. As a matter of fact, I have found by actual experiment that hot gas coming from the gas-producing apparatus is absolutely white-hot and brilliant, and that no smoke whatever comes out from the chimney of the boiler.

In another application for Letters Patent simultaneously filed herewith, Serial No. 333,226, I have fully described and claimed the method of heating, which consists, broadly, in generating a body of intensely-hot non-combustible gas and bringing the same into contact with the object to be heated, and this method, therefore, I do not herein claim. I do not, however, limit the adaptation of my invention to a steam-boiler, as here shown, inasmuch as it will be obvious that the hot gas generated may be utilized in any other desired way.

In the accompanying drawings, Figure 1 is a side elevation and partial vertical longitudinal section on the line 1 1 of Fig. 2 of my apparatus, combined with a tubular steam-boiler. Fig. 2 is a front end elevation. Fig. 3 is a horizontal section of the gas-producer on the line 3 3 of Fig. 2. Fig. 4 is a similar section on the line 4 4 of Fig. 4. Fig. 5 is a detached sectional view showing the water-supply pipe and the communicating conduit between the two boxes.

Similar letters of reference indicate like parts.

A is a steam-boiler, supported in the usual way on walls or piers and provided with a covering or casing B. At C are the grate-bars; D, the bridge-wall; E, the flame-space; E′, the fire-box; F, fire-tubes, extending through the boiler, and G a chamber communicating with the uptake H. The general construction and arrangement of the boiler, its casing, and combustion-chamber are the same as is present in any ordinary boiler of similar type. In order, however, to adapt the present boiler to the purposes of my invention, I cover the grate-bars with a layer I of fire-brick or tiles.

Disposed in front of the boiler is a chamber J, the vertical walls of which are double and are composed of four plate-iron boxes K L M N, Fig. 3. These boxes constitute water-jackets, and are supplied with water by the means hereinafter described. The plates forming the vertical sides of each box are brought together at the top and riveted, as shown at O, Fig. 1. The boxes K L M N rest upon a horizontal box P, which is in turn supported upon trucks Q. Near the upper portion of the boxes K M are notched projections R, Fig. 2, and on the boxes L N are downwardly-turned brackets S. Lock-bars T extend under the brackets S and through the notches in the projections R, and in this

way the boxes K L M N are secured together. On each side of the bottom P are notched projections U, and also on the boxes L N and near their lower portion are downwardly-turned brackets V. Lock-bars W pass under the brackets V and through the notches in the projections U, and in this way the lower box P is fastened to the upper boxes K L M N. Resting upon flanges *a* in the upper portion of the chamber J is a hopper *b*, provided with a bell *c*, which bell is supported by chains in any suitable manner, so that it may be raised and lowered, as desired. Through the body of the box M and near the bottom is a rectangular opening, in which is placed a metal frame or door *d*, lined with fire-brick *e*. This frame is held in place by a bar *f*, received in upwardly-turned brackets *g* on the exterior of the box M. On the exterior of the frame *d* is a spout *h*, communicating with a tap-hole *i*, which leads from a hearth *k*, which is made of limestone and fire-clay, or cement and fire-clay, rammed into the bottom of the chamber J. Entering the lower box P is a water-supply pipe *l*, and from the box P extend curved pipes *m*, which respectively communicate with each box K L M N, so that the water entering the box P rises up through the boxes K L M N, and finally escapes into the overflow-pipe *n*, and thence is led by a pipe *o*, Fig. 3, to any desired point, and preferably to the boiler feed-supply. Through the box K is made an opening *p*, which communicates with the fire-box E′ of the boiler.

q is an air-supply pipe leading from a blower or any other suitable source of air-supply and provided with branches *r*, Fig. 2, at the extremities of which are pipes *s* *s′* s^2 s^3. These pipes communicate with valve-chambers *t*, in which are arranged valves *u* *u′*. Extending from said valve-chambers are tuyeres *v* *v′*, which pass through the sides of the box M and open into the chamber J. In front of the chamber J, and in the floor, may be made a trough *w* to receive slag which is drawn out of the chamber J through the spout *h*.

The operation of the apparatus is as follows: A fire is first started on the hearth of the chamber J, using ordinary coal or coke. The supply of coke is then delivered into the hopper *b*, and the bell *c* being raised the chamber J is completely filled with coke; or, instead of first starting a fire in the bottom of the chamber, said chamber may be filled with coke at the outset almost to the level of the tuyere *v*, and the fire then started at the upper portion of the charge. In either case, as soon as the chamber J is filled the mouth of the hopper is closed and the valves *u′* are opened, so as to admit the air-current through the upper tuyeres *v*. This blast is kept up until the charge in the chamber is rendered incandescent, when the valves *u* in the lower tuyeres *v′* are opened and blast admitted from all the tuyeres simultaneously. While I may employ only coal or coke as the charge, it is preferable to mix therewith a certain quantity of silicate of iron, cinder, or slag, which under the action of the heat in the chamber combines with the ashes to form a thin slag, which descends upon the hearth *k*, and which may be drawn off through the tap-hole and spout *h*. When coal or coke alone is used the ashes will run out in a molten state through the tap-hole; but the slag so formed will be tough and liable to choke up the hearth and tap, and thus necessitate the removal of the door for purposes of cleaning the hearth. This is done through the aperture in which said door is received. It is therefore preferable to mix iron cinder with the coal in the manner above described. The slag as drawn through the spout *h* falls into the trough *w*, which contains water, and is there granulated and cooled.

It will be apparent that by the use of the two sets of tuyeres herein described, one set of tuyeres being arranged in the chamber J at a higher level than the other set, the combustion of the fuel is caused to take place first at the upper tuyeres, and that the carbonic acid resulting proceeding downward through the incandescent fuel is converted into carbonic oxide, and then is reconverted into carbonic acid at the lower tuyeres and becomes intensely heated, and in this condition passes out through the opening *p* and into the fire-box E′, and thence under the boiler and through the fire-tubes F to the chamber G, and finally out at the uptake.

I desire to call especial attention to the fact that the chamber J, with associated parts, is not a gas-producer in the sense that it generates a combustible gas, which is subsequently burned underneath the boiler, and in this respect my invention differs widely and materially from apparatus in which gas is substituted for solid fuel. The fuel is consumed completely in the chamber J under conditions which will make the resulting product a non-combustible gas heated to an intensely-high temperature, and not a gas which is consumable, which is produced by distillation, and which is subsequently ignited and then completely consumed at the point at which its heat is to be utilized. It is also to be understood that while my device is especially constructed to produce intensely-hot carbonic acid it may also be used to produce a current of carbonic oxide, which may be converted into carbonic-acid gas elsewhere; or, if suitable material be placed in the chamber, other ignitible gas may be made. In such use of my apparatus it is simply necessary to shut the valves *u*, connecting with the lower tuyeres *v′*, when there will be incomplete combustion of the fuel in the lower part of the chamber, and hence a distillation of the fuel there located. I prefer to use my apparatus, however, in the manner first above detailed—that is to say, to produce a current of highly-heated carbonic acid from anthracite coal or coke. It will, however, be apparent that not only do I produce an in-

tensely-hot current of gas resulting from a complete combustion, and hence utilization of the fuel, and at the same time do away with the serious objections resulting from smoke production, but that, furthermore, by the use of cinder combined with the fuel I obviate the inconveniences due to the production of large amounts of ashes, the proportion of slag collected being very much less in bulk than the otherwise uncombined ashes. This reduction in the quantity of refuse produced becomes of great importance in the application of my invention to marine boilers, inasmuch as it saves the constant handling of large amounts of ashes. The granulated slag produced is also a utilizable product, and, as is well known, may be applied to advantage for the manufacture of artificial stone, concretes, cements, &c. The object of placing the chamber J on the rollers Q is to allow of its removal, if desired, from the front of the boiler, the pipe *q* and the water outlet and inlet pipes being previously disconnected for that purpose.

I have already stated that the outlet-pipe *n* may communicate with a boiler, so that the water flowing out of the boxes K L M N P may be led into the feed, so that the gas-generating apparatus may also serve as a feed-water heater. To this end I connect to the pipe *n* a downwardly-extending pipe *o*, which communicates with a pipe *b'*, leading into the boiler, as shown in Figs. 1 and 3, and also with a pipe *c'*, leading to any other desired point. In the pipe *b'* is arranged a valve *d'*, and in the pipe *c'* is a valve *e'*. While the apparatus is in operation, the valve *e'* is closed and water is forced under pressure through the boxes K L M N P, becoming heated in its passage, and thence through the pipes *n o b'* into the boiler, the valve *d'* being open. When it is desired to direct the water from the boxes elsewhere than into the boiler, the valve *d'* is closed and the valve *e'* open, in which case the water will pass from the boxes and escape by the pipe *c'*.

I do not claim, broadly, a combustion chamber or stack having openings in its walls disposed opposite one another, so that the air-blast traverses the fuel in a horizontal direction. It is essential to my apparatus that the air shall enter two openings in the combustion-chamber, and then proceed downwardly through the charge in order to produce a highly-heated gas, and that the gas-escape opening shall be located at such a distance below these air-openings as that the gas shall be produced and heated within the combustion-chamber before it makes its exit through said escape-orifice.

I claim—

1. A combustion-chamber having at its bottom a hearth and at its top a fuel-supply opening, and in its wall openings disposed in the following order, namely: two air-inlet openings at different elevations and a gas-escape opening below said inlet-openings and above said hearth, in combination with means for producing a draft from said air-openings downwardly through the charge in said chamber and out at said gas-escape orifice.

2. The combination of the chamber J, having a fuel-supply opening in its upper portion and a gas-escape opening at the lower portion, and tuyeres *v v'*, communicating with a source of air-supply and entering through the wall of said chamber.

3. In combination with a steam-boiler, the chamber J, having a fuel-supply opening in its upper portion and a gas-escape opening communicating with the fire-box of said boiler, and tuyeres *v v'*, located between said openings and entering through the wall of said chamber at different elevations and communicating with a source of air-blast.

4. The combination of the boxes K, L, M, N, and P, united to produce the side walls and bottom of the chamber J, tuyeres *v v'*, entering said chamber through the box M at different elevations and communicating with a source of air-blast, and a gas-escape-flue opening through the box K into said chamber J.

5. The combination of the boxes K, L, M, N, and P, united to produce the side walls and bottom of the chamber J, a water-supply pipe entering one of said boxes and communicating conduits for said water-supply between said boxes, tuyeres *v v'*, entering said chamber through the box M at different elevations and communicating with a source of air-blast, and a gas-escape-flue opening through box K into said chamber J.

6. The combination of the boxes K, L, M, N, and P, united to produce the side walls and bottom of the chamber J, hearth *k* in the lower portion of said chamber, one of the walls of said chamber having a tap-opening above said hearth, tuyeres *v v'*, entering said chamber through box M at different elevations and communicating with a source of air-blast, and a gas-escape-flue opening through box K into said chamber J.

7. The combination of the boxes K, L, M, N, and P, united to produce the side walls and bottom of the chamber J, a water-supply pipe *o*, entering box P, and communicating conduits, as *m*, from said box P to boxes K L M N, outlet-pipe *o*, also communicating with said last-named boxes, tuyeres *v v'*, entering said chamber through the box M at different elevations and communicating with a source of air-blast, and a gas-escape-flue opening through box K into said chamber J.

8. The combination of the boxes K, L, M, N, and P, the box M having an opening, the frame or door *d*, removably supported in said opening, tuyeres *v v'*, entering said chamber through the box M at different elevations and communicating with a source of air-blast, and a gas-escape-flue opening through box K into said chamber J.

9. The combination of a steam-boiler, a combustion-chamber having double walls and a

fuel-supply opening at its upper portion, a hearth, a gas-escape opening located above said hearth, two tuyeres entering said chamber through said walls at different elevations between said fuel and gas-escape openings, a water-supply conduit communicating with the space between said walls, an outflow-conduit communicating with the water-space in said boiler, and means for producing a downward draft from said tuyeres and through said escape-orifice and into the fire-box of said boiler.

10. The combination of a steam-boiler, the boxes K, L, M, N, and P, united to produce the side walls and bottom of the chamber J, a water-supply conduit entering one of said boxes, communicating conduits for said water-supply between said boxes, an outflow-conduit extending between one of said boxes and the water-space in said boiler, and tuyeres entering said chamber at different elevations and communicating with a source of air-blast.

11. The combination of a steam-boiler, the boxes K, L, M, N, and P, united to produce the side walls and bottom of the chamber J, a water-supply conduit entering one of said boxes, communicating conduits for said water-supply between said boxes, outflow-conduit *o*, having two branches *b' c'*, the branch *b'* leading to the water-space in said boiler, valves *d' c'*, respectively, in said branches *b' c'*, and tuyeres entering said chamber at different elevations and communicating with a source of air-blast.

ROBERT F. NENNINGER.

Witnesses:

PARK BENJAMIN,

M. BOSCH.