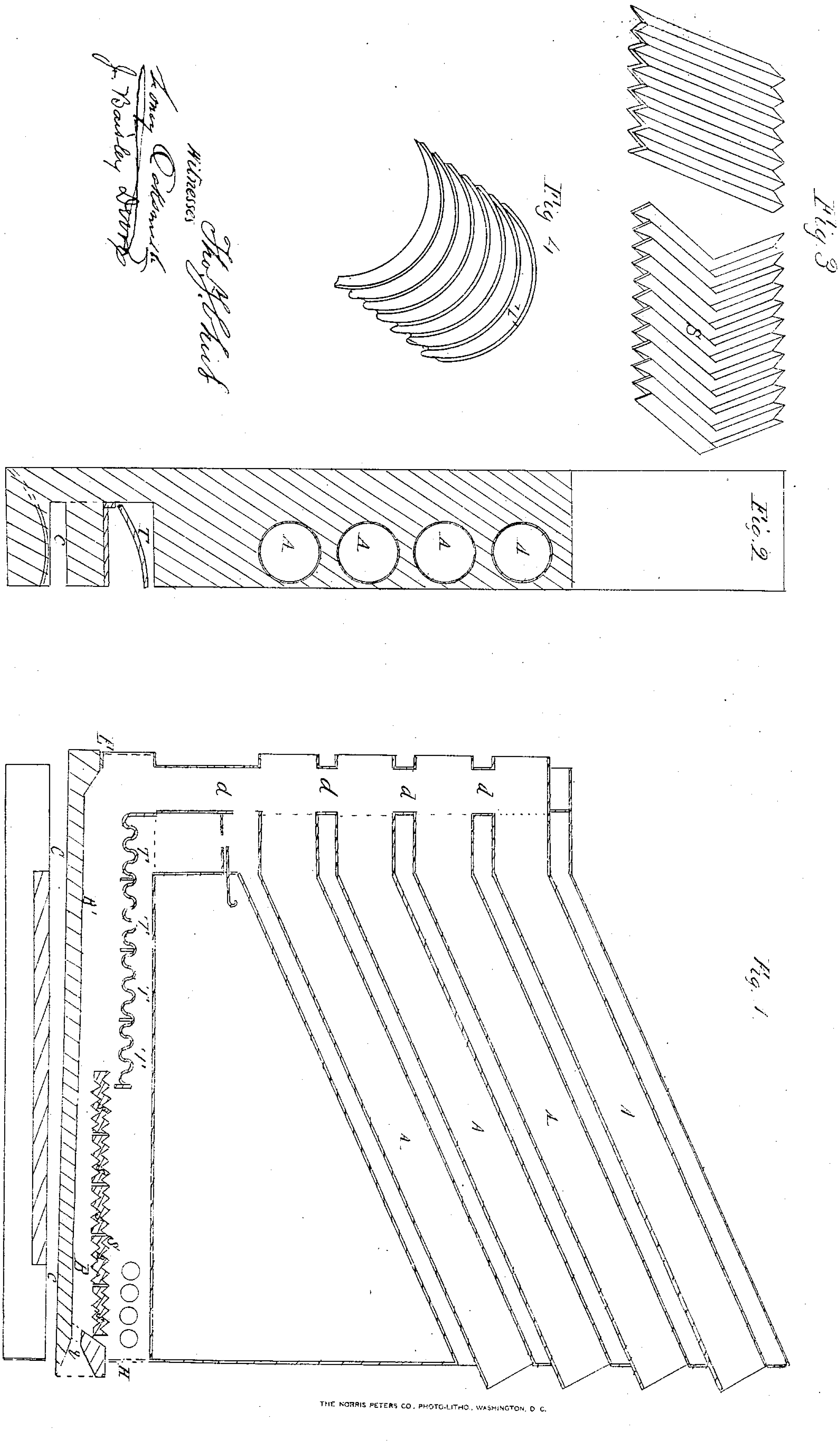
2 Sheets—Sheet 1.

T. J. CHUBB.

APPARATUS AND PROCESS FOR MAKING STEEL.

No. 79,313. **Patented June 30, 1868.**



2 Sheets—Sheet 2.

T. J. CHUBB.

APPARATUS AND PROCESS FOR MAKING STEEL.

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Fig. 6

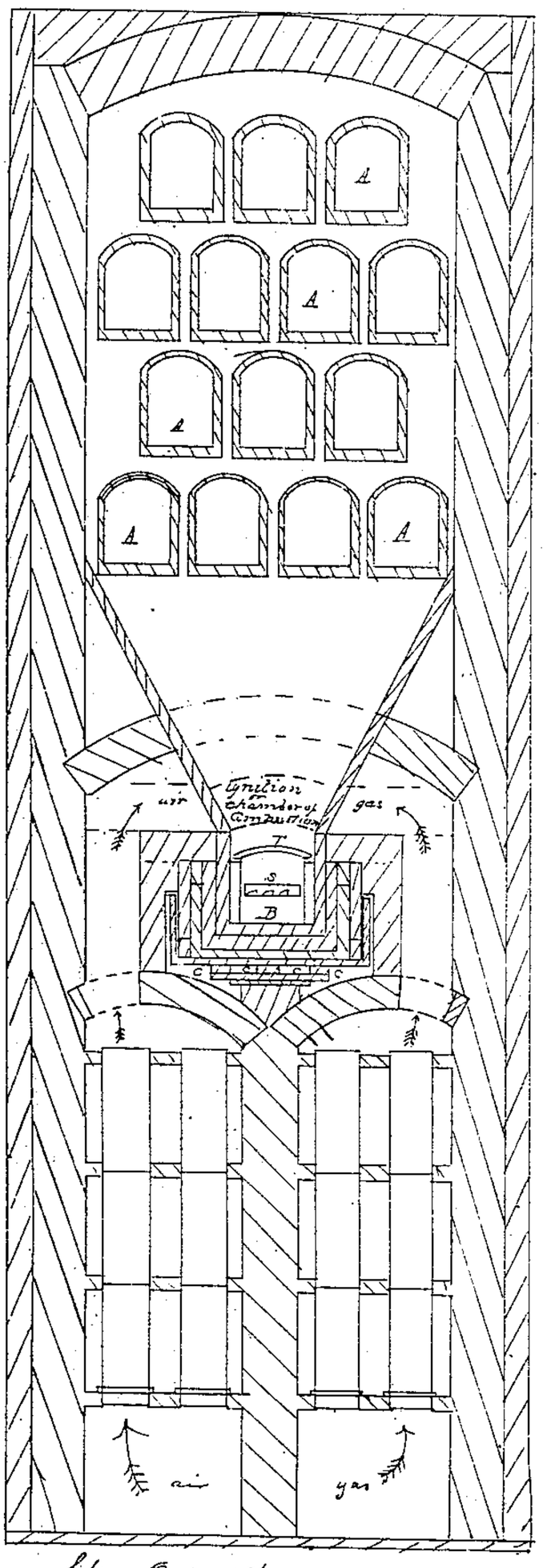
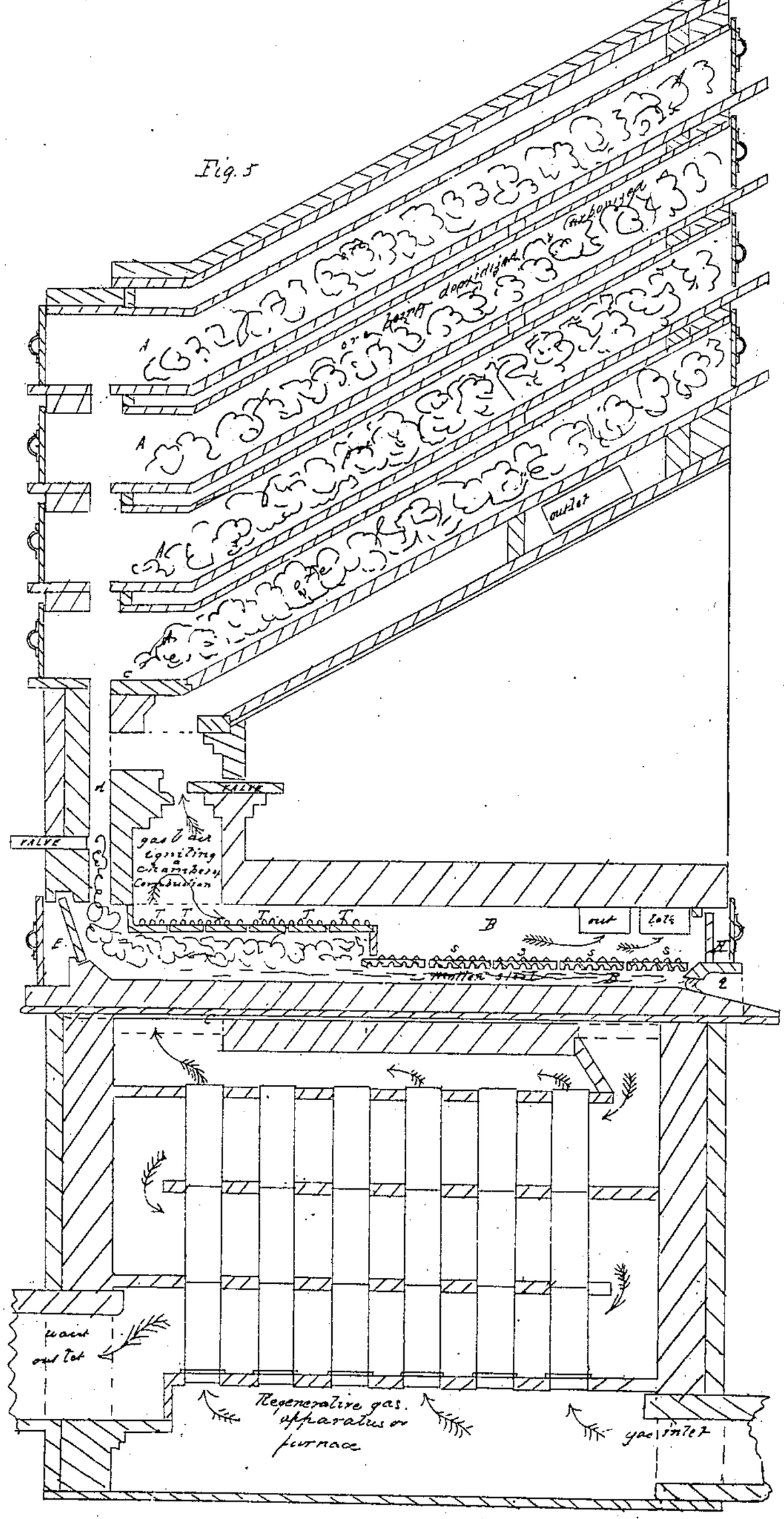


Fig. 5



Witnesses:
Sidney Oakesmith
J. Bailey Denver

Inventor:
Thos. J. Chubb.

United States Patent Office.

THOMAS J. CHUBB, OF WILLIAMSBURG, NEW YORK.

Letters Patent No. 79,313, *dated June* 30, 1868; *antedated December* 30, 1867.

IMPROVEMENT IN APPARATUS AND PROCESSES FOR MAKING STEEL.

The Schedule referred to in these Letters Patent and making part of the same.

TO ALL WHOM IT MAY CONCERN:

Be it known that I, THOMAS J. CHUBB, of Williamsburg, in the county of Kings, and State of New York, have invented new Improvements in Furnaces for Making and Melting Steel and other Metals; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 represents a vertical longitudinal section of a furnace with its several connections, including desulphurizing, deoxidizing, carbonizing, and melting-chambers.

Figure 2 is an end view of the same.

Figure 3, sheet 1, is one of the fire-shields and skimmers S, shown in figs. 1, 2, 5, and 6.

Figure 4, sheet 1, is one of the arch-bricks T, shown in figs. 1 and 2, also in figs. 5 and 6.

Figure 5, sheet 2, is a modification of the furnace, being a vertical longitudinal section, showing an air and gas-heating apparatus or regenerative-furnace for heating the same attached thereto.

Figure 6, sheet 2, is a sectional end view of fig. 5.

Similar letters of reference in all the figures indicate corresponding parts.

My invention consists—

In the construction of series of deoxidizing and carbonizing-retorts or chambers, arranged so as to prevent the gases from the (heat-producing) fuel from coming in contact with the ore in combination with and so as to discharge the ore into a melting-chamber while in a highly-heated state.

In the arrangement of a melting-chamber with openings and doors or gates at both ends, so as to facilitate the manipulation of the ore or metal under treatment from both ends.

In making provision for feeding the ore or metal at one end of the furnace, and tapping the molten metal at the other end.

In making provision for conducting heated air and gases of the fuel over the ore and molten metal, said gases entering at one side or end of the said furnace or melting-chamber, and passing out at the sides or other end.

In making provision for shielding the ore and molten metal from the direct action of the gases of the fuel by arches T.

In making provision for shielding and protecting the molten metal in the melting-chamber B, from the direct or chemical action of the air-flame or gases of the fuel, by the floating shields S.

In making provision for skimming off the surface of the molten metal by the floating skimmers S.

In arranging a chain or series of shields or scrapers or skimmers, S S S, fed in at one part of the furnace, and passing out at some other part thereof, thus producing a separation of the lighter portion of the molten mass from the heavier or lower strata, removing the upper or lighter strata to another part of or out of the melting-chambers or furnace entirely.

In the construction of a vessel or melting-chamber of a furnace, so arranged as to be sufficiently heated solely from above, when the metal and substances therein shall all be brought into a molten or liquid state previous to skimming, tapping, and drawing off the metal.

In the making provision for and melting of metal by heat applied solely from above the metal, in combination with a gas-regenerative apparatus or furnace.

In the arrangement of a furnace or a vessel or vessels in a furnace for the melting of metals, in combination with and heated by the flame produced by the mingling together of the air and gas arising from and having passed through an air-heating and gas-heating or reheating furnace, chamber, or apparatus in separate currents.

In providing for keeping the under side of the melting-chamber cool, or from melting or leaking, by the arrangement of an air-chamber or space, C, below the same.

The ore having been mixed with carbonates or other deoxidizing and carbonizing-matter, is fed into the upper ends of the retorts A A A, and the heat applied to the outside of the said retorts a sufficient length of time to thoroughly deoxidize all the ore, and carbonize it to the degree required.

The carburetted ore is raked down through openings *d*, figs. 2 and 5, falling into the melting-chamber B′. It is then pushed forward to fill the space beneath the arch T, and then the gas and air or flame are turned on, and made to flow over the ore or metal. When the ore in this chamber B′ has melted down, another charge is supplied from the retorts, until the chambers B B′ shall have become so full of molten matter as that any scum or cinder that may have formed upon the metal shall run out at the upper end E. Then more skimmers may be fed in at the lower end, through the doorway or opening H in the end of the chamber B, pushing the floats back, and adding more floating shields or scraping skimmer, until some of them pass out at the upper or other end E of the chamber B B′, and scrape out with them the upper strata or the cinder or scum upon the metal, thus separating the pure metal from the impurities. When the molten metal has been properly skimmed off and otherwise manipulated, and heated to the proper degree of heat, it may be tapped and discharged at the opening *q* into heated moulds or otherwise. A part of the molten metal should remain in the melting-chamber to assist in reducing the next charge. The operation should be continuous.

The heat to this furnace may be applied from any source. I prefer to heat the furnace by an air and gas-heating apparatus or furnace, by which a steady, high degree of heat may be obtained, without any injurious blast.

When melting of new or old bar, pig, or scrap metal, I prefer to have them in as small particles as convenient.

Small particles of metal may be fed into the upper retorts, or they may be fed into the furnace or melting-chambers B′ at opening E. Any chemicals may also be fed in with the ore or metal or metallic substances at the upper retorts, or at the openings E or H. The arch-bricks T may be used or not, at the option of the manipulator, or they may be readily taken out or replaced while the heat is on, or while the furnace is in full operation, or when destroyed by fire or otherwise, they may be replaced readily.

The fire-shields may be used or not, as they may be removed readily to allow the chemical action of the heated gas or gases, or heated or cold air to act chemically or otherwise upon the metal or other substances under treatment. Gas or gases rising from heated rosin, tar, coal-tar, coal or rock-oil, petroleum, or any carbonaceous matter, or chemical substances in the form of gas or vapors, may be thus passed over the molten metal, or brought in direct contact with the metals or ore beneath the arch T, or shields S, by removing the same at any time or during any part of the operation, or replaced, and such chemical action or actions discontinued at any time or part of the process.

The action of the heated air, gas or gases, may be regulated by valves, gates, or dampers outside the furnace. It is not essential that the upper retorts should be directly over the melting-chamber, or heated by the same means as is applied to the melting-chamber.

The arch-pieces T may be of an uneven surface on one or both sides, being ribbed, grooved, corrugated, or with hollows and projections, of any shape upon their surface, so as to give increased heat, absorbing, and conducting power from the outer or upper side to the lower or inside, and the lower or inside may also have projections, so as to conduct or radiate a greater amount of heat to the metal or material beneath it, than a plain surface would do. I prefer making them corrugated, so as to give both extended surface and increased strength, and at the same time securing a thin heat-conducting shield. The shield and scrapers S may also be of such shape as to secure all the advantages of a light floating scraper with many scraping surfaces, a thin good conductor of the heat to the metal beneath it, and an extensive heat-absorbing surface on top, thus bringing the metal in close contact with the flame or fire, without burning or exposing it to the direct action thereof, upon a principle that may be spread out to a large or extended surface, melting a large quantity of metal at one time, without the necesity of conducting the heat thereto through thick walls or expensive crucibles.

Several kinds of iron ores may be mixed with each other, such as oxides with carbonates, or iron ore with ores of other metals, such as manganese, titanium, or with carbon in any form, such as oil, rosin, tar, coal, coke, or charcoal, or with any other substance, or any proportions of each, according to the kind of ore or metal required, and thus fed into the upper ends of the retorts A A A, or into the chamber B′ direct, or the furnace or melting-chamber B′ may first be charged with pig or cast iron, and with the oxide of iron ore, or natured or partly natured iron, or with wrought iron or semi-steel, or the ore, when reduced and melted, may be charged with Frankenite iron, and wrought iron, or any highly-carbonized iron or ore, or with any other metal, such as manganese, titanium, or the ores thereof, or carbon or any other substance may be added at either end of the chamber B.

In fact this furnace is capable of converting, cementing, reducing, melting, and refining most any kind of ores, metals, or alloys thereof.

By the term cast steel, I mean iron combined with carbon and other substances, in such proportions or to such a degree that it will be crystallized, and yet be ductile or malleable, or hard and brittle, in accordance with the quantity of carbon and other substances combined with the iron, variable at the will of the manufacturer. It is cast steel so long as the molten metal can be run or cast into a mould. Iron taken out of a furnace, congealed in the form of a ball or a bloom, and squeezed, hammered, or rolled into solid metal, is not cast steel. By the term pig-iron, I mean any crude or cast iron, or iron containing a surplus of carbon, oxygen, and some silicates and impurities. By natured iron, I mean iron ore deprived of most of its carbon and impurities. By the term blister steel, is meant iron bars converted by the cementation process. Highly-carbonized ore is iron ore converted by a similar process, or found as a native carbonate of iron. Wrought iron is bar or new or old scrap-iron. Cast iron should be considered as a partly-refined pig-iron, and usually contains less carbon, although some qualities of pig-iron and old or new cast scrap-iron are all designated as cast iron.

Highly-carbonized iron is iron in any form combined with a large portion of carbon.

The heat or the heated air and gas may be applied from either end or side of the melting-chamber B B, or the part of the melting-chamber B where the ore or metal is melted, or where the igneous fusion first takes place, may be heated by separate means from the part of the chamber B where the metal is all in a fluid state.

The general arrangement of this furnace, or the several departments or parts thereof, may be varied without departing from the general principle of the invention, that is to say, so long as the ores or metals are fed into the furnace at one part and tapped or run out at another part, the scum or impurities continually pushed back from the tap-hole, thus producing a continuous refining process, as the quality of the material in the furnace is richer in pure steel as it nears the tap-hole end or part of the melting-chamber or furnace, and all the impurities are flooded or scraped back and out at the opposite side or end.

The floating shield-pieces may be made of platina, if desired, or the arch-pieces, T, and shield and scraper-pieces, S, may all be made in short lengths, and moulded out of fire-clay, plumbago, or other refractory substance, and the material composing the parts of the furnace exposed to high heat should be made of fire-clay. The lining of the melting-chamber may be made of fire-clay, soapstone, or other refractory substance.

Having described my improvements, and their application to the process and furnaces patented by me, May 21, 1867, No. 64,947, and June 4, 1867, No. 65,473.

I claim—

1. The construction of a series of deoxidizing and carbonizing-retorts or chambers, A A A, arranged so as to prevent the gases from the heat-producing fuel from coming in contact with the ore or the materials in the retort, in combination with a melting-chamber for the purposes set forth.

2. The arrangement of the melting-chamber B B′ with openings and doors at both ends, in such a manner as to facilitate the manipulation of the ore or metal under treatment from both ends, substantially as described.

3. Making provision for feeding loose ore and metallic and other substances in at one end of the melting-chamber or furnace B′, and tapping the molten metal at the other end, substantially as described.

4. Making provision for conducting heated air and gases over the ore or molten metal, said air and gases entering at one side or end of the said melting-chamber or furnace, and passing out at the sides or other end thereof, for the purpose of reducing said ore, metal, or metallic substances therein into a liquid or molten mass, substantially as described.

5. Making provision for shielding the ore, metal, and other substances from the direct action of the gases of the fuel by arches T.

6. Making provision for shielding and protecting the molten metal in a melting-chamber from the direct action of the air, flame, and gases of the fuel by floating shields, or an equivalent refractory substance or substances floating on the top of the metal, as described.

7. Making provision for skimming off the surface of molten metal by floating scrapers, or their equivalent, substantially as described.

8. Effecting a separation of the cinder or upper layer of substances floating on molten metal by the means herein specified and described.

9. The construction of a vessel or melting-chamber of a furnace, so arranged as it may be sufficiently heated solely from above, by which means the metal therein becomes fully melted into a liquid state previous to skimming, tapping, and drawing off the same, substantially as herein described.

10. Making provisions for and effecting the melting of metals by heat applied solely from above the metal, when said heat is derived from a gas-regenerative apparatus or furnace.

11. The arrangement of a furnace or of a vessel or vessels in a furnace for melting metals therein, in combination with and heated by the flame produced by the mingling together of the air and gas rising from and having passed through an air-heating and gas-heating or reheating furnace, chamber, or apparatus in separate currents.

12. Providing for keeping the under side of the melting-chamber, or chambers in which the melting-chamber or vessel is placed, cool, or from melting or leaking by the arrangement of a cold-air chamber or space below the same, C.

13. The employment of slabs or arch-pieces T T, for the purpose set forth.

14. The employment of scrapers or skimmers S S, or their equivalent, for the purpose set forth.

15. The employment of floating fire-shields and heat-conductors S S, or their equivalents, for the purpose set forth.

16. Constructing slabs, arches, and shields with an uneven or irregular surface on one or both sides thereof, for the purpose set forth.

17. The method or process of refining metals, and separating the dross and other extraneous matter from the surface of melted metal by mechanical power and appliances, or of inserting of refractive or infusible colder substances than the dross and scum, cooling and congealing them that they may be skimmed or removed from off the surface of the molten metal, substantially as set forth.

18. Making provisions in the construction of a melting-chamber of a furnace for reducing iron into such a liquid state by igneous fusion, that highly-carbonized iron ore, or pig-iron, cast iron, or steel, and natured iron ore, or wrought iron may fuse and mix with each other, and that the impurities and surplus carbon, silicon, and other matter that is not essential to the production of good cast steel, may be flooded and removed from the surface of the molten steel, refining and running the same into vessels or moulds, substantially as described.

19. Obtaining cast steel or products of any degree of malleability or ductility by melting together, in a vessel or chamber in a furnace, combinations of pig-iron and wrought iron, or of natured or partly-natured iron and cast iron, and fusing, mixing, refining, and running the same into moulds, substantially as described.

20. The production of cast steel by melting together, in a fixed or stationary melting-vessel, chamber, or furnace, cast iron and iron ore, when such iron ore has been previously reduced, or natured, or partly natured, or carbonized in a separate vessel, retort, or furnace, and when mixed with manganese or titanium, or the ores or compounds thereof, and fusing, mixing, and running the same into moulds.

21. The production of cast steel by first melting the iron or metal containing the most carbon in a stationary vessel, and adding the metal or ore containing the least carbon to the molten metal, and, when the whole is reduced to the proper consistency of cast steel, running the same into moulds.

22. Effecting a continuous process of reducing or melting and refining ores and metals by mechanical appliances, and at one heating, and in one furnace-chamber, substantially as described.

23. Effecting a continuous process of making cast steel from iron ore by submerging it into a bath of molten cast iron, or highly-carbonized iron, whereby the whole will be liquefied and brought to the consistency of cast steel, and refined and run into moulds.

THOS. J. CHUBB.

Witnesses:

FREDERICK SPECHT,

JOHN M. FLYNN.