G. F. RENDALL.

ORE REDUCING FURNACE.

APPLICATION FILED NOV. 20, 1906.

931,145.

Patented Aug. 17, 1909.

5 SHEETS—SHEET 1.

Fig. 1.

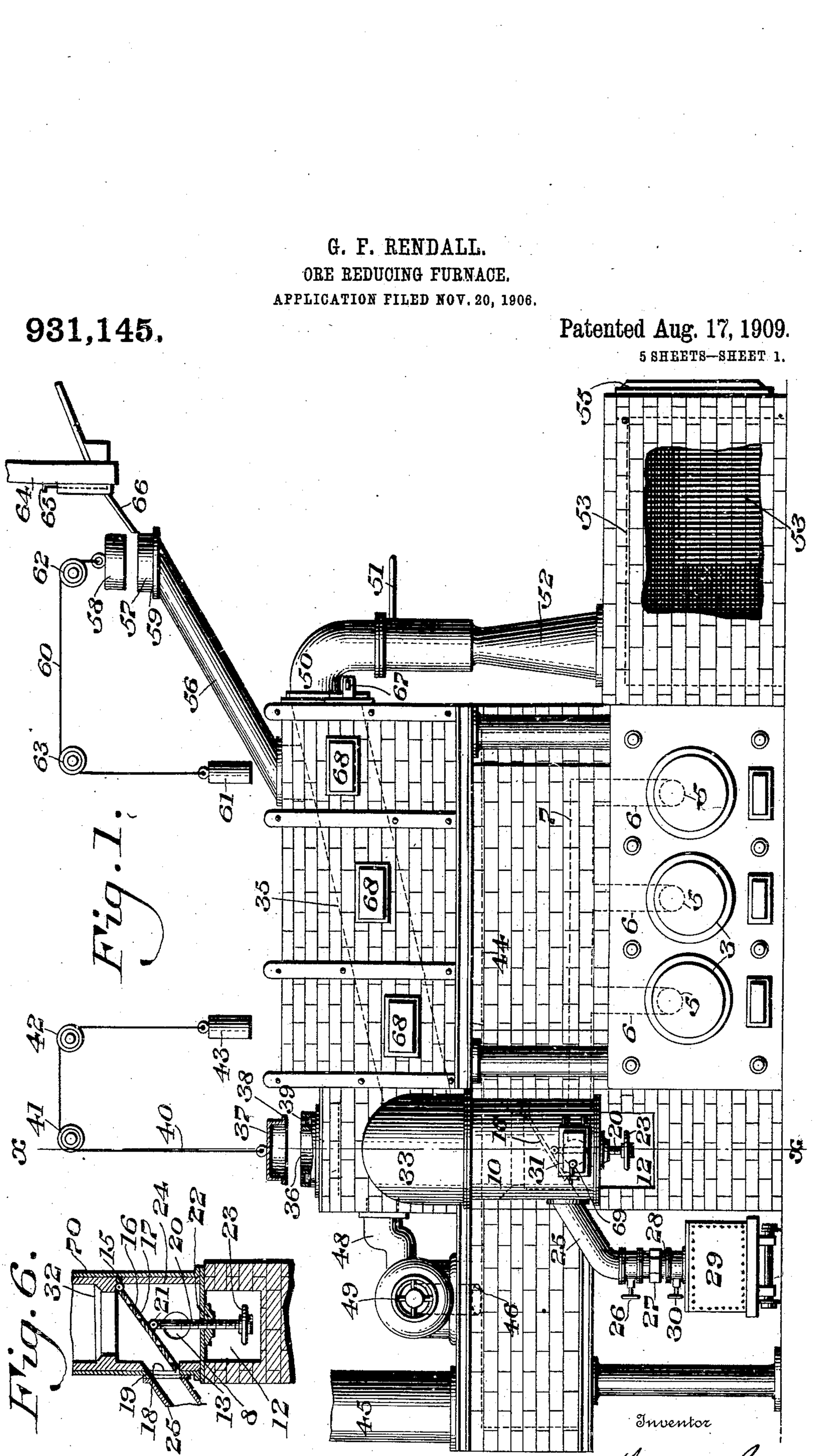

Fig. 6.

Witnesses

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5 SHEETS—SHEET 2.

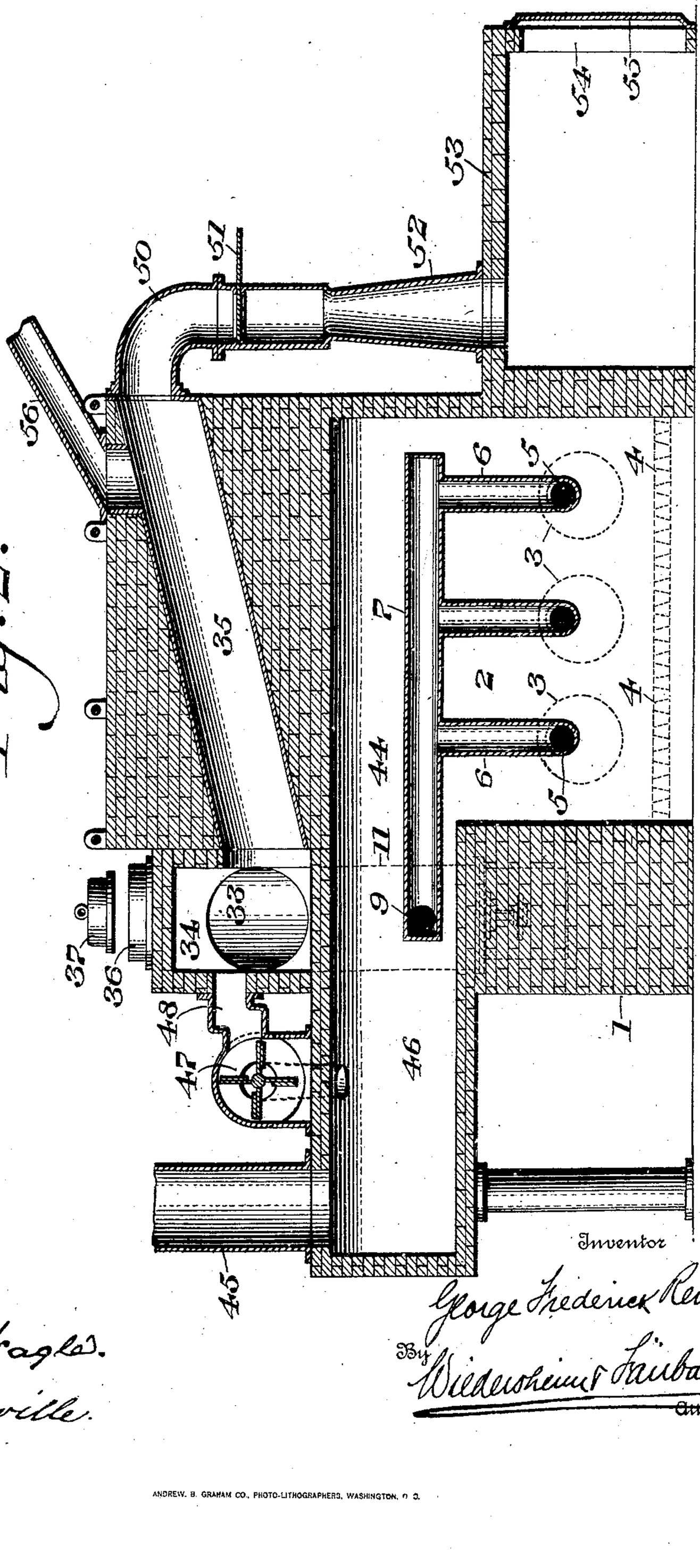

Fig. 2.

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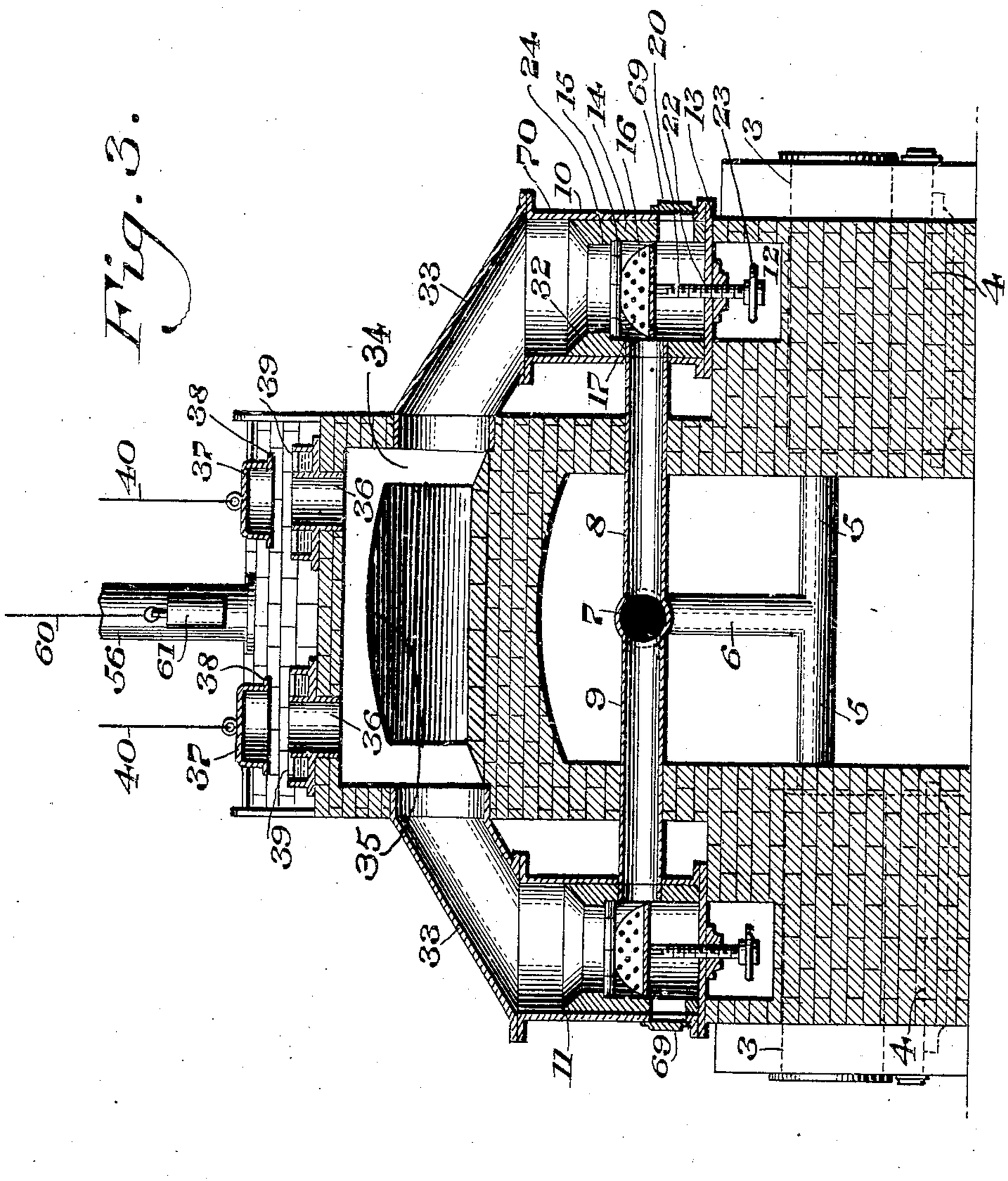
5 SHEETS—SHEET 3.

Fig. 3.



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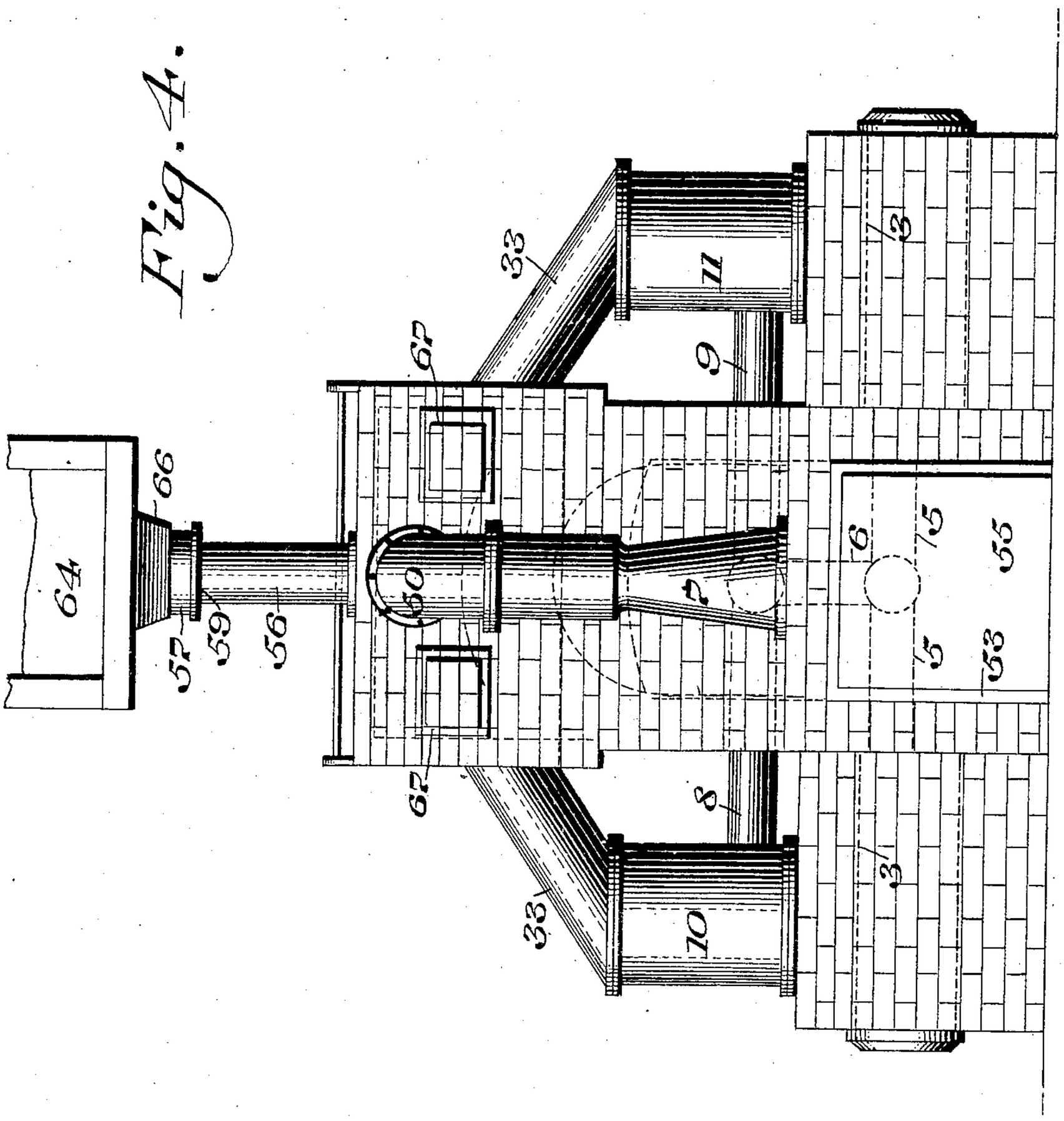
5 SHEETS—SHEET 4.

Fig. 4.



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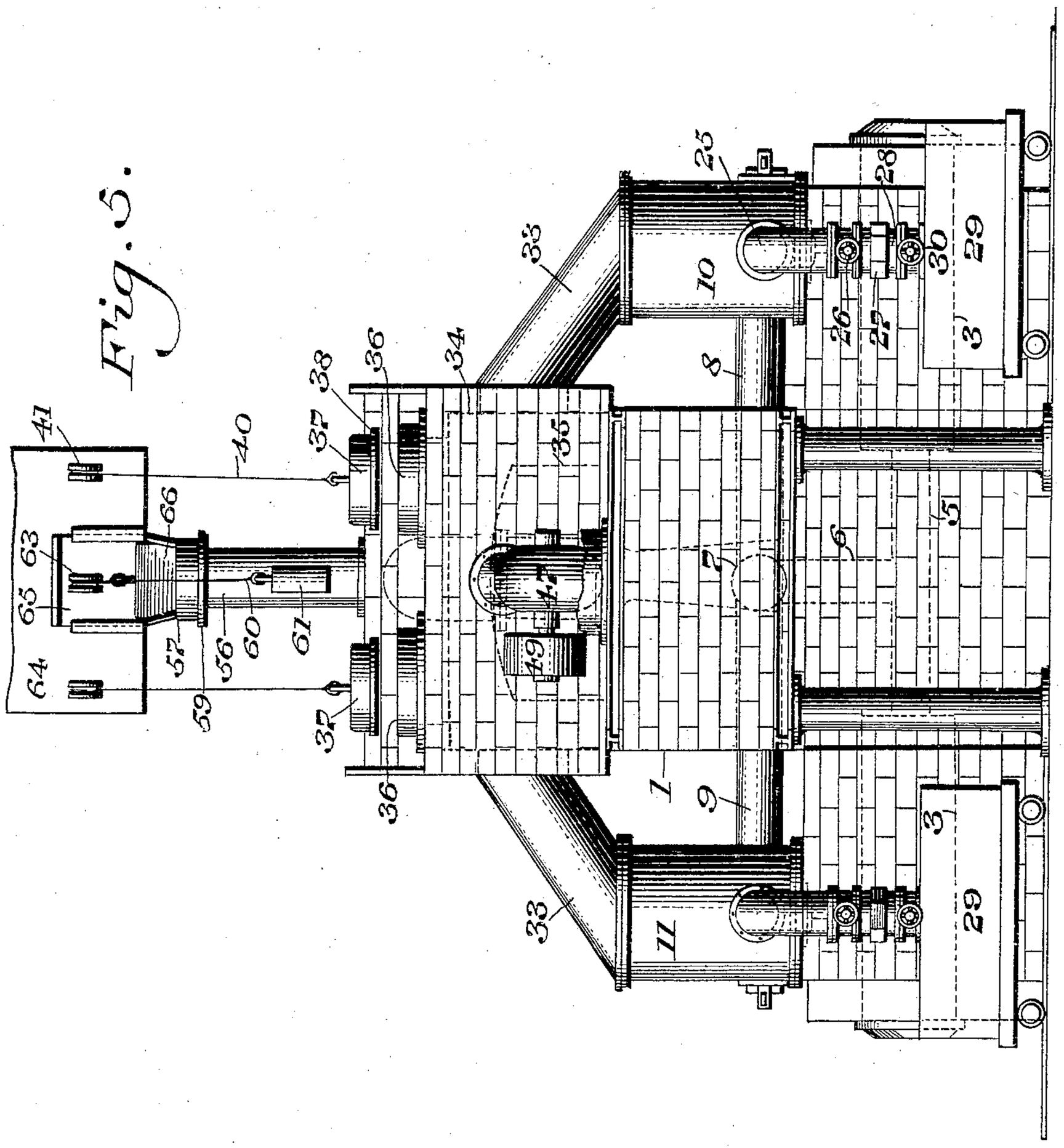
5 SHEETS—SHEET 5.

Fig. 5.



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UNITED STATES PATENT OFFICE.

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ORE-REDUCING FURNACE.

No. 931,145. Specification of Letters Patent. Patented Aug. 17, 1909.

Application filed November 20, 1906. Serial No. 344,266.

To all whom it may concern:

Be it known that I, GEORGE FREDERICK RENDALL, a subject of Great Britain, residing in the city and county of New York, State of New York, have invented a new and useful Ore-Reducing Furnace, of which the following is a specification.

My present invention consists of a novel and useful construction of a furnace, in which I am enabled to reduce minerals by the use of gas and produce a very pure product, the employment of fluxes in the operation of reduction being entirely dispensed with, thereby greatly decreasing the cost of the operation.

My invention further consists of a novel construction of a furnace, in which the gas is first employed to calcine the ore and eliminate the sulfur and phosphorus contained therein and then the gas is combined with heated air to produce the necessary combustion for heating the ore.

It further consists of a novel construction of discharging mechanism by the employment of which the ore is discharged, without coming into contact with the atmosphere, into a closed vessel or receptacle from which all air has been excluded and thus preventing any oxidization of the ore.

It further consists of a novel construction of movable perforated bottom by means of which the entire furnace charge is subjected to a gaseous treatment.

It further consists of a novel construction of a furnace in which the heated air in the furnace is passed into the reducing chamber in order to provide for the combustion therein.

It further consists of a novel construction and arrangement whereby the furnace is not liable to be injured by the explosions of gas.

It further consists of other novel features of construction, all as will be hereinafter fully set forth.

For the purpose of illustrating my invention, I have shown in the accompanying drawings one embodiment thereof which has been found in practice to give satisfactory and reliable results, although it is to be understood that the various instrumentalities of which my invention consists may be variously arranged and organized and that my invention is not limited to the precise arrangement and organization of these instrumentalities, as herein shown.

Figure 1 represents, in side elevation, a furnace embodying my invention. Fig. 2 represents a longitudinal section of Fig. 1. Fig. 3 represents a section on line *x*—*x*, Fig. 1. Fig. 4 represents an end elevation of Fig. 1. Fig. 5 represents an end elevation of Fig. 1, showing the end opposite to that seen in Fig. 4. Fig. 6 represents a sectional elevation on an enlarged scale of a portion of the furnace.

Similar numerals of reference indicate corresponding parts in the figures.

Referring to the drawings, 1 designates a furnace casing, provided with a chamber 2, in which is located the gas retorts 3, in proximity to which is located a grate 4, by means of which the gas retorts may be externally heated as desired.

5 designates laterally extending conduits leading from the gas retorts 3 and communicating with upwardly extending conduits 6, which communicate with a conduit 7, from which branches 8 and 9 extend.

10 designates a reducing retort with which the conduit 8 communicates, and 11 designates a corresponding reducing retort with which the conduit 9 communicates, and since these retorts are constructed in a similar manner, I will describe but one thereof. The casing 1 which in the present instance I have shown as being preferably constructed of brick work or equivalent material, is provided with a chamber 12 which, as indicated in Fig. 1, is open to the atmosphere.

13 designates a plate or supporting member on which the outer casing 70 is seated, said casing being provided with an internal lining 14 of any suitable construction.

15 designates a rod or member secured in any suitable manner within the reducing furnace or retort 10.

16 designates a plate pivoted to the rod 15 and provided with conical-shaped apertures 17, it being noted that the apertures at the top of the plate are smaller than the other end of the apertures at the bottom of the plate, so that there will be less liability of the charge passing therethrough. The retort 10 is provided with an aperture or discharge opening 18 through the lining 14 and the outer casing 70, the upper face of this aperture, as at 19, being angularly inclined or beveled in order that the apertured plate 16 may be seated thereagainst when in raised position, and the lower portion of this aper-

ture 18 serves as a stop for limiting the downward movement of the pivoted plate.

20 designates a screw or equivalent device, one end of which is pivoted at 21 to the plate 16 or an enlargement thereof, the thread of said screw engaging a threaded opening 22 in the bottom plate 13 and, at its outer end, this screw is provided with an actuating handle 23 by means of which the apertured plate 16 may be raised or lowered as desired. The walls of the chamber 24 in which the said plate 16 is located are preferably of such a contour that the plate will be guided thereby when it is being actuated.

25 designates a discharge conduit communicating with the opening 18 and provided with a controlling valve 26 by means of which said conduit may be sealed when desired. The end of the conduit 25 may be connected by means of a coupling 27 with a conduit 28 connected with a suitable carriage or car 29, it being noted that the conduit 28 is provided with a valve 30 by means of which said conduit 28 may be sealed so as to prevent any atmosphere entering the car 29 after the charge has been placed therein.

The retort furnace 10 is provided with a suitable door 31 of any suitable or conventional type. The upper portion of the chamber 24 is provided with a restricted outlet, the upper end of which diverges as seen at 32.

33 designates a conduit communicating with the reducing retort or furnace 10 and also with a chamber 34 communicating with the lower end of the combustion chamber or furnace 35. The chamber 34 is provided with apertures 36 which are closed by means of covers or caps 37 having flanges 38 which are adapted to be seated in the water or liquid seal 39 when in closed position, said covers or caps 37 having connected therewith, cables 40 which pass over pulleys 41 and 42, secured to any suitable fixed point above the furnace, and the cables 40 are provided at their ends with the counterweight 43.

The chamber 2 communicates with a longitudinally extending chamber 44 which extends beneath the furnace 35 to the end of the furnace at which point it communicates with a stack or chimney 45 extending outwardly therefrom.

46 designates a conduit communicating with the interior of a blowing mechanism 47 of any suitable or conventional type, the discharge outlet 48 of which communicates with the chamber 34 so that the heated air in the chambers 2 and 44 may be drawn into the chamber 34 when desired, it being noted that the blowing mechanism 47 is provided in the present instance, with a pulley 49 or equivalent device whereby the same may be connected to any suitable type of actuating mechanism.

The furnace 35 inclines upwardly and communicates at its upper end with a deflected conduit 50, provided with a controlling valve or slide 51, the lower end of this conduit 50 having diverging inner walls as at 52, and communicating with a gas receiver or container 63, which is provided with an opening 54, adapted to be closed by means of a door or gate 55 of any suitable type. The furnace 35 is charged by means of a conduit 56 communicating therewith and having at its upper end, an upwardly extending sleeve 57 over which a cap 58 is adapted to pass, said cap being adapted to be seated against a flange 59 on said conduit 56. The cap or cover 58 is counterbalanced by means of a cable 60 provided with a suitable counterweight 61, said cable passing over the pulleys or equivalent devices 62 and 63, which are secured to any suitable fixed point.

64 designates a conveyer shaft, the discharge opening of which is controlled by a suitable slide 65 in order to control the passage of ore from the chute or conveyer 64 by means of the guide 66, into the conduit 56.

67 designates doors or closures providing communication with the end of the furnace 35, and 68 designates doors or closures providing communication with the furnace 35 along the sides thereof. The retorts 10 and 11 are provided with suitable doors or closures 6.

The operation of the furnace will now be readily understood. The retorts 3 are first filled with any suitable gas producing material. The furnace 35 is filled by means of the conduit 56 communicating therewith, which latter may be closed when desired by means of the cap or cover 58. The gas produced in the retorts 3 passes through the conduits 5, 6, 7 and the branches 8 and 9 leading from the latter, into the reducing retorts or furnaces 10, thence into the chamber 24, it being understood that the apertured plates or bottoms 16 are now in their raised and closed position. The gas passes through the apertures 17 therein and through the charge which is supported thereabove.

In order to heat the charge in the furnace 35, a blowing mechanism 47 is employed, which is provided with a pulley 49 in order that the same may be driven by any suitable actuating means therefor, such as a motor or equivalent device. The heated air surrounding the conduits and the chambers 2 and 44 is drawn through the conduit 46 into the blowing mechanism and discharged therefrom through the conduit 48 into the chamber 34, at which point it commingles or unites with the gas entering thereinto through the conduits 33 leading from the retorts 10. An explosion is produced when the air comes in contact with this gas and

in order to prevent any injury to the lining of the furnace casing, I provide the caps or covers 37, so that any excess of gas due to the explosions will raise the covers and permit a portion of the gas to escape through the apertures 36 and the liability of any injury to the furnace or its adjuncts is positively prevented. In this manner, combustion is produced in the furnace 35 and the charge contained therein is highly heated. The gas after passing through the charge in the furnace 35, passes through the conduit 50 and into the container 53, it being understood that this conduit 50 may be closed when desired by means of the slide or equivalent valve 51 located therein. The charge in the furnace 35, which has been treated, passes therefrom into the chamber 34, and apertures 67 are provided at one end or both ends, by means of which the charge may be rabbled, when desired, into the chamber 34 from whence it descends through the conduits 33 into the reducing retorts 10. The apertured plate 16 is now lowered by actuating the handle 23 and the charge passes therefrom into the conduit 25.

A car or carriage 29 is brought into position under the discharge opening of the conduit 25 and by means of the coupling 27, the conduit 28 carried by the car 29 is sealed with respect to the conduit 25. The valves 26 and 30 are now opened and the material may pass from the conduit 25 into the car 29, after which the valve 30 is closed in order that there will be no possibility of any atmosphere coming into contact with the reduced material, during its discharge from the furnace, and I also preferably exhaust the air from the car or carriage 29 before the material is placed therein, so that there is no liability of any reoxidization taking place during the cooling of the ore. The closures 37 and 58 are so counterbalanced that they are normally closed.

It will now be apparent that the gas produced in the retorts 3 performs a dual function, in that it is first employed to calcine the ore, thereby eliminating the sulfur and phosphorus contained therein which has not already been eliminated in chamber 35 and after passing through the charge, it combines with the heated air in order to produce combustion and the proper heating of the ore contained in the furnace chamber 35.

Owing to the provision of the conduit 25 and the controlling valve 26 therefor, the ore which has been reduced may be discharged from the retorts 10 into the cars, wagons or closed packages without coming into contact with the atmosphere and since the air is excluded from these cars, wagons or packages, there is no danger of reoxidization. After the ore has been sufficiently cooled, it is treated magnetically or by concentration to eliminate all gangue, which leaves the ore in an elementary condition. It is then placed in suitable packages, in the case of iron in metal cases, and melted in a bath of molten material or in a cupola form of furnace. I attach much importance to this feature, since it enables the ore to be mixed prior to melting with any desired compound and prevents small particles of fine material escaping into the flues prior to fusion. I also find that it is very advantageous to utilize the heated air externally generated around the retorts for mixing with the gas to produce the combustion necessary for heating the charge.

It has further been found very advantageous in practice to admit the gas through a perforated movable bottom, thereby subjecting the entire charge to a gaseous treatment. Owing to the safety mechanism employed, there is no liability of the furnace being injured in any manner owing to the explosions of gas therein. The perforated movable bottom of the furnace may be readily actuated owing to the provision of the screw or equivalent member which is secured or equivalent member which is attached thereto and which is readily accessible at all times to the furnace operator.

It will now be apparent from the foregoing that I have devised a novel and useful construction of an ore reducing furnace, which embodies the features of advantage enumerated as desirable in the statement of invention and above description and while I have, in the present instance, shown and described one embodiment thereof which has been found in practice to give satisfactory and reliable results, it is to be understood that it is susceptible of modification in various particulars without departing from the spirit and scope of the invention or sacrificing any of its advantages.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a reducing furnace, a retort having an apertured bottom, a gas producer discharging thereinto below said bottom, an explosion chamber above said retort, a combustion chamber communicating with said explosion chamber, and means for passing heated air into said explosion chamber to produce the requisite combustion in said combustion chamber.

2. In a reducing furnace, a retort having an apertured bottom pivoted thereto and a discharge opening beneath said bottom, said bottom when lowered forming an inclined guide for discharging material from said retort directly into said opening, and means for adjusting said bottom to vary the amount of such discharge.

3. In a furnace, the combination of a gas producer, a retort and a furnace, said retort

having a discharge opening therefrom, an apertured bottom pivoted above said opening and controlling the same, connections leading from the gas producer and communicating with said retort below the apertured bottom thereof, and means for forcing air, heated externally of the gas producer, into the retort above the charge therein.

4. In a furnace, the combination of a gas producer, a retort and a combustion chamber, said calcining retort having a discharge opening therefrom, an apertured bottom pivoted above said opening and controlling the same, connections leading from the gas producer and communicating with said retort below the apertured bottom thereof, means for forcing air, heated externally of the gas producer, into the retort above the charge therein, and a gas receiver in communication with the combustion chamber.

5. In a furnace, a retort having a chamber and an explosion chamber thereabove, and a discharge opening beneath said chamber, an apertured bottom member pivoted below said chamber and controlling said discharge opening, and means for actuating said member.

6. In a furnace, a retort having a chamber, an explosion chamber thereabove, and a discharge opening beneath said chamber, an apertured bottom member having conical-shaped apertures therethrough pivoted beneath said chamber and controlling the discharge of ore therefrom through said discharge opening, and means for actuating said member.

7. In a furnace, a retort having a lower chamber, an upper chamber and a discharge opening from said lower chamber, a bottom member pivoted in said lower chamber and having conical-shaped apertures, said member controlling the discharge of ore from said calcining chamber through said discharge opening, and a screw engaging with said retort and pivotally connected with said member for actuating the latter.

8. In a furnace, the combination of a retort having an explosion chamber communicating therewith, a furnace from which the ore is automatically fed to said retort, a gas producer communicating with said retort, means for forcing heated air into said explosion chamber, a safety valve for said chamber, and means for discharging ore from said retort without the ore coming into contact with any atmosphere.

9. In a furnace, the combination of a retort having an explosion chamber communicating therewith, a furnace from which the ore is automatically fed to said retort, a gas producer communicating with said retort, means for forcing heated air into said explosion chamber, a safety valve for said chamber, and means for discharging ore from said retort without the ore coming into contact with any atmosphere.

10. In a furnace, the combination of a retort having an explosion chamber communicating therewith, a furnace from which the ore is automatically fed to said retort, a gas producer communicating with said retort, means for forcing heated air into said explosion chamber, a safety valve for said chamber, a discharge conduit leading from said retort, and means for closing said conduit.

11. In a furnace, a retort having a lower chamber, a combined, commingling and explosion chamber, and a discharge opening beneath said lower chamber, an apertured bottom member pivoted beneath said lower chamber and controlling the discharge of ore therefrom through said discharge opening, means for actuating said member, means for forcing a reducing gas into said retort beneath said member, and means for leading a heated gas into said commingling and explosion chamber.

12. In a furnace, a retort having an explosion chamber thereabove, a chamber therebelow, an apertured bottom member pivoted between said retort and the lower chamber and a discharge conduit from said lower chamber controlled by said member, means for conducting a reducing gas to said lower chamber, means for forcing air into said explosion chamber, and actuating means for said member.

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