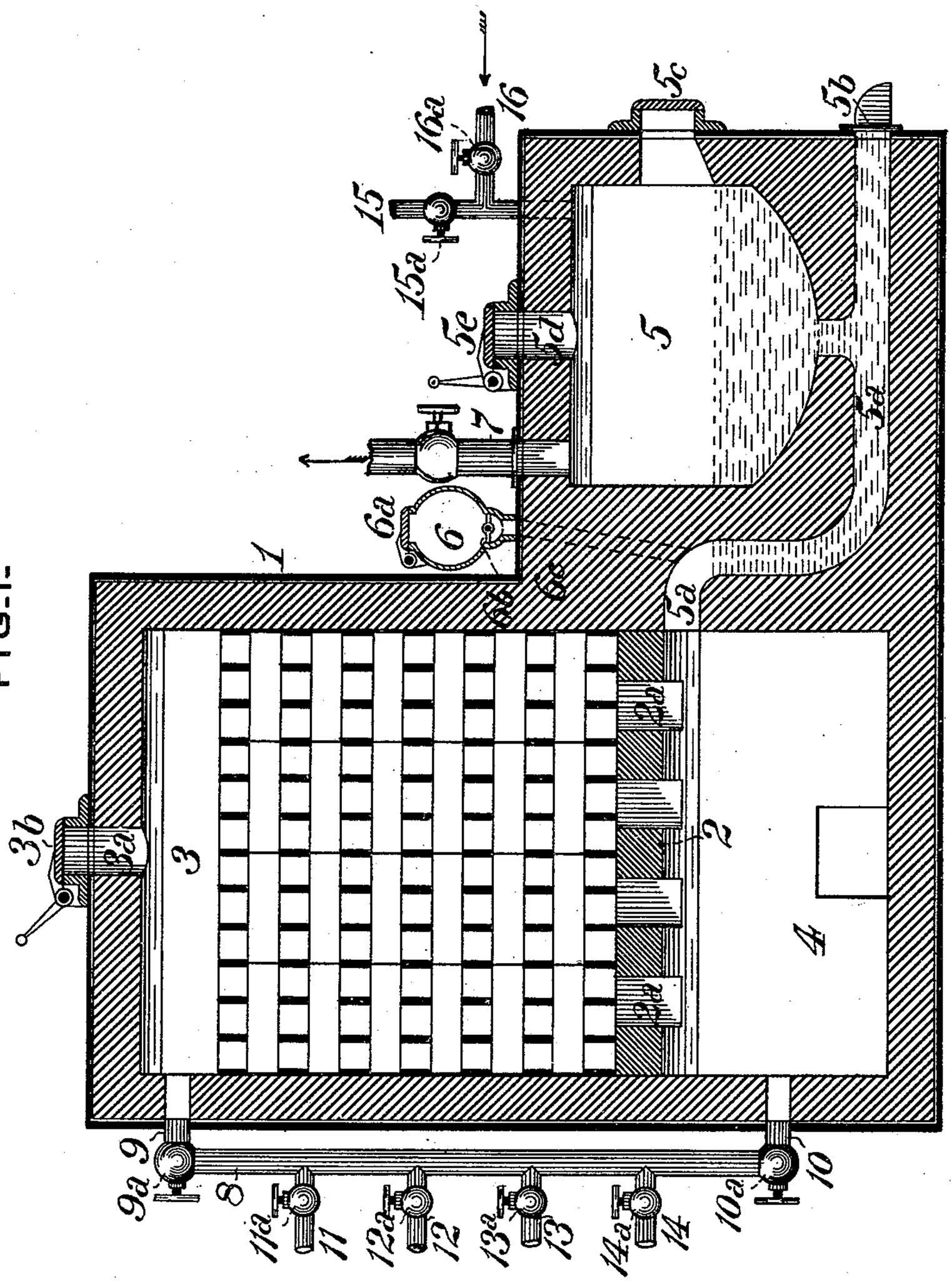
(No Model.) 2 Sheets—Sheet 1.

B. BRAZELLE.

PROCESS OF AND APPARATUS FOR PURIFYING, REFINING, AND CARBURIZING METALS.

No. 482,001. Patented Sept. 6, 1892.

FIG. 1.



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(No Model.) 2 Sheets—Sheet 2.

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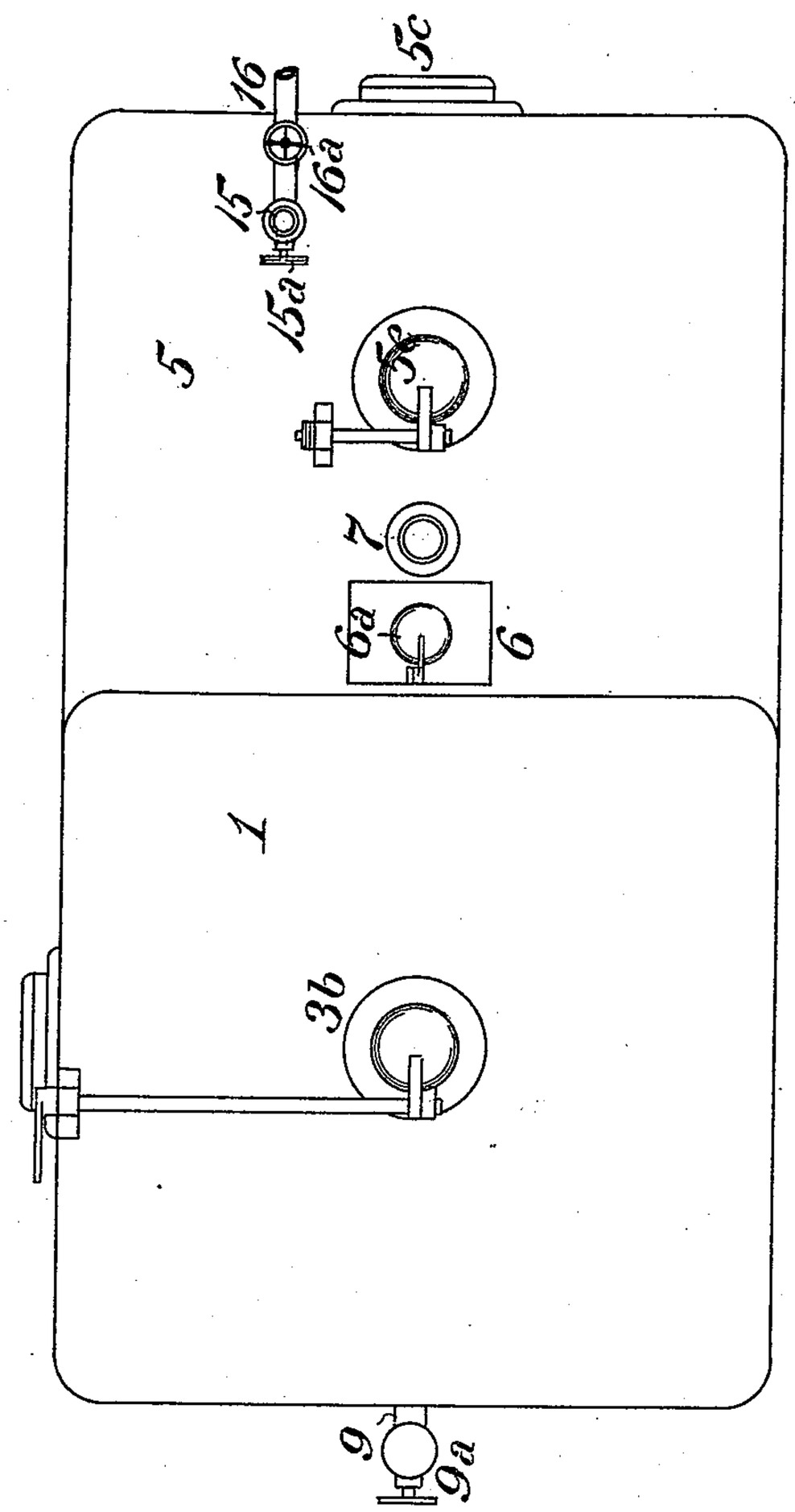
No. 482,001. Patented Sept. 6, 1892.

FIG. 2.



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UNITED STATES PATENT OFFICE.

BENJAMIN BRAZELLE, OF ST. LOUIS, MISSOURI.

PROCESS OF AND APPARATUS FOR PURIFYING, REFINING, AND CARBURIZING METALS.

SPECIFICATION forming part of Letters Patent No. 482,001, dated September 6, 1892.

Application filed March 31, 1892. Serial No. 427,224. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN BRAZELLE, of the city of St. Louis, in the State of Missouri, have invented a certain new and useful Improvement in Processes of and Apparatus for Purifying, Refining, and Carburizing Metals, of which improvement the following is a specification.

My invention relates to the purification, refining, and carburization of metals while in a molten or liquid condition by oxidizing and deoxidizing them and eliminating their undesirable elements by the action of blasts of highly-heated oxidizing and deoxidizing gases and solids passing through them and adding desirable elements by forcing them into the liquid metal by blasts of highly-heated non-oxidizing gases.

The object is to effect the separation, refining, carburizing, and combining of metals for industrial uses in a simple, inexpensive, and expeditious manner; and to this end my invention, generally stated, consists in a novel method of and apparatus for burning fuel with air, heating a body of refractory material to a high temperature, cutting off the supply of air and fuel, and supplying a charge of molten metal to an inclosed chamber, forcing an air-blast first through the body of hot refractory material and thence through the body of molten metal, shutting off the air-blast and forcing blasts of non-oxidizing gases first through the hot refractory material and thence through the body of molten metal, and from time to time reheating the body of refractory material, drawing off the treated metal, and supplying a fresh charge to be treated.

The improvement claimed is hereinafter fully set forth.

The subordinate details of my improved process may be preliminarily stated as embodying the heating of a body of refractory material to a high degree by burning fuel, (in this case oil or gas with air,) supplying a body or charge of molten metal to a closed chamber, and forcing blasts of oxidizing gases—such as air, carbonic acid, or steam—together or separately, first through the heated body of refractory material and thence through the body of molten metal, in order to eliminate by burning or oxidizing the impurities or undesirable elements, such as silicon, carbon, sulphur, phosphorus, antimony, arsenic, lead, &c. If oxides remain in the metal after the removal of impurities, as stated, the refractory material may be reheated and blasts of non-oxidizing gases—such as hydrogen, hydrocarbon gases, &c., but preferably hydrogen—are passed first through the hot refractory material and thence through the body of molten metal, in order to eliminate the oxides by deoxidation, and also to eliminate any other remaining impurities which will be absorbed by or combine with hydrogen, such as sulphur, phosphorus, &c. The metal having been deoxidized and the impurities eliminated, the hydrogen-blast is shut off and the metal may be withdrawn; but if it should be desired to add to or combine with the molten metal some other element, such as carbon, manganese, spiegel, &c., as for the purpose of making steel, such element or elements are introduced into the apparatus and are forced into the body of molten metal by blasts of highly-heated non-oxidizing gases, as hydrogen or nitrogen, preferably nitrogen, for the reason that it is more inert and is less liable to be occluded in the metal when passing through it, the gas-blasts leaving the desired elements in the body of molten metal. The blasts of highly-heated gas which introduce and incorporate the added element or elements into and with the body of metal maintain the latter in a state of fluidity until the end of the operations without exerting any external oxidizing influences which would interfere therewith.

In the accompanying drawings, Figure 1 is a vertical longitudinal section through an apparatus adapted to the practice of my invention, and Fig. 2 a plan or top view of the same.

In the practice of my invention I provide a chamber or casing 1, which is formed of iron lined with fire-brick and which is divided horizontally by an arch 2, having a series of passages 2^a into an upper regenerator-chamber 3 and a lower combustion-chamber 4. The regenerator-chamber 3 is filled nearly to its top with loosely-piled fire-brick or other refractory material, and is provided at top with an outlet 3^a, controlled by a valve or door 3^b. A chamber 5, adapted to contain a

charge of liquid metal, is located adjacent to the combustion-chamber 4 and communicates therewith by a passage 5^a, which extends through the wall of the chamber 5, and is controlled at its outer end by a suitable tapping-gate or valve 5^b. The metal-chamber is provided with a side cleaning-opening closed by a door 5^c and has an outlet-passage 5^d, controlled by a valve 5^e in its top. A hopper 6, having a cover 6^a closing an opening in its top and a valve 6^b controlling an opening in its bottom, is located above the metal-chamber 5 and communicates below the valve 6^b through a passage 6^c with the passage 5^a, which connects the combustion-chamber and the metal-chamber. A pipe 7, controlled by a suitable valve or valves, leads from the top of the metal-chamber to a gas-holder. A pipe 8 is connected at its top by a branch 9, controlled by a valve 9^a, with the regenerator-chamber 3 and is connected at its bottom by a branch 10, controlled by a valve 10^a, with the combustion-chamber 4.

The following connections are made to the pipe 8 between the valves 9^a and 10^a, viz: a pipe 11, leading to an air-pump or pressure-blower and controlled by a valve 11^a; a pipe 12, leading to a receptacle containing hydrocarbon oil or hydrogen or other non-oxidizing gas and controlled by a valve 12^a; a pipe 13, leading from a source of supply of nitrogen gas and controlled by a pipe 13^a, and a pipe 14 for steam and oil supply, said pipe being controlled by a valve 14^a. The metal-chamber 5 has connected at its top an oil or gas supply pipe 15, controlled by a valve 15^a, and a pipe 16, leading to an air-pump or pressure-blower and controlled by a valve 16^a.

In the operation of an apparatus provided with the above-described or equivalent means for practicing my improved process the outlet-valve 3^b of the regenerator-chamber 3, the valve 11^a of the air-blast pipe 11, the valve 12^a of the gas-supply pipe 12, and the valve 10^a of the pipe 10, leading into the combustion-chamber 4, are opened. The blast of air and gas entering the combustion-chamber 4 is ignited and burned therein. The metal-chamber 5 is heated preparatory to charging it with molten metal by opening the valves 15^a and 16^a of the oil or gas and the air-supply pipes 15 and 16. The blast of air and gas entering the metal chamber 5 is ignited and burned therein, and the heated products of combustion which escape through the passage 5^a into the combustion-chamber 4 thence pass, together with those of the combustion which takes place therein, through the openings 2^a of the arch 2 into and through the regenerator-chamber 3, escaping therefrom through the outlet 3^a, the refractory material in said chamber being highly heated by the products of combustion from both the chambers 4 and 5. All the valves are then closed. A charge of molten metal is then introduced into the metal-chamber 5 from any suitable source of supply—as, say, a blast-furnace—through the passage 5^d, and the door 5^e of said passage being left open the valve 11^a of the air-blast pipe 11 and the valve 9^a of the pipe 9, leading into the regenerator-chamber 3, are opened. The air-blast entering the regenerator-chamber is forced downward through the highly-heated refractory material therein into the combustion-chamber 4, and thence through the passage 3 and upwardly through the molten metal in the chamber 5, the air-blast in its passage through the body of molten metal burning, oxidizing, and eliminating therefrom the contained impurities—such as silicon, sulphur, phosphorus, antimony, lead, &c.—and, together with the separated impurities, passing off through the open outlet 5^d.

When it is desired to use other oxidizing gases, such as carbonic acid or steam, they may be introduced and forced through the hot refractory material in the regenerator 3, either separately or mingled with the air-blast, and thence through the molten metal. The oxidizing-blast having to a certain extent oxidized the desirable metal or elements, they are deoxidized by shutting off the air or oxidizing blast, closing the valve 5^e and opening the valve (not shown) which controls the pipe 7, the valve 12^a of the hydrogen-supply pipe 12, and the valve 9^a of the pipe 9, leading into the regenerator-chamber 3. A blast of hydrogen then enters the regenerator-chamber and is forced downward through the hot refractory material therein into the combustion-chamber 4, and thence through the passage 5^a into the metal-chamber 5 and through the molten metal therein, in its passage deoxidizing the latter by combining with the oxygen therein, and also taking up and carrying off such impurities as sulphur, arsenic, phosphorus, &c. The gas which passes out at the pipe 7 is delivered to a holder. When desired, hydrocarbon gases may be used in the same manner, either separately or mingled with the hydrogen-blast.

The objectionable or undesirable elements of the metal having been removed, all the valves are closed, and the purified metal may be drawn off at the tapping-gate 5^b; or if it is desired to produce steel the metal may be carbonized by opening the valve 12^a of the pipe 12 and putting said pipe in communication with a hydrocarbon oil-receptacle, opening the valve 13^a of the nitrogen-supply pipe, the valve 9^a of the inlet-pipe 9, and the valve of the pipe 7. The nitrogen-blast and oil entering the regenerator-chamber 3 are forced downward through the heated refractory material, the heat thereof carbonizing the oil. The nitrogen and carbon pass into the chamber 4, and thence through the passage 5^a into and through the molten metal in the chamber 5, the carbon being taken up by the metal and the nitrogen passing off through the pipe 7 to a holder.

Hydrocarbon gas may be introduced with or without the nitrogen, if preferred, or, if it be desired, use solid carbon, such as pow-

dered charcoal, or to introduce spiegel, manganese, aluminium, &c., these materials are charged either separately or together into the hopper 6, and by means of the valve 6^b are passed into the pipe 6^c, and thence into the passage 5^a. The hot nitrogen-blast entering the passage 5^a forces the solid element or elements forward and into the molten metal, the nitrogen at the same time by its mechanical action expelling any occluded gases that may be in the body of metal and thereafter passing off, as before stated. Any other desired elements may be introduced in like manner. After these operations have been effected all open valves are closed and the metal may be drawn off at the tapping-gate 5^b. A fresh charge of molten metal is thereafter introduced into the chamber 5.

The refractory material in the chamber 3 is heated as often as necessary by buring oil or gaseous fuel; or solid carbonaceous fuel may be employed, if preferred. It is important that the temperature of the refractory material in the chamber 3 should be kept fully as high as that of the charge of metal under treatment, in order that the air and gas blasts may be highly heated, so as to keep the molten metal in a limpid or liquid state to the end of the operation. The chamber 5 may be cleaned, as from time to time required, through the opening controlled by the door 5^c.

I claim as my invention and desire to secure by Letters Patent—

1. The improvement in the method of purifying and refining metals, which consists in introducing molten metal into an inclosed chamber, highly heating a mass of refractory material in a separate chamber, passing an air-blast first through the hot refractory material and thereafter through the molten metal, and shutting off the air-blast and forcing a blast of hydrogen first through the hot refractory material and thereafter through the molten metal, substantially as set forth.

2. The improvement in the method of purifying and refining metals, which consists in introducing molten metal into an inclosed chamber, highly heating a mass of refractory material in a separate chamber, passing an air-blast first through the hot refractory material and thereafter through the molten metal, shutting off the air-blast and forcing a blast of hydrogen first through the hot refractory material and thereafter through the molten metal, and shutting off the hydrogen-blast and forcing a blast of nitrogen gas and a hydrocarbon first through the hot refractory material and thereafter through the molten metal, substantially as set forth.

3. The improvement in the method of purifying and refining metals, which consists in introducing molten metal into an inclosed chamber, highly heating a mass of refractory material in a separate chamber, passing an oxidizing-blast—such as steam or carbonic acid, or both—first through the hot refractory material and thereafter through the molten metal, shutting off the oxidizing-blast and forcing a non-oxidizing blast—such as hydrogen or hydrocarbon gas—first through the hot refractory material and thereafter through the molten metal, and shutting off the non-oxidizing blast and forcing a solid material—such as charcoal, coke, spiegel, manganese, aluminium, &c.—into the body of molten metal by means of a blast of nitrogen gas previously heated by passing it through the hot refractory material, substantially as set forth.

4. In an apparatus for purifying and refining metals, the combination, substantially as set forth, of a combustion-chamber, a valve controlling an outlet therefrom, a regenerator-chamber communicating therewith and containing a body of loose refractory material, a metal-chamber communicating by a passage with the combustion-chamber and having a charging-opening and a lower tapping-gate, air and gas and hydrocarbon pipes leading into the upper portion of the metal-chamber, air, gas, and steam, and oil pipes controlled by valves and leading into a connecting-pipe which communicates at its ends with the regenerator-chamber and the combustion-chamber, respectively, and valves controlling communication between said connecting-pipe and said chambers.

5. In an apparatus for purifying and refining metals, the combination, substantially as set forth, of a combustion-chamber, a valve controlling an outlet therefrom, a regenerator-chamber communicating therewith and containing a body of loose refractory material, a metal-chamber communicating by a passage with the combustion-chamber, a charging-hopper for solid material, a valve-controlled pipe leading therefrom to the passage leading to the metal-chamber, an upper charging-opening and a lower tapping-gate on the metal-chamber, air and gas and hydrocarbon pipes leading into the upper portion of the metal-chamber, air, gas, and steam and oil pipes controlled by valves and leading into a connecting-pipe which communicates at its ends with the regenerator-chamber and the combustion-chamber, respectively, and valves controlling communication between said pipe and said chambers.

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