

Z. A. WILLARD.

Furnaces for Roasting and Treating Ores.

No. 134,782.

Patented Jan. 14, 1873.

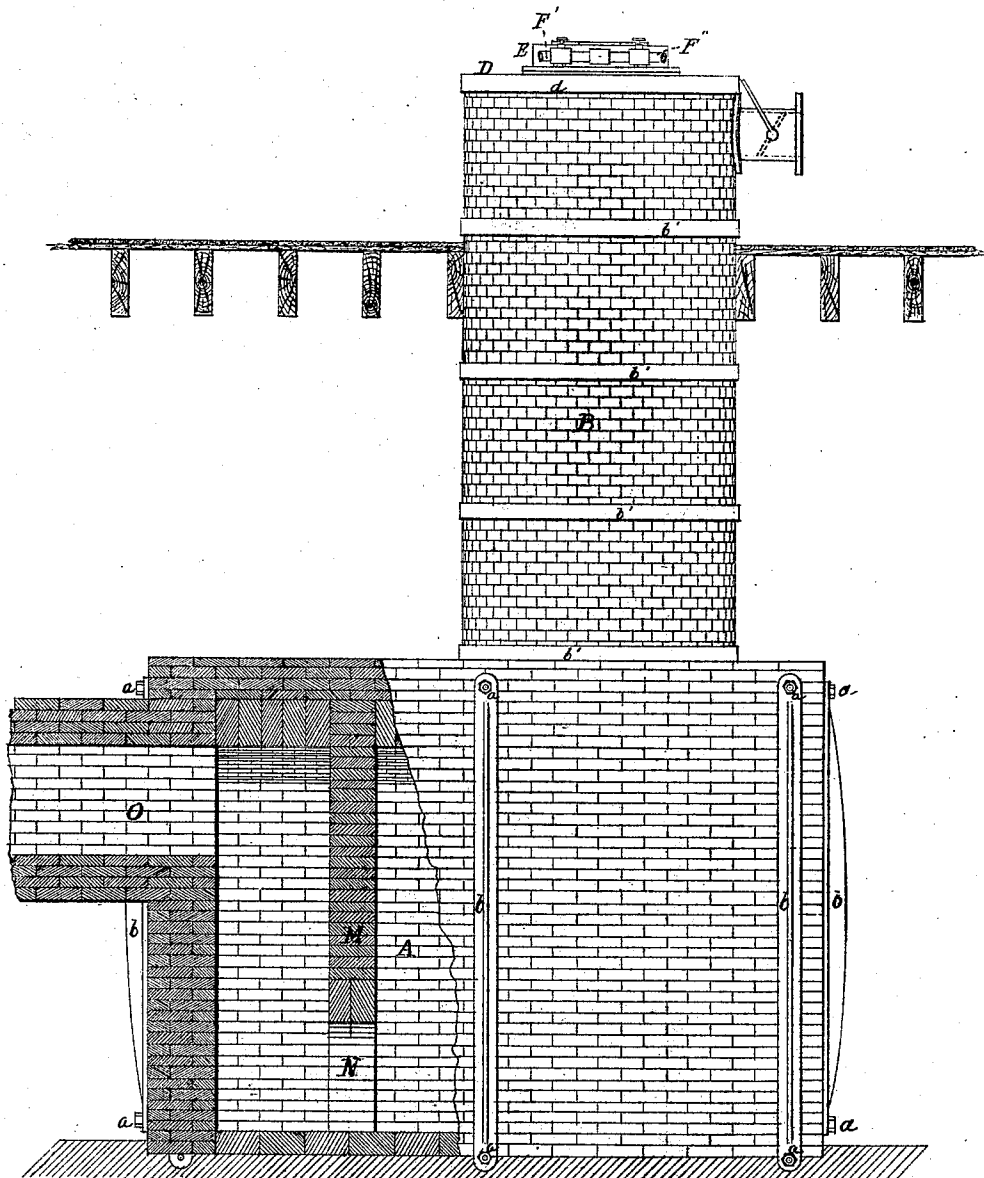


Fig. 1.

Witnesses.

D. B. Whitney
Wm. C. Hickman

Inventor.

Z. A. Willard.

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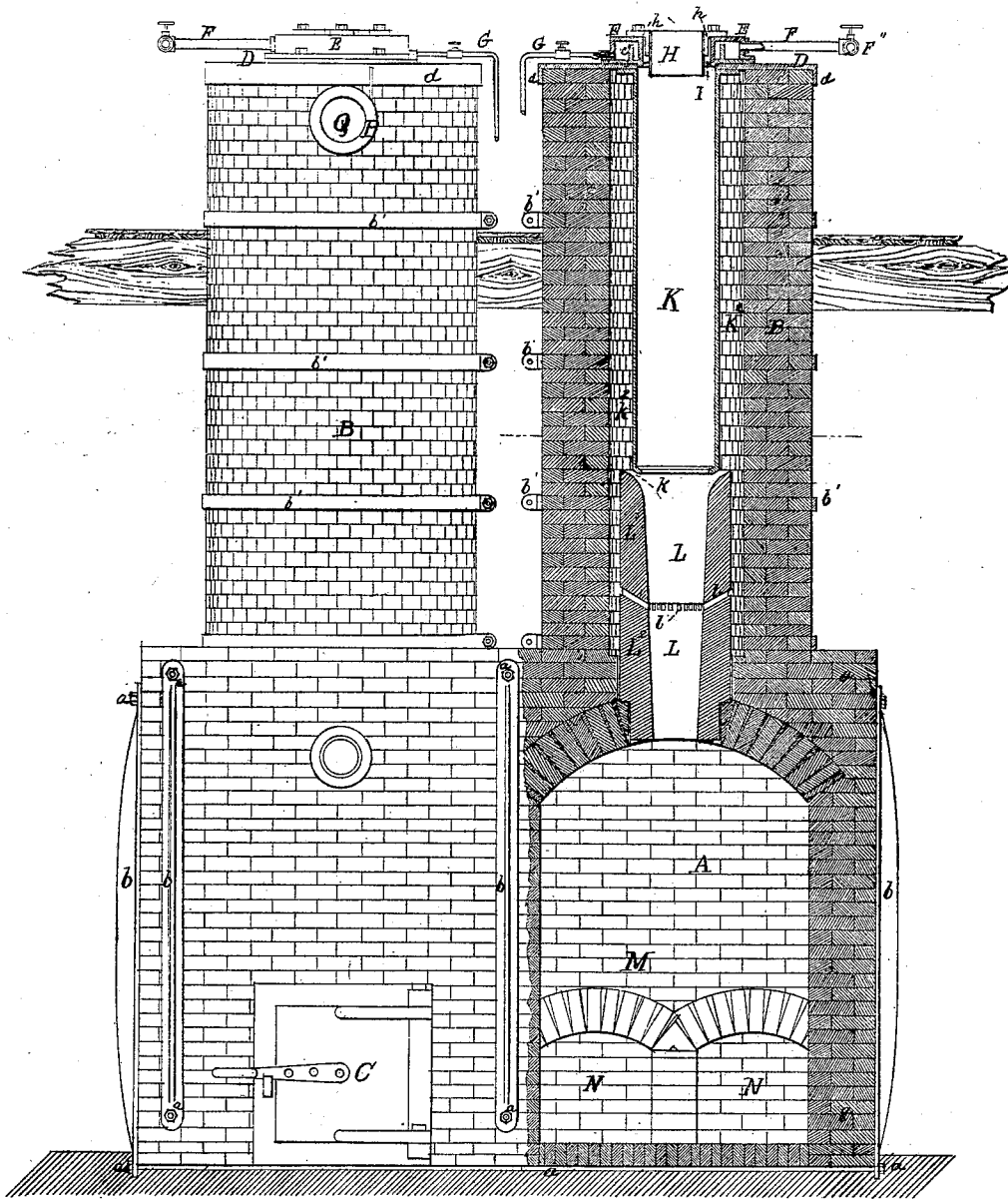


Fig. 2.

Witnesses.

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Wm. C. Hibbard

Inventor.

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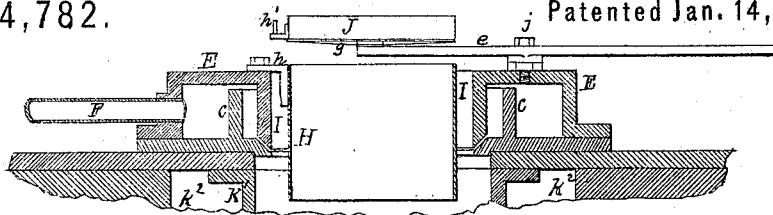


Fig. 5

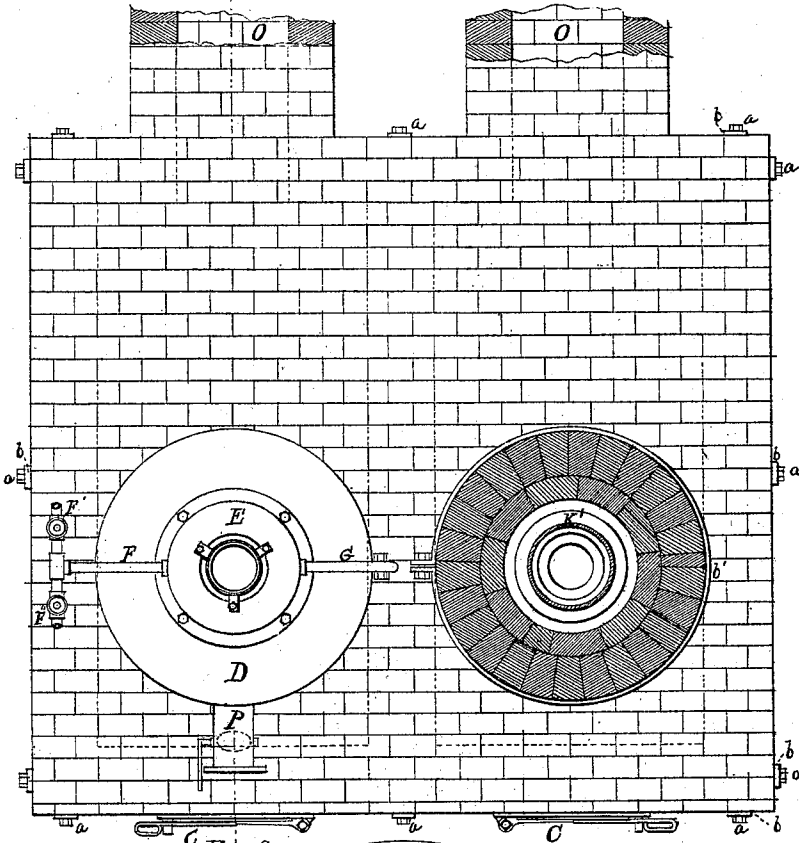


Fig. 3.

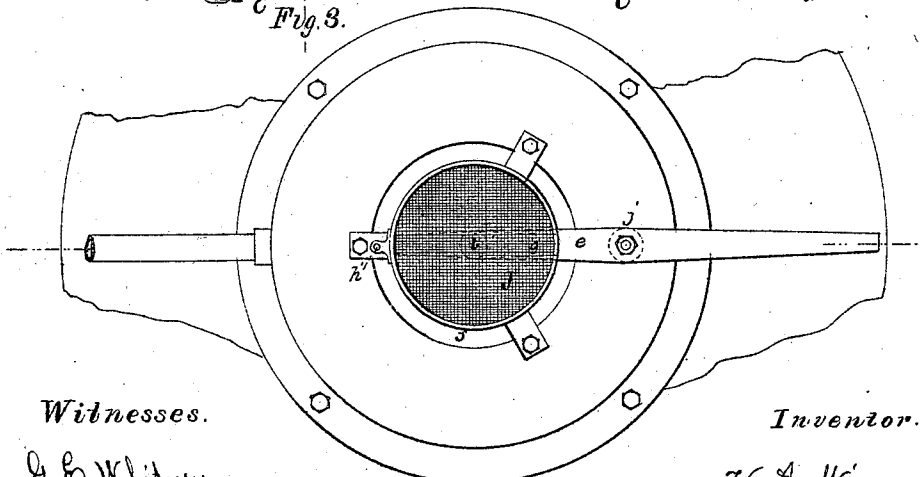


Fig. 4.

Witnesses.

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4 Sheets--Sheet

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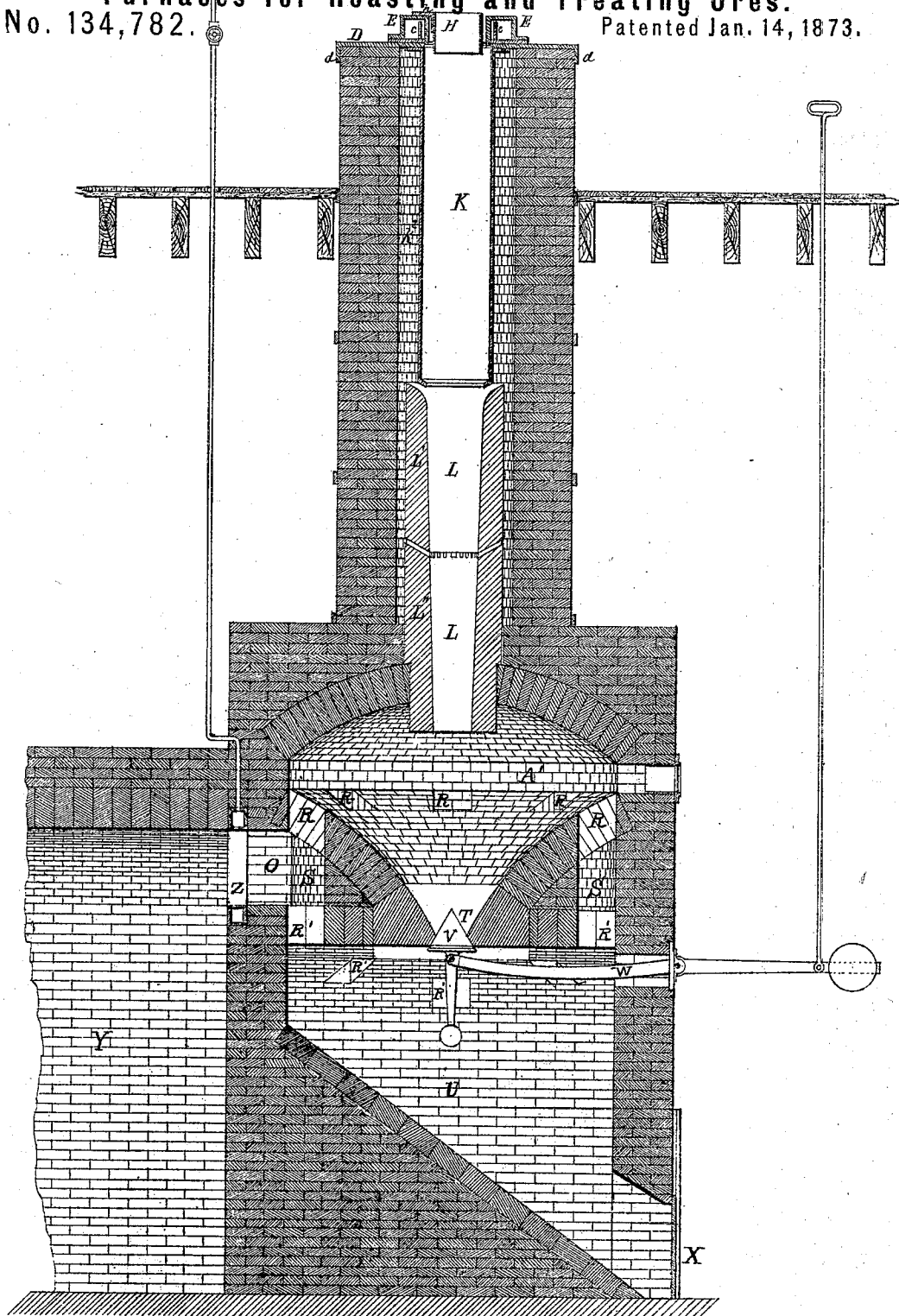


Fig. 6.

Witnesses.

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UNITED STATES PATENT OFFICE

ZABDIEL A. WILLARD, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN FURNACES FOR ROASTING AND TREATING ORES.

Specification forming part of Letters Patent No. 134,782, dated January 14, 1873.

To all whom it may concern:

Be it known that I, ZABDIEL ADAMS WILLARD, of Boston, county of Suffolk and State of Massachusetts, have invented certain Improvements in Metallurgic Processes, and in the apparatus for carrying on the same, of which the following is a specification:

The general purpose of my invention relates to the construction and mode of operation of a furnace or apparatus in which ores, minerals, or other similar matters may be treated by heat by a continuous operation, and by means of gaseous fuel—that is, a fuel that is supplied to the furnace in the form of gas or vapor, so that the constitution of the gases within the working-chamber of the furnace may be measurably controlled and determined. The furnace herein described is adapted to the desulphurizing of ores, and to use the vapor of hydrocarbons mixed with steam and air for the fuel; but is obviously adapted to other similar purposes, and to use other forms of gaseous fuel. The apparatus may be said to consist of four parts or subdivisions, viz.: First, the burner, so called, through which the gaseous fuel is introduced; second, the primary or mixing chamber, into which the gases are introduced, and in which they mutually react upon each other to prepare them for combustion; third, the combustion-chamber, in which the greatest heat is generated and the most of the work is done; and, fourth, the receiving-chamber, in which all the matters passing through the furnace are received, the solid matters being deposited therein, while the spent gases pass off through a flue to the chimney. These parts are arranged upon a vertical axis, one above the other, and the material to be treated is introduced at the top and falls through them in succession by gravity. My invention relates to the construction and mode of operation of each of these parts severally, and to the manner of arranging and combining them in relation to each other so as to produce the desired result.

The several features of my invention are as follows: First, making the burner of an annular form, or with a substantially continuous jet or discharge, extending around and near the walls of the chamber which receives the gases, and which discharges them inward toward the center in an inclined direction, so that all parts

of the chamber may be uniformly supplied with fuel, and also so as to leave an opening through which the matters to be treated may be introduced into the chamber; second, the combination, with the discharging-orifice of the burner, of a shield placed at a short distance therefrom, and against which the jet of gases is discharged and mixed with a suitable supply of air, which is drawn in behind it by the discharge as it enters the primary chamber; third, combining with the discharging-orifice of the burner a trap or recess for intercepting the liquids which may enter the burner from the condensation of the vapors or otherwise, and prevent them from being discharged into the furnace; fourth, the combination, with the burner and its accessories, of a primary or mixing chamber, in which the influent gases are mixed and react upon each other by a partial combustion, and are prepared for the complete combustion by the access of air thereto, as will be described; fifth, the combination, with said primary chamber and burner, of the secondary chamber or crucible, and the air-jet or jets for introducing air into the gases to complete their combination within the same, and generate therein the intense heat by which the work is mainly done; sixth, the combination, with the secondary chamber or crucible, of the receiving-chamber, in which the solid matters are deposited and the spent gases separated therefrom, to pass off to a chimney; seventh, the combination and arrangement of the burner, the primary chamber, and the secondary chamber, upon a vertical axis, so that the matters to be treated will be carried through the same by gravity, and discharged below; eighth, the combination, with the primary chamber, of the heating-chamber, by which the walls of the chamber are preserved and the air is heated before it enters the secondary chamber to complete the combination. Other peculiarities of construction will be mentioned in the following description:

In the accompanying drawing, Figure 1 is a longitudinal elevation of a furnace of my improved construction. Fig. 2 is a front elevation of a pair of furnaces with one of the furnaces in vertical section. Fig. 3 is a plan of the furnace with one tower in horizontal section. Fig. 4 is a plan of the furnace and sieve

on an enlarged scale. Fig. 5 is a vertical section of the same; and Fig. 6 is a sectional elevation of a modification of the furnace, which will be described.

A is an oblong chamber, built of masonry, as is shown, into which the materials are received as they are treated, and above which is a round tower, B, placed nearer to the front end. Both this and the chamber A are provided with stay-rods *a*, and binders *b*, and hoops *b'*, to confine the brick-work in a manner well known in building furnaces. C is the door for removing the contents of the chamber A. D is a cast-iron plate, which covers the top of the tower, and is provided with a ledge, *d*, which projects downward and incloses the top of the brick-work. In the center of this plate is a large opening, through which the gaseous fuel and the materials to be treated are introduced. E is the device which I call the burner, from its analogy to a gas-burner, by which the gaseous fuel is supplied to the furnace. It consists of an annular chamber, formed of cast-iron, quadrangular in cross-section, which is divided into unequal parts by a vertical partition, *c*, which extends from the bottom nearly to the top, and serves to diffuse and mix the vapors equably, and as a trap to intercept the liquids which may be produced by condensation of the vapors and prevent them from reaching the orifice of discharge, which is placed at the lower inner angle of the burner. This orifice is inclined downward at an angle of about 45°, and is formed by leaving a very narrow space (say about one thirty-second of an inch) between the two parts of which the burner is composed, as is shown in Figs. 4 and 5. The gaseous fuel is led into the burner through the pipe F, which is connected with as many branch pipes as there are kinds of gas or vapor to be used with it, each of which pipes is provided with a cock or valve to control the supply and to enable the vapors or gases to be mixed in any desired proportion. In this arrangement only two branch pipes, F' F'', are shown, by one of which steam and vapor of petroleum or naphtha is supplied, and by the other steam alone, as will be hereafter explained. G is a drain-pipe for drawing off the liquid matters from the outer chamber of the burner. H is an annular screen, of thin plate-iron, which is placed within the central opening of the burner, and about an inch, more or less, from the same, and is supported upon the burner by the brackets *h*, leaving an annular space between it and the burner. Through the opening I the matters to be treated are introduced into the furnace in the form of powder by means of the sieve J, or by some other equivalent device which will scatter or diffuse the same equably over the horizontal area of the opening. To the under side of the plate D is attached the cylindrical pipe or casing K¹ which forms the walls of the first or primary chamber K, and between this and the brick-work of the tower a space, K², is left,

which forms a heating-chamber for the air which is introduced to complete the combustion. Below the pipe K¹ is placed the secondary chamber L, which I call the crucible, which is formed by the two annular fire-blocks L' L'', the lower one, L'', of which is set into the brick-work below, and the upper one, L', is set upon this, as is shown. The top of the upper block L' reaches within about an inch of the lower end of the pipe K¹, which leaves an annular opening, *k*, inclining downward, through which the air is introduced from the chamber *k''*, and in the joint between the blocks a series of radial openings, *l*, is made, inclining downward, through which the air is also admitted from the space K². The crucible may be made of fire-bricks, if necessary, as well as the other parts of the furnace that are exposed to intense heat, but for this part I prefer two fire-blocks made of some refractory material, of the form shown. The chamber A is arched to support the tower, as shown, and is about six feet high and eight feet long, and toward the back end is provided with a screen-wall, M, with arched passages N below to carry off the spent gases from the chamber. The purpose of this is to prevent the current of flame and material from the lower end of the crucible L from passing directly to the flue O, which leads to the chimney, and allows the flame to continue down to the bottom of the chamber A and deposit the solid matters there. The sieve J is made with a hoop of thin iron, *f*, and a screen of woven wire, about twenty-eight to the inch. It has a cross-bar, *g*, provided with a boss at the center to receive a pivot, *i*, upon which it is oscillated through an arc of a few degrees in a horizontal plane by a crank and a pitman (not shown) connected with the wrist-pin *h'*, which is fixed in a boss upon the outer end of the cross-bar. The central pivot *i* is fixed in the inner end of the lever *e*, which has a fulcrum at *j* upon a stud inserted in the top of the burner, as shown, and the outer end of the lever projects a sufficient distance for a handle, by which the sieve can be swung aside from above the chamber of the furnace when required. When the sieve is in use the lever is clamped by the screw and nut at its fulcrum *j*, which keeps the sieve in a position concentric with the burner. P is the pipe by which air is introduced into the chamber K² from a blower or by the draft of the chimney, and the volume of which is controlled by the valve or damper Q, or some equivalent device.

The method of using this furnace in treating sulphuret ores containing gold, for instance, (for which purpose I have used it with great success,) is as follows: The gaseous fuel which I have mostly used in it consists of a mixture of hydrocarbon vapor and steam, produced by passing a current of naked steam, of a pressure of about sixty pounds per inch, into and through petroleum, or naphtha, or gasoline, so called, contained in a strong cistern or generator which allows the steam to carry

along with it as much of the hydrocarbon vapor as it will take. This is led to one of the branches of the pipe F. Steam from the same source is led to the other branch. The hydrocarbon vapor is first admitted into the burner and lighted. The vapor escaping from the orifice of the burner downward is projected against the shield, and takes with it some air from the annular space between the shield and the burner. The steam then is turned on a little, and the proportions of the vapors are right when their reaction or primary combustion in the chamber K has the appearance of a very pale blue lambent flame, perfectly transparent, and apparently not evolving a great heat. The draft of the chimney is started just enough to prevent the escape of the gas upward through the central opening I of the burner. As the current of gases in the chamber K passes downward it meets the current of air which enters at the orifice *k* and instantly bursts into a vivid flame, producing an intense heat within the crucible L. For many purposes the introduction of the air at *k* is sufficient; but the combustion of the gases is more complete, and the heat in the crucible is made more intense, by the introduction of the second current of air at *l*, and also appears more perfectly to oxidize the matters to be treated. After the furnace is hot the sieve J is swung over the central opening in the burner and set to vibrating. A stream of finely-pulverized ore is then fed into the sieve by any suitable means that can be regulated—such, for instance, as are used to feed a grist-mill, and for a furnace of the size shown in the drawing at the rate of about eight hundred pounds, more or less, per hour. The powdered ore falls from the sieve into the chamber K, diffused over the entire horizontal area, and as soon as it meets the gaseous fuel in the chamber it ignites, burning with a yellow flame through the whole height of the chamber K. It then enters the crucible L, where the intense heat produces a rapid and very complete decomposition of the ore. From the crucible the ore falls upon the floor of the chamber A, and the waste gases pass under the screen-wall M and through the flue O into the chimney. The treated material is removed at the door C.

In some cases, when the ore requires to be exposed to the heat for a longer time than during its descent through the tower, I propose to make the chamber A' below the crucible of the form shown in Fig. 6, with a hopper or funnel-shaped bottom, so that the matters, after they have passed through the crucible will be subjected to the action of the intense flame striking down upon them.

For treating some ores, which I propose to melt in this way, I use at the bottom a hearth and a tap-hole, by which to draw off the melted matters in a well-known manner. The spent gases in this case rise and pass off through the flues R into the annular flue S, and through the flue O into the condensing-chamber, and

from thence to the chimney. At the bottom of this chamber A' is an opening, T, through which the contents are discharged into the chamber U below it. This opening is closed by the valve V opening downward, as shown, which is carried upon the end of the lever W which extends out through the walls of the furnace, and by which the valve V is worked. The lever is counterpoised at the outer end, so as to hold the valve up to its seat. Immediately under each flue R is an opening, R', into the chamber U, for the purpose of allowing any solid matters that may pass into the flue R to be deposited in the chamber; and, to enable this to take place, the chamber must be kept tightly closed. The bottom of the chamber U may be made inclined, as shown, which will cause the contents to run down to the door X, which slides vertically, and from beneath which, when partly raised, the treated matters may be shoveled out without opening the chamber and admitting the air. Y is a portion of a condensing-chamber, into which the flue O leads from the furnace, and in which any solid matters carried forward by the current may be deposited; and at the point where the flue enters the chamber I place a steam-case, Z, which surrounds the flue and has a continuous discharging-orifice like the burner, which is inclined, so as to throw the jet of steam forward and toward the center of the flue. The object of this construction is to so command the entire area of the flue by the steam-jet that all matters which pass through the flue shall be brought in contact with the steam to aid in depositing them, and also to control the draft through the furnace, so that at all times it can be nicely regulated.

In the use of hydrocarbon vapors for fuel, in order to produce a complete combustion, the mixture of the vapor with steam, and the mutual action that they have upon each other in the primary chamber, by what I have called the primary combustion, appears to be, from my experiments, very important to prepare the gases for the complete or intense combustion in the crucible; and the atmosphere of the furnace thus composed also appears to produce a very beneficial action in desulphurizing and decomposing the ores, the theory of which I will not attempt to explain.

In the application of the distinguishing characteristics of this furnace to special uses, the proportion and mode of arrangement of the several parts would obviously be considerably modified; but in all cases I believe it would be found best to introduce the mixture of hydrocarbon vapor, steam, and air into a chamber by a device substantially in operation like the burner, and in which chamber they are made to react upon each other by the primary combustion, so called, and are thus prepared for the complete intense combustion by bringing them in contact with a supply of air in a suitable chamber adapted to sustain the intense heat produced.

What I claim as my invention is—

1. The combination of the delivery-orifice, by which the gaseous fuel is introduced, with the primary chamber in which the gases are mixed and prepared for final combustion, substantially as described.

2. The combination of the delivery and inlet orifices of the burner with the partition *c*, substantially as described.

3. The combination of the delivery-orifice of the burner and the shield or its equivalent, substantially as described.

4. The combination of the annular casing, the annular orifice of discharge, and the shield constituting what I call the burner, substantially as described.

5. The combination of the primary chamber and the burner or its equivalent with the secondary chamber or crucible and the air-jet or jets for completing the combustion, substantially as described.

6. The combination of the air-heating cham-

ber K^2 with the primary chamber, substantially as described.

7. The combination and arrangement of the central opening of the burner, the primary chamber, the secondary chamber or crucible, and the receiving-chamber, one above the other, so that the matters to be treated will be carried through them by gravity, substantially as described.

8. The combination of the conical hearth of the receiving-chamber and its discharging-orifice with the crucible, substantially as described and shown in Fig. 6.

9. The passages R' , in combination with the flues R and the lower chamber U , substantially as described.

Executed July 18, A. D. 1871.

Z. A. WILLARD.

Witnesses:

G. E. WHITNEY,
WM. C. HIBBARD.