(No Model.) 3 Sheets—Sheet 1.

J. HENDERSON.

PROCESS OF CONDENSING CERTAIN GASEOUS COMPOUNDS.

No. 283,342. Patented Aug. 14, 1883.

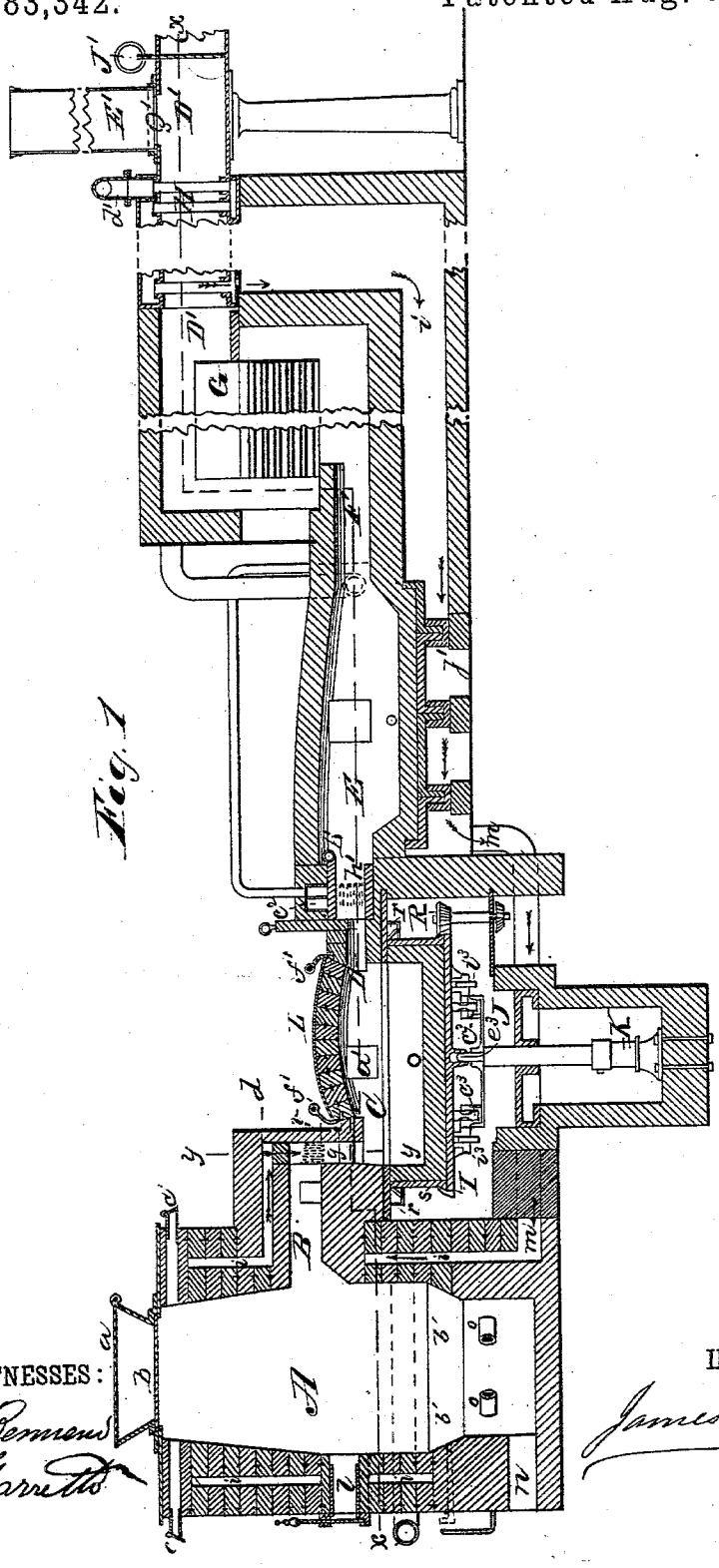


Fig. 1

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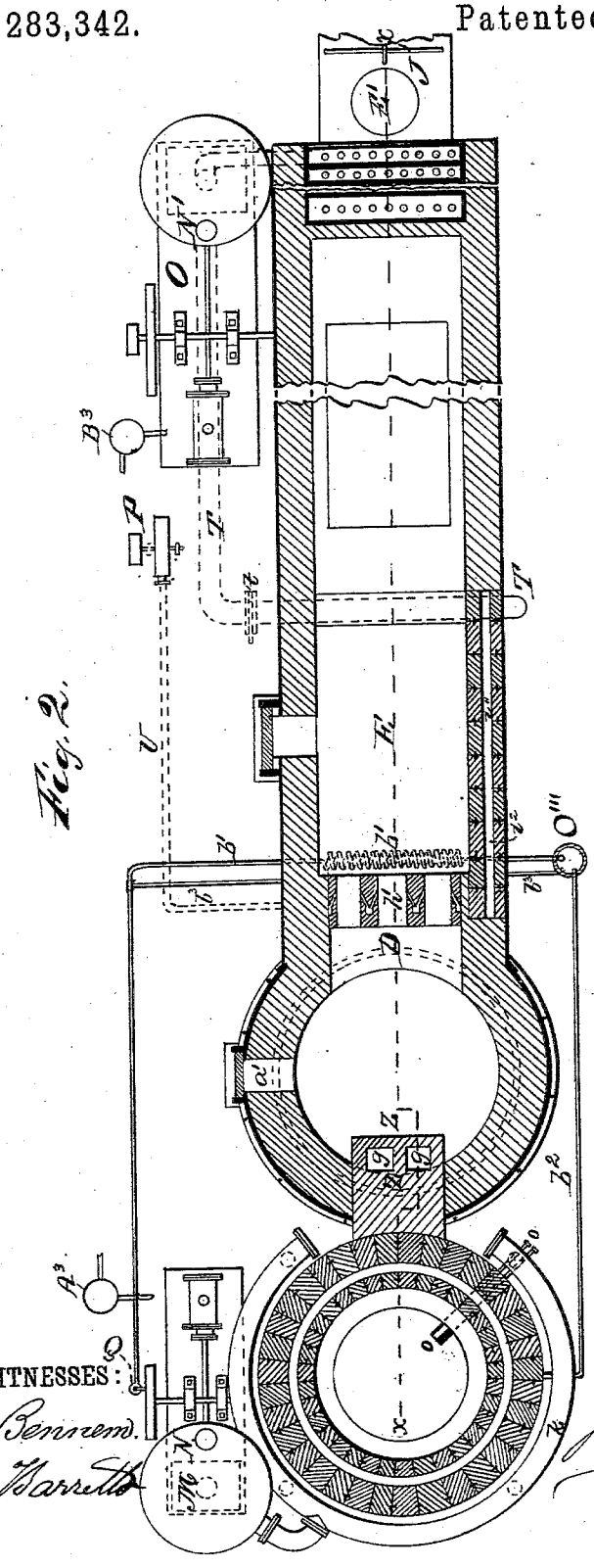
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Fig. 2.



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PROCESS OF CONDENSING CERTAIN GASEOUS COMPOUNDS.

No. 283,342. Patented Aug. 14, 1883.

Fig. 3.

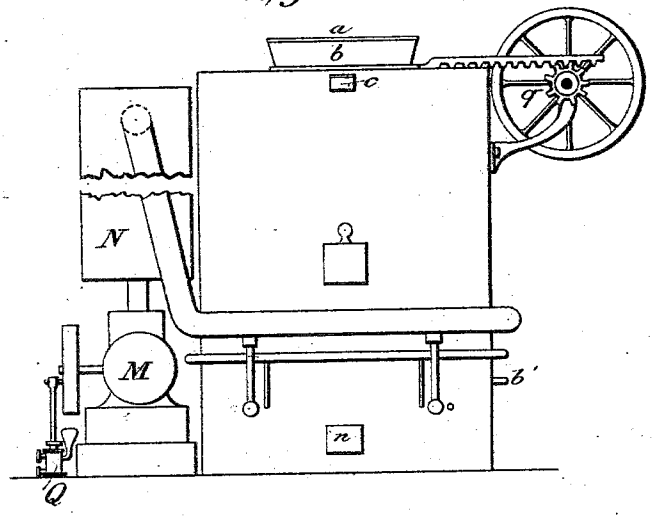


Fig. 4.

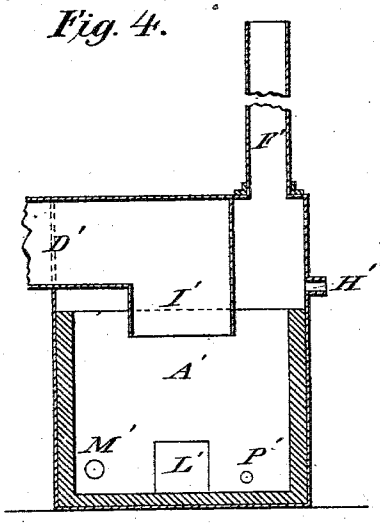


Fig. 6.

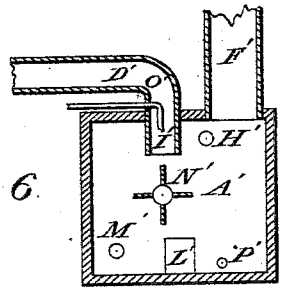


Fig. 7.

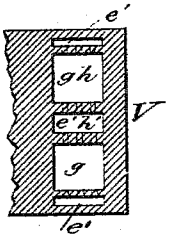
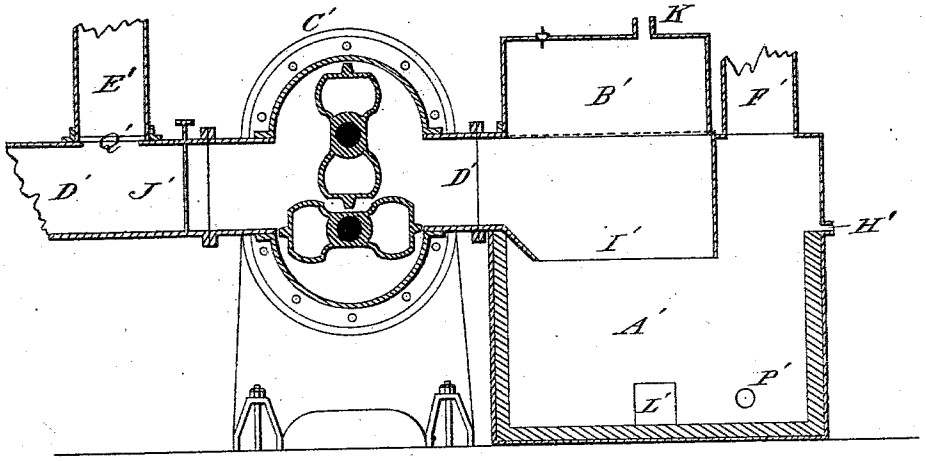


Fig. 5.



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UNITED STATES PATENT OFFICE.

JAMES HENDERSON, OF BELLEFONTE, PENNSYLVANIA.

PROCESS OF CONDENSING CERTAIN GASEOUS COMPOUNDS.

SPECIFICATION forming part of Letters Patent No. 283,342, dated August 14, 1883.

Application filed June 15, 1883. (No model.)

To all whom it may concern:

Be it known that I, JAMES HENDERSON, of Bellefonte, Pennsylvania, have invented a new and Improved Process of Condensing Certain Gaseous Compounds, of which the following is a full, clear, and exact description.

This my invention is particularly applicable to the condensation of gases arising from the purification of iron and steel, according to the processes set forth by me in Letters Patent, wherein fluorides and oxidizing agents are used; but the apparatus described may be used in connection with other processes.

The apparatus which I prefer to use in carrying on this process is represented by the accompanying drawings, in which—

Figure 1 is a longitudinal section of the furnace or apparatus for the production of steel or iron. Fig. 2 is a horizontal section on the line *x x*, Fig. 1. Fig. 3 is a front elevation of the gas-producer. Figs. 4, 5, and 6 are vertical sections of modifications of condensers used in connection with the furnace in condensing the gases produced in the furnace. Fig. 7 is a plan at the exit of the flue B on the line *z z*, Fig. 2.

The gas-producer A is of the ordinary construction, and in it gases are generated and fed through the outlet B into a reverberatory furnace, C, where the metal or other articles to be treated are placed. From the reverberatory furnace C the gases pass through the outlet D to a second heating-chamber, E, and thence to the chamber F beneath the multitubular boiler G, and through the tubes thereof to the space above it, thence through the air-heating apparatus and surface-condenser H, and thence through the passage D′ to the condenser A′, where the condensable matters are condensed and the non-condensable gases pass off by the chimney F′ to the outer air.

It is designed that the fuel-chamber of the gas-producer shall at all times when working be charged with fuel to the top. Light fuel or kindling is inserted near the bottom through *n* and ignited, and a blast of air from the receiver N and blast-machine M is applied through the tuyeres *o o*.

About one foot above the air-tuyeres is arranged one or more tuyeres, *b′*, in the gas-producer, connected by suitable pipes with a steam-supply, so that steam shall be thereby delivered to the gas-producer.

The air and steam delivered by the tuyeres *o* and *b′*, respectively, to the fuel in the producer unites with the carbon of the fuel, producing carbonic oxide, hydrogen, and hydrocarbon gases. These mixed gases escape through the outlet-flue B to the small flues *g g*, where they are admixed with air issuing from the tuyeres *h*, connected with the channels *e′ e′*, so that the combustion takes place in the small flues *g g*. The air for burning the gases is supplied by the blast-machine O through the air-receiver N′.

The steam supplied through the tuyeres *b′* is fed by a small pump or cylinder, with a piston attached by a piston-rod and crank-pin, to the blast-engine M, so that a certain proportion of water or steam is fed to any amount of air that may be fed by the blower attached to engine M, so that the air and steam supplied by the gas-producer insure such proportion as will not reduce the temperature of the producer enough to produce carbonic acid, where carbonic oxide would be otherwise produced above the steam-inlet if steam were not used.

Enough air additional to that required to combine with the combustible gases of the fuel is supplied from the blast-machine O to burn the hydrogen and carbonic oxide obtained by the decomposition of the steam on the incandescent fuel.

The pump Q may be used to force steam into the producer, or it may force water through the iron coil *b′* in the chamber E, where it is converted into steam, and thence forced into the producer; or, when steam is forced by the pump Q, it may pass through the coil *b′* and become thereby highly superheated. It is preferred to use a steam-separator, O‴, to take all water out of the steam.

The air-heating apparatus and surface-condenser shown at H, Figs. 1 and 2, consist of vertical wrought-iron pipes, connecting with upper chambers, and with lower chambers, through which the air passes out. These pipes are of sufficient number and area to absorb the heat in the gases after leaving the flues above

the boiler—say from 350° to 400° Fahrenheit—to the temperature of the outside atmosphere, or thereabout.

The air enters, as shown, at the part farthest from the boiler, and leaves the apparatus at the point nearest the boiler, so that the current of air in the heater passes in the opposite direction to the gases passing from over the boiler, and the gases are condensed by cooling on the surface.

I do not claim any particular kind of air-heating apparatus or surface-condenser, as there are many kinds used for heating air and condensing vapor, many of which are suitable.

The hearth of the furnace in the chamber C is mounted on a table and placed under the center of the chamber. This table is mounted on a hydraulic ram, by which it may be raised and lowered.

The mode of operation, when fluorides are used in purifying iron in this apparatus, is as follows: The hearth is preferably covered with a mixture of fluor-spar or other suitable fluoride in admixture with iron ore or other suitable oxidizing agent, and molten iron is either poured in upon them, or pig metal is melted on them, whereupon chemical reactions take place between the silicon, sulphur, phosphorus, and carbon in the iron and the reagents, which cause gases containing silicon and phosphorus to be evolved. The fluorides of phosphorus and fluorides of silicon combine with the watery vapor arising from the combustion of the hydrogen in the flues of the furnace, or from steam introduced in the gases. The gaseous fluorides are condensed on the surface-condenser or air-heating apparatus H, hereinbefore described. The condensable compounds (not including carbonic acid) formed by the reduction of the fuel to gases and burning them with air are condensed upon the surface-condensers, or by being forced into the tank-condensers, (shown in Figs. 4, 5, and 6,) and may be recovered therefrom.

Steam may be introduced into the gases evolved in the furnace-hearth as they are leaving the furnace at the neck D in the flues *h'*, as well as in the gas-producer, as above described, or steam may be introduced at this point instead of in the gas-producer; but I prefer to introduce it in the gas-producer, as the action of the gases on the metal treated is more satisfactory.

From the surface-condenser or air-heating apparatus H the gases which may not have been condensed therein are passed through the flues D' to the water-condenser, where the remaining condensable gases (excepting carbonic acid) are condensed by being brought in contact with cool water.

The damper J' and valve Q' are arranged in the flue D' and chimney E', respectively, so that when J' is closed Q' may be opened, and the gases thus allowed to pass direct to the chimney without going through the water or tank condenser.

The opening M', Figs. 4 and 6, is for the supply of water to the tank, and H' is a discharge-pipe for overflow. Liquid by-products may be drawn off through P', and the solid products taken out through L', Figs. 4, 5, and 6. The non-condensable gases escape by the chimney F'.

The blower C', Fig. 5, is placed in flue D', and draws the gases from the furnace and forces them under the water of the condenser.

The water-tank B', Fig. 5, has small fine holes perforated through the bottom, through which water is sprayed among the gases passing into the condenser. The water is supplied through pipe K', Fig. 5.

O', Fig. 6, is a steam-jet placed in flue D' to exhaust the gases from the furnace and force them into the water in the condenser.

N', Fig. 6, is a stirrer to stir the contents of the condenser during the operation of condensing and prevent clogging. It consists of a shaft through the sides and across the tank, having blades or vanes in the tank and a pulley outside, by which it may be driven.

The condensers are preferably made of wood and lined with lead. They may be made of iron and lined with silicious material. The condensers should be discharged between each operation or "heat."

I may carry on the processes hereinbefore described with a Bessemer converter, wherein iron and steel are purified by the use of a fluoride and oxidizing agent, which may be introduced into the converter either with the blast or thrown on the bottom. The action of the air and reagents on the impurities of the metal produce gaseous compounds, which pass away from the converter, and into these gases is introduced a steam-jet, which is condensed with the gases on the surface-condenser or air-heating apparatus, and further condensed by being forced into a water or tank condenser.

I prefer to use the apparatus described herein and in application No. 37,559, wherein steam is introduced into the gas-producer and becomes decomposed into fuel-gases, which are used in the furnace; but steam may be introduced into the resulting gases after they leave the furnace with good effect.

In purifying iron and steel by the use of a fluoride and oxidizing agent in a Bessemer converter the fluorides introduced into the converter either with the blast or thrown on the bottom, and the action of the air and impurities of the iron on the fluoride, produces gaseous compounds, which pass away from the converter, which compounds form chemical combinations with the watery vapor introduced therein after they leave the converter. The gases thus produced are preferably conveyed to a steam-boiler to cool the gases, and thence to surface-condensers formed of metal tubes, for the circulation of cool air or water therein, and are condensed thereon.

The steam used in the gas-producer produces hydrogen therein, and this or the hydro-

gen of the fuel, or both, upon combustion with air, produce watery vapor, which combines with the fluorides of silicon or phosphorus.

When a surface-condenser is used, the condensed compounds are of much greater strength than when water-condensers are used.

The pipes of the surface-condensers are preferably made of lead when hydrofluoric compounds are produced, and the temperatures to which the pipes are exposed do not reach the fusion-point of lead.

When fluorides and oxides are used upon an open hearth, wherein the fuel used contains hydrogen, either from the coal or introduced as steam in the producer, gaseous compounds are formed, which are condensed upon the cool surface of the surface-condensers. Where there is not enough hydrogen in the fuel used to absorb these gases, steam may be introduced in the neck of the furnace and mingled with them.

I do not claim, broadly, the condensation of the gases produced from fluorides and oxidizing agents in the purification of iron when the gases so produced are condensed with water, as the same is already patented to me by Letters Patent of June 26, 1883.

What I claim as new, and desire to secure by Letters Patent, is—

1. The process of refining iron or steel by the action of fluorides and recovering the condensable gaseous products thereof, consisting of subjecting the molten metal to the combined action of a fluoride and oxidizing agent in the presence of steam or watery vapor, and condensing the resulting compounds on surface-condensers, as specified and set forth.

2. The process of refining iron or steel by the action of fluorides and recovering the condensable gaseous products thereof, consisting of subjecting the molten metal to the combined action of a fluoride and an oxidizing agent, and introducing therein steam or watery vapor, and condensing the resulting compounds on surface-condensers, as specified and set forth.

JAMES HENDERSON.

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JOHN E. ELMENDORF.