No. 721,092. PATENTED FEB. 17, 1903.

G. F. RENDALL.

# PROCESS OF MAKING METAL OXIDS.

APPLICATION FILED FEB. 8, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

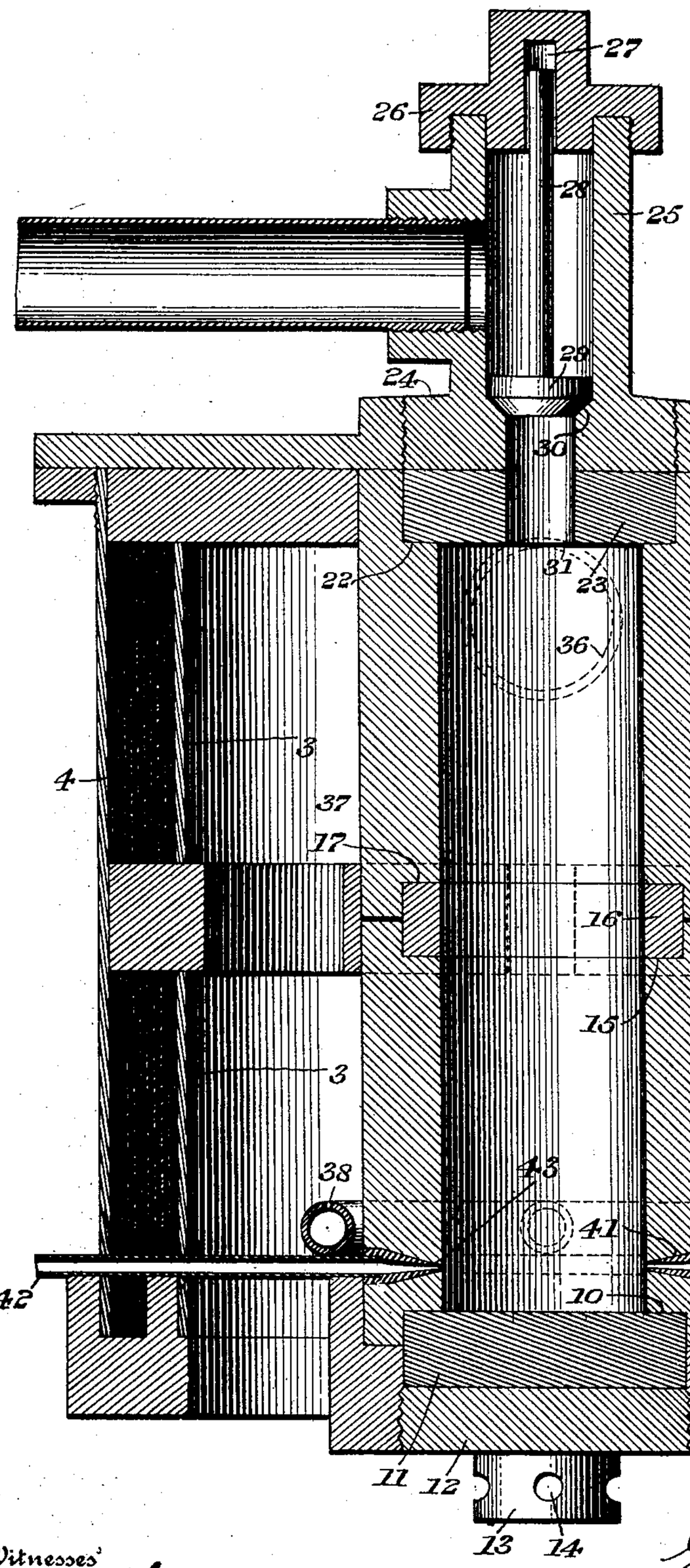


Fig. 1.

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 2.

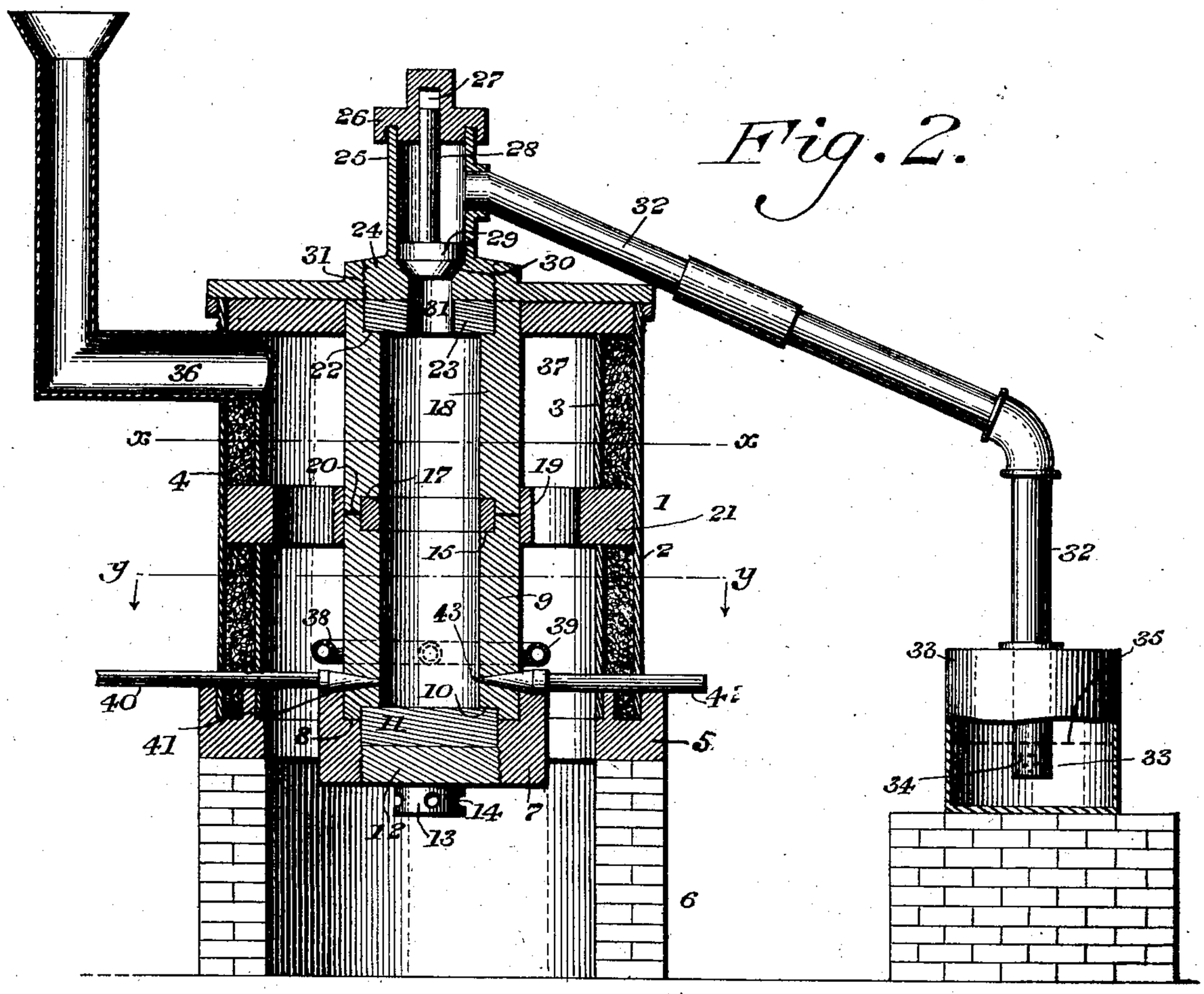



Fig. 3.
ON X—X FIG. 2.

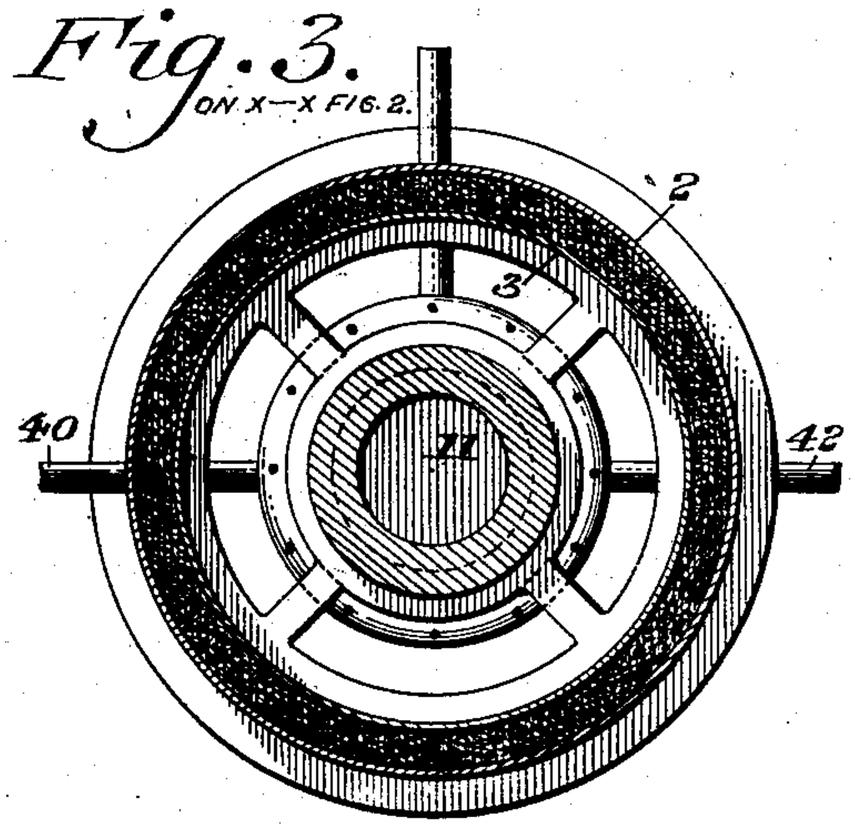
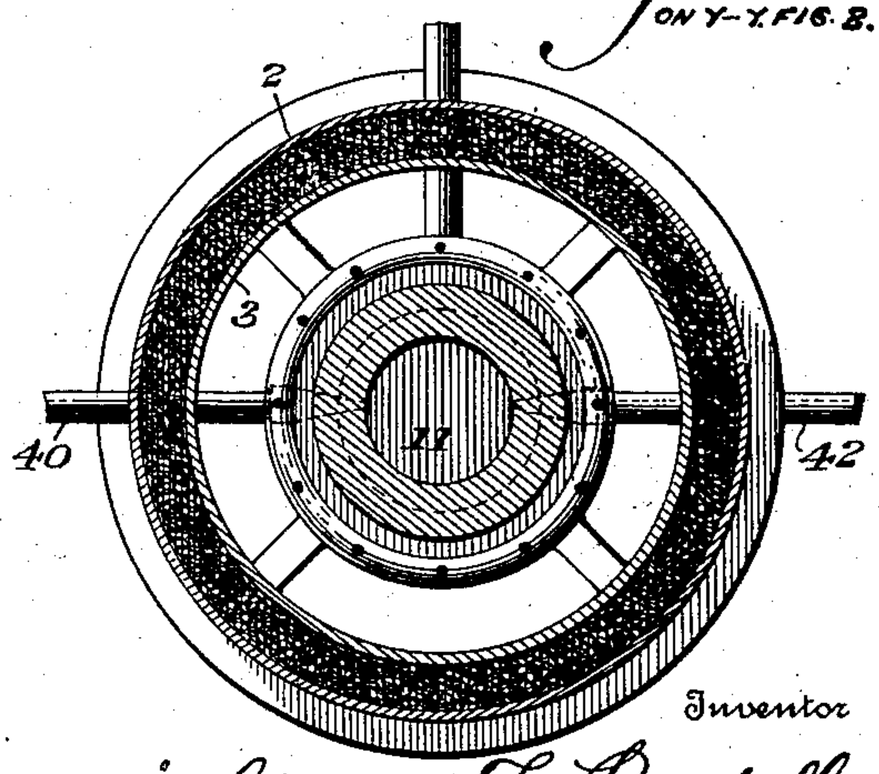



Fig. 4.
ON Y—Y FIG. 2.

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# UNITED STATES PATENT OFFICE.

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## PROCESS OF MAKING METAL OXIDS.

SPECIFICATION forming part of Letters Patent No. 721,092, dated February 17, 1903.

Application filed February 8, 1902. Serial No. 93,202. (No specimens.)

*To all whom it may concern:*

Be it known that I, GEORGE FREDERICK RENDALL, a subject of the King of Great Britain, residing in the city, county, and State of New York, have invented a new and useful Process of Making Sponge Metals and Oxids, of which the following is a specification.

My invention consists of a novel process or method of producing sponge metals and oxids of great purity whereby I obviate any necessity for added fluxes, thereby reducing the cost of fuel and enabling metals which only part from their oxygen at a very high heat to be readily reduced.

In the accompanying drawings I have shown one form of apparatus wherein the steps of my novel method may be effected; but I do not desire to be limited thereto, as my method can be carried out in other forms of apparatus, as will be evident to those skilled in the art.

Figure 1 represents a vertical sectional view of an apparatus wherein my novel method of producing sponge metals and oxids may be effected. Fig. 2 represents a vertical sectional view of the furnace seen in Fig. 1, showing also a condensing-chamber provided with a liquid seal and a pipe leading from the furnace thereto. Fig. 3 represents a section on line *x x*, Fig. 2. Fig. 4 represents a section on line *y y*, Fig. 2.

Similar numerals of reference indicate corresponding parts in the figures.

Referring to the drawings, 1 designates the casing of the furnace, the same consisting, preferably, of the wrought-steel or other metallic outer and inner tubes 2 and 3, respectively, between which is located the packing 4, of suitable non-conducting material.

5 designates the base, upon which the outer and inner tubes constituting the casing of the furnace are supported, said base being sustained upon masonry or any other suitable support 6. The inner portion 7 of the base is recessed, as at 8, for the reception of the lower portion of the crucible or furnace proper, 9, which is made of a special composition of plumbago or similar material, the lower portion of the furnace being provided with a recess 10, within which is seated the plate or closure 11, of plumbago or similar material, which is held in position by the threaded plug 12, which latter is provided with a boss or projection 13, having holes 14 therein, whereby said plug can be screwed into position when the parts are assembled. The upper extremity of the portion 9 of the furnace is recessed, as at 15, for the reception of the ring 16, of plumbago or similar material, the top of said ring seating in a recess 17 in the lower part of the top portion 18 of the crucible or furnace proper, it being apparent that the juxtaposed ends of the portions 9 and 18 of the crucible or furnace proper meet on about the line 20, said line 20 being located within the portion 19 of the supporting-plate 21, of fire-clay or other suitable material, it being noted that in the present instance said plate is of substantially the diameter of the inner portion of the wall 2 and that the wall 3 is preferably made of sections, between which said plate 21 is interposed.

22 designates a recess in the upper portion of the crucible or furnace proper, within which is seated the plate 23, of plumbago or other similar material, said plate being held in position by the threaded plug 24, which has the extension 25 thereon, the top of which is closed by a cap 26, which has the recess 27 therein, which serves as a guide for the upper extremity of the valve-stem 28, which is attached to the relief-valve 29, which is adapted to rest upon its seat 30, said valve forming a closure of the passage 31 and serving to permit the escape of fumes or gases from the interior of the crucible or furnace proper to the pipe 32, which leads to the tank 33, the lower extremity of the said pipe 32 having a discharge portion provided with perforations 34, which are adapted to discharge into the lower portion of said tank 33, the water-level therein being indicated by the line 35.

36 designates a suitable flue whereby the products of combustion will be conducted from the chamber 37 to the atmosphere.

38 designates a suitable source of heat, which in the present instance consists of an annular pipe or burner 39, having openings in the upper portion thereof, whereby the source of heat, which is preferably crude oil or gas, will be introduced into the chamber 37 for the purpose of heating the walls of the crucible or furnace proper, which is composed of the members 9 and 18.

I generally employ a steam or air blast,

thereby creating an oxyhydrogen-blowpipe and providing the highest degree of temperature yet obtained. Marsh-gas ($CH_4$) will be found a high reducing agent.

40 designates a pipe discharging into a nozzle or orifice 41, located in the lower portion of the furnace, said pipe 40 being utilized for the purpose of conveying a liquid hydrocarbon in suitable quantities into the lower portion of the furnace.

42 designates a pipe discharging into the nozzle or orifice 43 for the purpose of conveying oxygen into the lower portion of the furnace.

In carrying out the various steps of my method the ore is first carefully prepared for the furnace and all dross eliminated by magnetic treatment, concentration, or otherwise. After this treatment the ore in a finely-pulverized condition (not briquetted) is placed in the furnace composed of the portions 9 and 18, said furnace being preferably of tubular form, and the top and bottom thereof are next perfectly or hermetically closed by means of the plumbago plates 11 and 23 and the threaded closures 12 and 24, respectively, whereby any admission of oxygen is prevented. The walls of the furnace are next heated to a high degree of heat—at least to a red heat—by means of the oxyhydrogen-blowpipe or other heating means 39, wherefrom it will be seen that the furnace is externally heated in a direct and positive manner, whereby the interior and the contents of the furnace are also heated.

As I have already stated, the walls of the furnace can be made of any highly-refractory substance, providing the same is capable of withstanding the intense heat without fusing. After the furnace-walls have been heated to a sufficiently high degree of heat a liquid hydrocarbon, preferably crude petroleum, is injected by means of a force-pump (not shown) or a similar device into the pipe 40 in small amounts, thereby eliminating any danger from explosion.

As soon as the hydrocarbon reaches the interior of the furnace it is instantly converted into a gas which combines with the oxygen residual in the ore and furnace and passes again gradually through the relief-valve 29, which is so constructed as to be normally seated by gravity or other means, said relief-valve preventing any readmission of oxygen. An intense internal heat is thus formed and marsh-gas ($CH_4$) is generated, (which is a very active reducing agent.)

By the above steps and in my improved construction of furnace lime and carbon can be liquefied, phosphorus is eliminated entirely from iron or phosphate rock, aluminium is reduced to a metal condition, as can be manganese or titanium. It is of course to be understood that the furnace relief-valve 29 can be designed any suitable size which will admit of a free escape of the gases generated, whereby there will be no danger of explosion, and as all the oxygen is eliminated in conjunction with the gas found there can be no internal combustion.

When the furnace has been operated a sufficient length of time, the injection of liquid hydrocarbon into the pipe 40 is stopped and the external heat applied through the medium of the burner 39 is reduced or extinguished, as desirable, after which the bottom plate 11 of the furnace is removed and the entire contents thereof are dumped on the furnace floor or hearth. In the reduction of metallic ores the contents is a sponge metal of great purity with a residual portion of silicon, which can be pressed or shaken out. In the reduction of iron some powdered charcoal is used on the sponge to prevent oxidation and the entire mass is squeezed and hammered into bars of unequaled purity and softness, every particle of phosphorus, arsenic, or sulfur having been eliminated.

In the production of aluminium and lead it is generally desirable to remelt the sponge to obtain adhesion and solidity. The oxygen, however, having been eliminated renders this a simple operation at the ordinary melting heats of the respective metals.

In the production of carbid of calcium the material when reduced, which requires an approximate heat of about 3,000° Fahrenheit, which may be varied as required, is poured in a liquid state of fusion on the furnace-hearth, where it forms an ingot.

In the manufacture of phosphorus from ore, phosphate-rock, or bone the phosphorus passes away through the relief-valve and can be condensed in water in another receptacle.

When it is desired to form oxids, more especially oxid of lead (litharge) and oxid of zinc, (zinc-white,) a supply of oxygen is forced into the interior of the furnace by means of an opening near the bottom in conjunction with the oil or after the metallic ore has been converted into sponge. The oxid passes away through the relief-valve and is saved in usual and customary receptacles.

I am aware that there have been many methods of externally heating furnace-walls, crucibles, and tubular furnaces. I am also aware that furnaces are in use where oil or liquid hydrocarbon is used, generally in a blowpipe formed for the direct reduction of metals in combination with oxygen. What, however, I consider as new, and desire to protect by Letters Patent, are the following methods or processes, forming a part of my invention. As is well known to those skilled in the art, it is now customary to place ores with added fluxes in a furnace, reduce them with a blast to increase the heat until in a molten condition, whereupon the metal can be poured or tapped through a plug-hole. In blast-furnaces of usual construction a blast is used to create internal heat, and except in crucible-smelting values are lost by escaping fumes and

actual consumption, whereas it will be seen that in carrying out my method as above outlined there is no loss.

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

1. The herein-described process of making oxids, which consists first in placing the ore within the furnace, second excluding air from the contents of the furnace, next heating the walls of the furnace externally, next injecting liquid hydrocarbon and oxygen into the interior of the furnace thereby forming metallic oxids.

2. The herein-described process of making oxids, which consists in placing the ore in a pulverized condition in the furnace, next excluding oxygen from the interior of said furnace, next heating the walls of said furnace externally, next injecting liquid hydrocarbon into said furnace, next injecting oxygen into said furnace, next permitting the escape of the fumes and gases from said furnace automatically, and lastly, condensing said fumes and gases in a suitable receptacle.

3. The herein-described process of making oxids, which consists in placing the ore in a suitable condition in the furnace, next excluding oxygen from the interior of said furnace, next heating the walls of said furnace, next injecting hydrocarbon into said furnace, next injecting oxygen into said furnace, next causing the fumes and gases to be discharged from said furnace and lastly, condensing said fumes and gases in a suitable receptacle.

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