

(No Model.)

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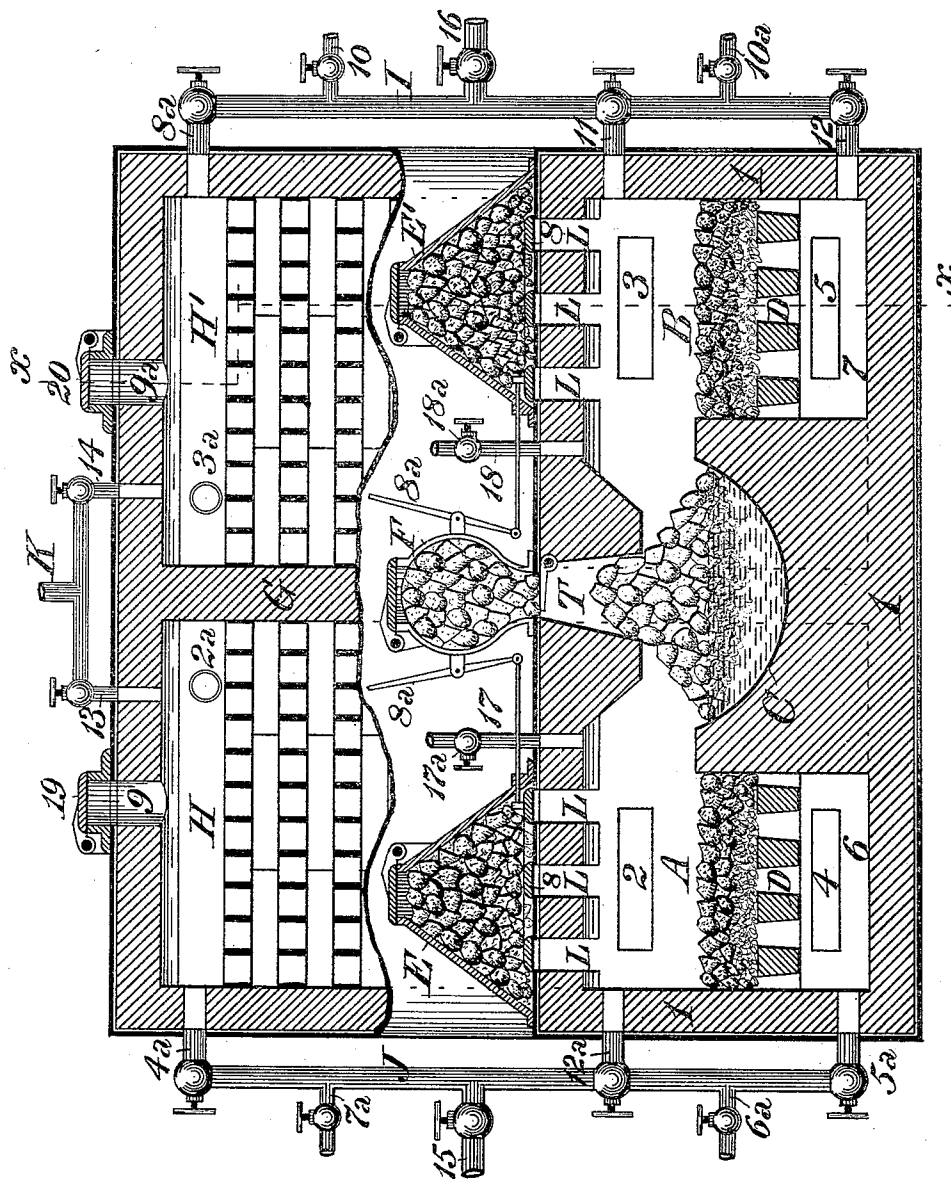
B. BRAZELLE.

PROCESS OF AND APPARATUS FOR SMELTING ORES.

No. 529,476.

Patented Nov. 20, 1894.

FIG. 1.



WITNESSES:

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INVENTOR.

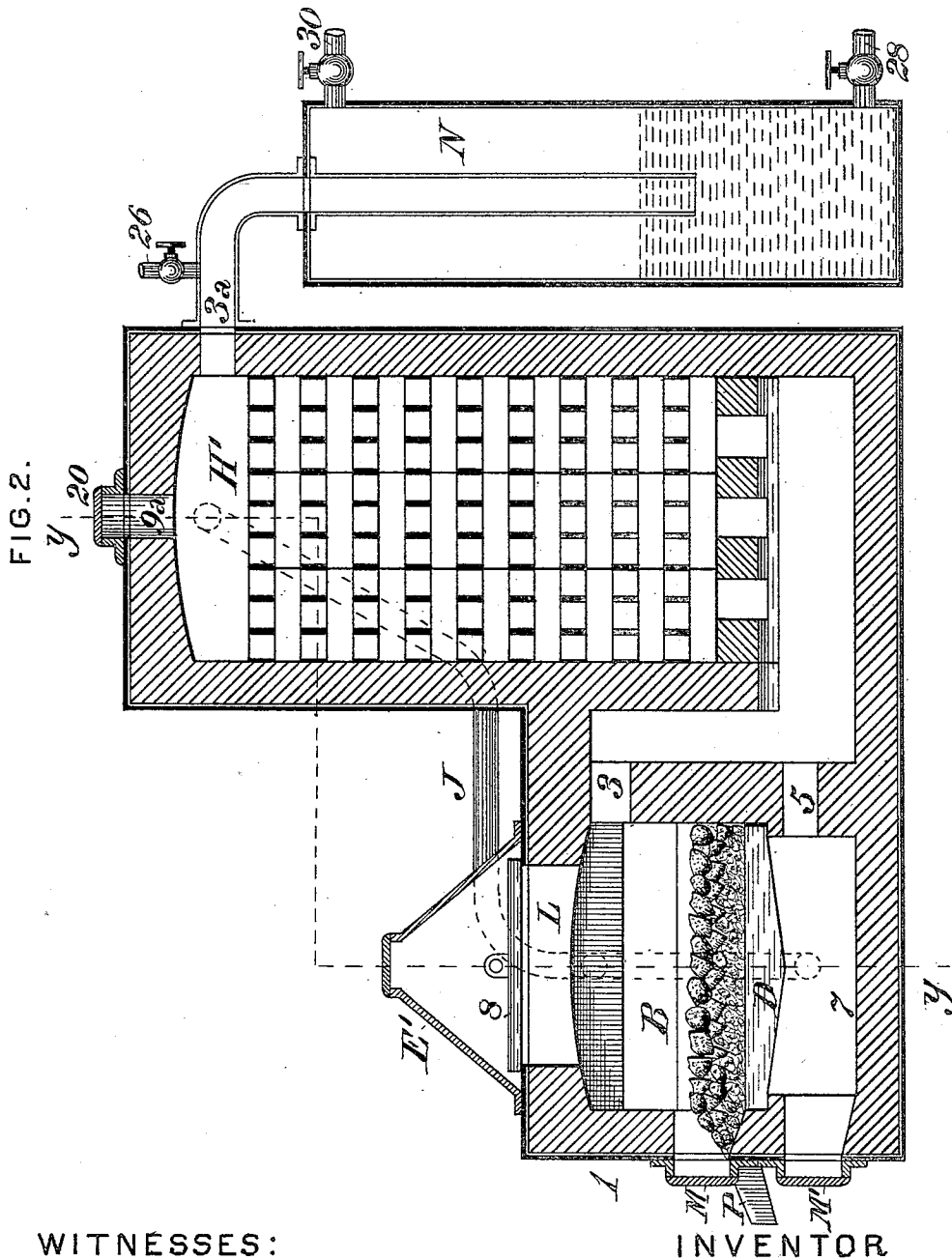
Bey "Brazelle"
by J. H. Gordon Bell
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UNITED STATES PATENT OFFICE.

BENJAMIN BRAZELLE, OF ST. LOUIS, MISSOURI.

PROCESS OF AND APPARATUS FOR SMELTING ORES.

SPECIFICATION forming part of Letters Patent No. 529,476, dated November 20, 1894.

Application filed October 6, 1892. Renewed May 15, 1894. Serial No. 511,369. (No model.)

To all whom it may concern:

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

My invention relates to the smelting of ores, and the separation therefrom of their metallic values, as gold, silver, copper, iron, lead, zinc, &c., and its object is to economize and perfect the operation by admitting of the employment of any desired description of fuel, and effecting rapid smelting and separation without previous treatment of the ore; also to provide an apparatus of such construction that the operations of smelting may be varied in accordance with the nature of the ore to be smelted, and to provide means for the convenient introduction of fuel to, and its distribution in the fuel chambers.

To this end, my invention, generally stated, consists in a novel method of and apparatus for effecting in proper relation, the operations of supplying and distributing fuel to two fuel chambers, charging ore into a hearth, blasting and burning one body of fuel, heating and smelting a body of ore, and forcing the hot products of combustion together with the vaporized portion of the ore through the other incandescent body of fuel or carbon; also in providing for forcing non-oxidizing gases, (as hydrogen, hydro carbon, or carbonic oxide) with or without chlorine gas or steam, through or onto the ore or gangue and thence through incandescent carbon.

The improvement claimed is hereinafter fully set forth.

In the accompanying drawings, which illustrate an apparatus adapted for the smelting ores in accordance with my invention: Figure 1 is a vertical longitudinal section through the apparatus at the line *y, y*, of Fig. 2; Fig. 2, a transverse section at the line *x, x*, of Fig. 1, and Fig. 3, a rear view, partly in elevation and partly in section.

For the practice of my invention I provide a furnace 1, having at its opposite ends two fuel chambers A, B, and having an intermediate ore supporting hearth C. Each fuel chamber has a refractory grate D, at bottom, below which grates ash pits 6, 7, are formed

in the furnace. Fuel charging hoppers E, E', are located over the fuel chambers A, B, and communicate with the respective chambers by throats L, formed in the crowns thereof. The throats L, L, are controlled by gridiron slide valves 8, actuated by levers 8^a. An ore charging hopper F is located above and communicates by a throat T with the furnace chamber above the ore supporting hearth C. Pipes 17, 18, controlled by valves 17^a, 18^a, and connected with a chlorine gas supply, lead into each of the fuel chambers A and B respectively. I also provide a pair of heat storage chambers H, H', separated by a vertical wall G, said chambers being filled with refractory material, as fire-brick, and provided at top with outlets 9, 9^a, controlled by valves 19, 20. A steam and gas supply pipe K leads through pipes 13 and 14, into the chambers H and H' respectively.

A pipe J on one side of the apparatus is provided with the following branch connections, to wit: an air blast pipe 15, leading to a pressure blower; a pipe 7^a leading to a gas supply, a steam supply pipe 6^a, pipes 4^a, 12^a leading into the chambers H and A respectively, and a pipe 5^a leading into the ash pit 6. A pipe I on the opposite side of the apparatus is provided with similar branch pipes, that is to say, pipes 12, 11, and 8^a, leading into the ash pit 7, and chambers B and H' respectively, and valve controlled air and steam supply pipes 16 and 10^a.

Ports 2, 3, lead out of the fuel chambers A, B, into the chambers H and H' respectively, and ports 4, 5, lead from the corresponding ash pits 6, 7, into the corresponding chambers. The chambers A, B, are provided with raking doors M, and their ash pits 6, 7, are provided with ash removing doors M'. A tap P is provided to draw off liquid metal and slag from the hearth C.

Condensers N, N', partially filled with water, are located at the backs of the chambers H, H', respectively, and are provided with water supply pipes 26, 27, discharge pipes 28, 29, gas delivery pipes 30, 31, dip or seal pipes 24, 25, and gas inlet pipes 2^a, 3^a, leading out of the chambers H and H', respectively. All of said pipes are provided with and controlled by suitable valves.

In the operation of an apparatus provided

with the above or equivalent means for the practice of my invention, the hopper F and hearth C are charged with ore, the hoppers E, E', are charged with coal, and the gridiron valves, 8, are reciprocated by means of the levers 8^a, allowing the coal to fall through the throats L into the chambers A and B, and distributing the coal evenly over the grates D, D. When smelting gold and silver ores, the ports 2, 3, in the chambers A, B, are closed, and the charge of fuel having been ignited, the valve of the water supply pipe 26, the valve of the gas delivery pipe 30 of the condenser N, and the valves of the air blast pipes 15, 4^a, 12^a, are opened. The blast of air entering the chamber H is forced downward and through the port 4 into the ash pit 6, and up through the fuel in the chamber A, burning the fuel and generating gases, which are ignited and burned by the air blast entering at the pipe 12^a. The heat thereby generated is forced through the charge of ore on the hearth C, smelting it, and vaporizing a part of the metallic values, which latter, together with the products of combustion enter the chamber B as oxides and are forced through the incandescent carbon in said chamber. The oxygen of the metallic oxides combines with the hot carbon, setting the metals free, and the carbonic acid gas is converted to carbonic oxide gas. The gas and the metallic values enter the ash pit 7, pass through the port 5, thence up through the chamber H', heating the fire-brick therein, and through the pipe 3^a to the condenser N. The separated metallic values fall to the bottom of the water, whence they may be drawn off at the pipe 28, and the gases ascend and pass out at the pipe 30, to a holder provided to store them.

As soon as the chamber H' has become heated, all open valves are closed, and the direction of the air blast is reversed by opening the valves of the pipes 27, 31, 29, of the condenser N', and the valves of the pipes 16, 8^a, 11. The blast of air entering the chamber H' is forced down through the hot fire-brick therein, and through the port 5 into the ash pit 7, up into and through the fuel in the chamber B, in which the evolved gases from the fuel are ignited and burned by the air blast entering at the pipe 11. The generated heat is forced through the ore on the hearth C, smelting it, and vaporizing a part of the metallic values, which, together with the hot products of combustion, enter the chamber A, as oxides, and are forced through the incandescent carbon in said chamber. The metal oxides are deoxidized and the carbonic acid gas converted to carbonic oxide gas. The gas and metals enter the ash pit 6, pass through the port 4, thence up through the chamber 4, heating the fire-brick therein and pass through the pipe 2^a into the condenser N'. The metals fall to the bottom and the gases ascend and pass out at the pipe 37 to the holder.

When the chamber H has become heated, and the charge of ores melted and a gangue

or slag formed, all open valves are closed, and the gangue or slag may be deoxidized and reduced as follows: The valves of the pipes 26, 30, 28 of the condenser N, and the valves of the pipes 15, 7^a, 4^a, are opened, and a blast of air and gas passes into the hot chamber H, in which it is ignited and burned, forming carbonic acid and water. The products are forced down through the heated fire-brick and highly super-heated, and thence pass through the port 4 into the ash pit 6, and up through the incandescent carbon in the chamber A, the carbonic acid being converted to carbonic oxide gas, and the water or steam being decomposed into hydrogen gas. The hot gases are forced onto or in contact with the hot gangue and slag, deoxidizing it and reducing the metallic oxides to metals. The gases enter the chamber B and are forced through the incandescent carbon into the ash pit 7, and pass through the port 5, up through the fire-brick in the chamber H', and through the pipe 3^a into the condenser N, and thence to holder. The air and gas blast valves are now closed, and if it is desired to make volatile chlorides, the valve of the pipe 17 is opened, and chlorine gas entering the chamber A, is forced onto the slag and liquid metals forming volatile chlorides, which enter the chamber B, and pass through the hot carbon into the ash pit 7, and through the port 5, up through the hot fire-brick in the chamber H', and out at the pipe 3^a, into the condenser N. All open valves are now closed, and the liquid bullion on the hearth C, and also the slag, is drawn off at the tap P. Charges of fuel are now supplied to the fuel chamber, and a charge of ore mixed with suitable fluxes is introduced onto the smelting hearth, and the valves of the pipes 27, 31, 29, of the condenser N', and the valves of the pipes 8^a, 10, 16, 11, 7^a, 12^a, are opened. The blast of air and gas entering the hot chamber H' is ignited and burned, and the products are forced down through the hot fire-brick and pass through the port 5, into the ash pit 7, and up through the fuel in the chamber B, in which the converted and evolved gases are ignited and burned by the air blast entering at the pipe 11. The resultant hot products are forced through the body of ore, smelting it and vaporizing a part of the metallic values, which, together with the gaseous products, enter the chamber A as oxides, and mingle with a gas blast entering at the pipe 12^a, which blast, by combining with the oxygen, reduces the metallic oxides to metal. The metals and gaseous products pass through the incandescent fuel, which converts the carbonic acid to carbonic oxide gas, and the steam to hydrogen. The gases and metals enter the ash pit 6, and pass through the port 4, up through the hot fire-brick in the chamber H, and thence through the pipe 2^a into the condenser N', the metals falling to the bottom and the gases passing off to the holder.

The ore having been smelted down, the slag

and matte may be deoxidized and the metallic values separated from the same in the following manner: The valves of the pipes 7^a, 12^a, 11, 16, having been closed, a non-oxidizing gas blast is passed into the chamber H', and forced down through the hot fire-brick therein. After being highly preheated, the gas blast passes through the port 5, into the ash pit 7, and up through the incandescent fuel in the chamber B. The hot gas is then forced onto the hot slag and matte on the hearth C, deoxidizing them and freeing the metals, which fall to the bottom of the hearth. The gas then enters the chamber A, and passing through the incandescent fuel therein, enters the ash pit 6, from which it passes through the port 4, up through the fire-brick in the chamber H, thence through the pipe 2^a into the condenser N', and thence to the holder. The liquid bullion and slag may be drawn from the hearth through the tap P.

When smelting lead, tin and zinc ores, the operation is preferably as follows: The ports 2, 3, in the chambers A, B, are opened and the ports 4, 5, in the ash pits 6, 7, are closed. Charges of fuel and ore having been introduced and the fuel ignited, the valves of the pipes 26, 30, 28, of the condenser N, are opened, and the outlet valve 20 and the valves of the pipes 15, 13, 4^a, 12^a, 5^a, are opened. Blasts of air and gas entering the chamber H, (steam being also admitted if desired with the gas) are ignited and burned, and the hot products are forced down through the fire-brick in the chamber H, highly heating the latter, and pass through the port 2 into the chamber A. A blast of air entering the ash pit 6, passes through the fuel in the chamber A, burning it and generating gases which are ignited and burned by the blast of air entering at the pipe 12^a. The hot products, mingling with the hot products from the chamber H, pass together through the body of ore, vaporizing and eliminating sulphur, arsenic, phosphorus, &c., and forming oxides, &c., after which they enter the chamber B, pass through the port 3 into the chamber H', and pass up through and heat the fire-brick therein and thence pass off at the outlet 9^a. The outlet valve 20 and the valve of the pipe 12^a, are then closed, and the valves of the pipes 10, 11, opened, and the combustion in the chambers H and A is increased and the charge of ore highly heated, in order to smelt it down to slag, and to vaporize a large part of the metallic values, &c. The hot products and metallic oxides enter the chamber B, in which they mingle with a blast of hydro-carbon and hydrogen gas, and together pass through the port 3 into the chamber H' and up through the hot fire-brick, the combined action of the heat and deoxidizing gases reducing the metallic oxides to metal. The reduced metals and gases pass through the pipe 3^a into the condenser N, the gases passing off to the holder and the metals collecting on the bottom, from which they are removed. The ore having been reduced to

slag, gangue, &c., the valves of the air and gas supply pipes are closed, and the valves of the pipe 6^a, and the pipe 4^a, are opened. Steam enters the chamber H, and passing down through the highly heated fire-brick, is highly superheated, after which it passes through the port 2 into the chamber A, and coming in contact with the heated silica of the slag, the silica is converted into "a light mineral wool" and thus frees part of the metallic values. When steam is brought into contact with molten silicious slag, the silica of the slag is, by the action of the steam, reduced to fiber, and forms a light woolly substance, ordinarily termed "mineral wool." This is usually produced, when desired for commercial purposes, by directing a jet or current of steam (not superheated) into a stream of molten slag, as it runs from the tap hole of an ordinary cupola, but owing to the comparatively low temperature of the steam, it chills the slag to a greater or less degree, and is not therefore entirely effective. The steam being, under my invention, highly superheated, its effectiveness, in the formation of mineral wool, is correspondingly increased.

It will be seen that the current of steam entering by the port 2 is deflected by the angular face of the top wall at the left of the throat T, and acts by its impact upon the upper surface of the molten metal on the hearth C, in forming mineral wool therefrom.

While in ordinary practice, as above stated, steam is directed upon a stream of molten slag, I have found that the production of mineral wool will also be effected by bringing superheated steam into contact with the surface of a body of smelted ore as set forth, although the fiber of the mineral wool will not be as long in this case as if contact is made with a stream of comparatively small body.

The steam blast passes through the port 3 into the chamber H' and up through the fire-brick and through the pipe 3^a into the condenser N. The steam blast may now be shut off, and the remaining slag and gangue deoxidized to free the metals, by opening the valves of the pipes 7^a, 4^a, and passing a blast of hydrogen or hydrocarbon gas into the chamber H, and down through the hot fire-brick and through the port 2 into chamber A. The hot gas blast coming into contact with the hot slag, gangue, &c., takes up the oxygen of the oxides and frees the metals, which fall to the bottom of the hearth. The gas blast passes through the port 3 into the chamber H', and up through the hot fire-brick, and thence, through the pipe 3^a to the condenser N, and therefrom to the holder. At the close of the operation the gas blast is shut off.

Should it be desired to reduce the slag, gangue, &c., by the use of chlorine gas, forming volatile chlorides, the valves of the pipes 10, 11 and 17, are opened. Chlorine gas enters the chamber A, and coming into contact with the slag, gangue, &c., volatile chlorides, &c.,

are formed, which enter the chamber B, and mingling with the gas blast entering at the pipe 11, together pass through the port 3 into the chamber H' and up through the hot fire-brick therein, the combined action of the heat and hydrogen gas reducing a part of the metallic chlorides to metal, after which they pass through the pipe 3^a into the condenser N. Any liquid metals on the hearth C, may be drawn off at the tap P.

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

1. The improvement in the process of smelting ore, which consists in deoxidizing a smelted body of ore by burning gaseous fuel with air in a chamber, forcing the hot resultant products through a body of heated fire-brick, then through a body of incandescent carbon, forcing the resultant non-oxidizing gases onto the body of hot slag or gangue, then through a second body of incandescent carbon, then through a body of hot fire-brick, and thence into a condenser, and delivering the gas to a holder, substantially as set forth.

2. The improvement in the process of smelting ore which consists in chloridizing a body of smelted ore by forcing chlorine gas onto a hot body of slag and gangue, forcing the volatile chlorides through a body of incandescent carbon, then through a body of hot fire-brick, and thence into a condenser, substantially as set forth.

3. The improvement in the process of smelting ores, which consists in burning gaseous fuel with air in a chamber, forcing the hot products of combustion through a body of hot fire-brick, then through a body of incandescent carbon, burning the gases with air and heating and smelting a body of ore, mingling the hot products of combustion and vaporized values with non-oxidizing gases, and together forcing them through a second body of incandescent carbon, then through a body of hot fire-brick, and thence into a condenser, substantially as set forth.

4. The improvement in the process of smelting ore, which consists in forcing a blast of non-oxidizing gas through a hot body of fire-brick, then through a body of incandescent carbon, then onto a body of smelted ore, then through a second body of incandescent carbon, then through a body of hot fire-brick, and thence to a condenser and holder, substantially as set forth.

5. The improvement in the process of smelting ore, which consists in burning gaseous fuel with air in a chamber with or without the admission of steam, forcing the hot products through a body of fire-brick to heat it, forcing an air blast through a body of carbonaceous fuel, burning the evolved gases with air, mingling the hot products with the products of the said gaseous fuel from said first chamber, heating a body of ore to eliminate impurities, forcing the hot products through a body of fire-brick, to heat it, and thereafter increasing the heat and smelting

the body of ore, mingling the hot products of combustion and vaporized metallic values with non-oxidizing gases, and together forcing them through a body of hot fire-brick, thence to a condenser, and the gas to a holder, substantially as set forth.

6. The improvement in the process of smelting ore, which consists in forcing steam through a body of hot fire-brick, then onto a hot body of smelted ore to convert the silica to "mineral wool" in order to free metallic values, substantially as set forth.

7. The improvement in the process of smelting ore, which consists in forcing a non-oxidizing gas through a hot body of fire-brick, then onto a hot body of smelted ore, then through a second body of hot fire-brick, and thence to a condenser and gas holder, substantially as set forth.

8. The improvement in the process of smelting ore which consists in forcing chlorine gas onto a hot body of smelted ore, in order to eliminate therefrom contained base metals or elements, as iron, zinc, lead, copper, sulphur, and arsenic, by forming volatile chlorides therewith, mingling the evolved volatile chlorides with a non-oxidizing gas, as hydrogen, and together forcing them through a body of hot fire-brick, in order to deoxidize the base metals, and delivering the base metals into a condenser, substantially as set forth.

9. In an apparatus for smelting ore, the combination, substantially as set forth, of a furnace having two fuel chambers, grates located in each of said chambers, ash pits located under each of said grates, fuel charging hoppers, having at their bases, valves controlling a series of throats leading into said fuel chambers, an ore supporting hearth located between said fuel chambers and ash pits, an ore charging hopper located above said hearth, and ports leading from said fuel chambers and ash pits into a pair of heat storage chambers.

10. In an apparatus for smelting ore, the combination, substantially as set forth, of a furnace having two fuel chambers, a lower ash pit and an upper fuel charging hopper for each fuel chamber, an ore smelting hearth interposed between and communicating with the fuel chambers, an ore charging hopper above the ore smelting hearth, a pair of heat storage chambers filled with firebrick and provided with top outlets, each of said chambers communicating with one of the fuel chambers, a pair of condensers, pipes leading from said heat storage chambers to said condensers, gas delivery pipes and water discharge pipes leading out of said condensers, air, gas, and steam supply pipes leading into each of the fuel chambers, ash pits, and heat storage chambers, and chlorine gas supply pipes leading into the fuel chambers.

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Witnesses:

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