(No Model.)

J. REESE.

Process of and Apparatus for Regenerating and Utilizing the Waste Gases of Metallurgical Furnaces.

No. 240,844. **Patented May 3, 1881.**

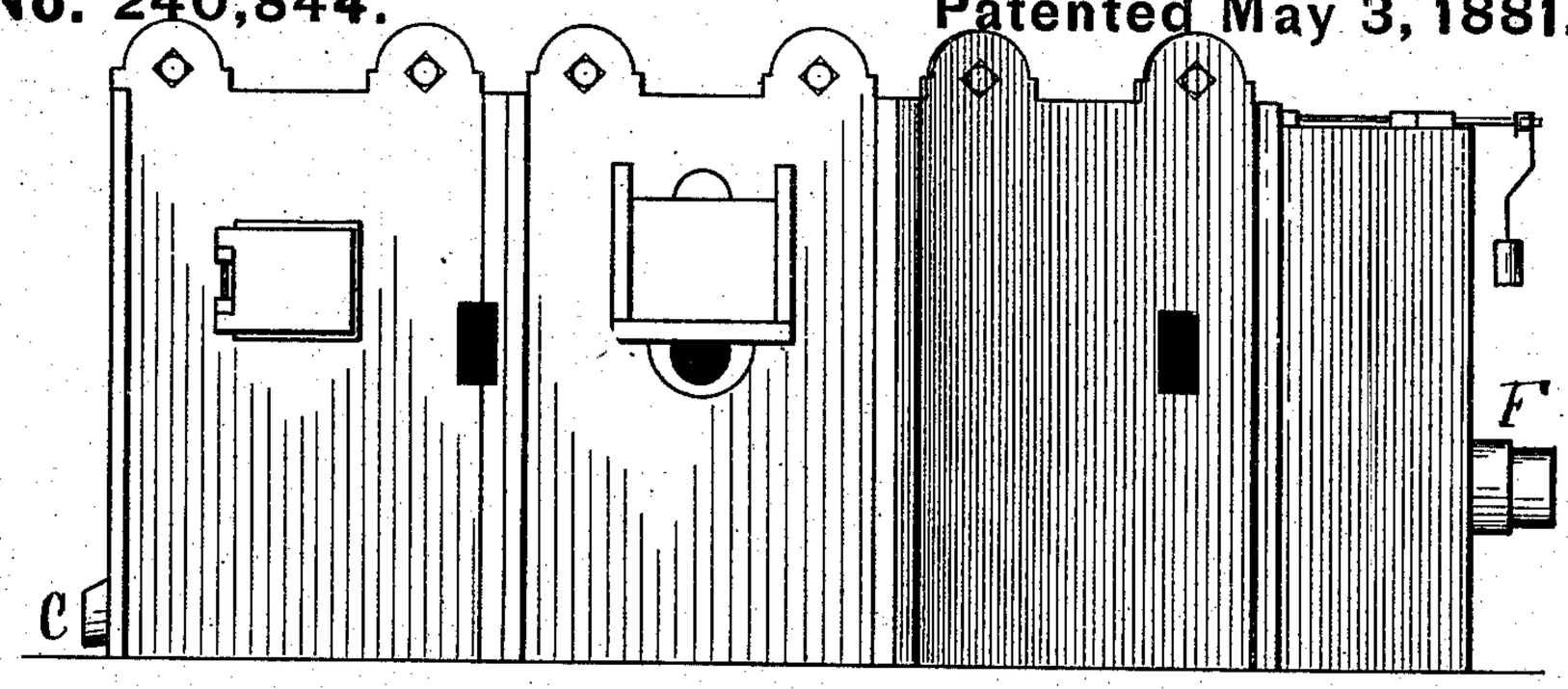

Fig. 1.

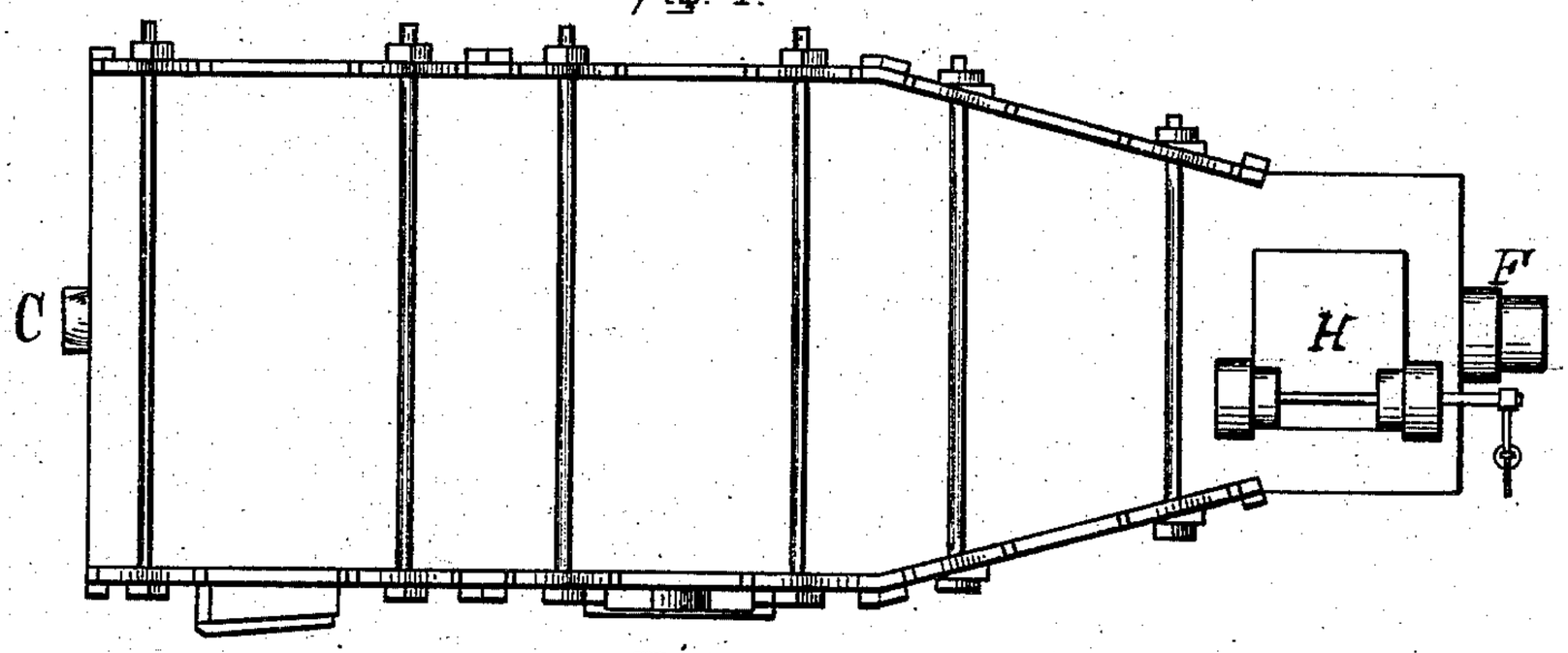

Fig. 2.

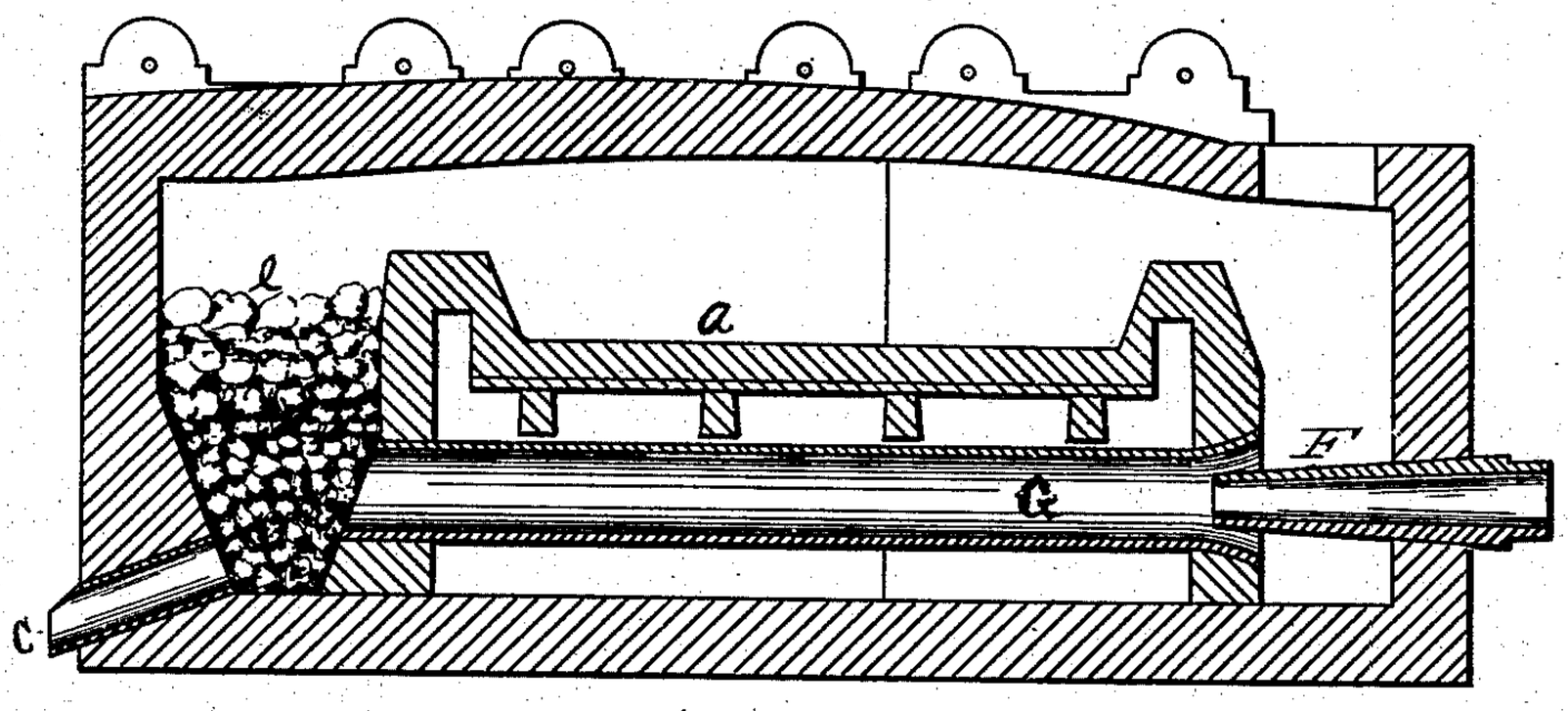

Fig. 3.

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PROCESS OF AND APPARATUS FOR REGENERATING AND UTILIZING THE WASTE GASES OF METALLURGICAL FURNACES.

SPECIFICATION forming part of Letters Patent No. 240,844, dated May 3, 1881.

Application filed March 11, 1880. (No model.)

To all whom it may concern:

Be it known that I, JACOB REESE, of the city of Pittsburg, county of Allegheny, and State of Pennsylvania, have invented a new and useful Improvement in Regenerating and Utilizing the Waste Gases of Puddling, Heating, and other Metallurgical Furnaces; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings, in which—

Figure 1 indicates a side elevation of a puddling-furnace embodying my improvement. Fig. 2 is a ground plan of the same. Fig. 3 is a longitudinal vertical section of the same.

Like letters refer to like parts wherever they occur.

In the practice of the ordinary puddling, heating, and other metallurgical furnaces, an enormous waste of heat and fuel takes place. In the ordinary metallurgical furnaces only about ten per cent. of the heat-units of the fuel is utilized, about fifteen per cent. being lost by radiation and seventy-five per cent. passing up the flue or stack. This latter waste is due to the fact that it is necessary to keep up a rapid circulation of the heated air and products of combustion, and as the flame passes quickly over the working-chamber its effects are utilized only for a very short time. However, by the application of blast and the form of fire-chambers set forth in Letters Patent granted to me on the 5th day of February, 1861, I have found that a more perfect combustion could be secured, lessening the amount of fuel employed about twenty-five per cent. to the ton of manufactured iron, and that by the adoption of the improvement set forth in Letters Patent No. 45,343, granted to me on the 6th day of December, 1864, a still further saving could be effected by utilizing a portion of the waste gases, amounting to fifty per cent. over the ordinary furnace. In operation, however, both of the improvements developed serious defects. In the first it was found that the introduction of the cold-blast caused the slag to chill as it formed, and therefore prevented its practical operation; and in the second the great heat of the flame and gas by expansion and contraction soon warped the fan and its mechanism to an extent that prevented its operation. Therefore, though in each of the preceding cases a great saving of fuel was effected during the limited time either could be maintained in practical operation, still the improvements have remained inoperative and useless.

The object of my present invention is to remedy the defects to which I have referred, to utilize more fully the waste gases and products of combustion, and to do away with the costly stacks at present used for puddling, heating, and other metallurgical furnaces.

To this end my invention consists, mainly, in the method of regenerating and utilizing the waste gases of metallurgical furnaces—viz., first, oxidizing or causing the combustion of said gases after they leave the working chamber or hearth and before they reach the fuel-chamber; secondly, passing the carbonic acid and other products of combustion through a mass of fuel contained in a closed chamber and undergoing slow combustion, in order to regenerate the same or reduce the carbonic acid to carbonic oxide; and, finally, conducting the hot carbonic oxide and other gases thence to the working-chamber, whereby loss both of fuel and metal is prevented.

It consists, secondly, in furnaces adapted to the carrying out of such method—viz., a furnace provided with, first, a metal-working chamber and waste-gas flue leading therefrom to a combustion-chamber; secondly, a combustion-chamber provided with a tuyere or air-injector, for introducing air to induce combustion and circulation of the waste gases; and, thirdly, a closed fuel-chamber interposed between the combustion-chamber and the working chamber or hearth, whereby the gases may be regenerated or the carbonic acid converted into carbonic oxide before reaching the working-chamber.

It consists, finally, in specific combinations and arrangements of the elements, as hereinafter more fully set forth.

I will now proceed to describe my invention as applied to puddling-furnaces, though it is not confined thereto, but is applicable to various metallurgical operations.

By an inspection of the drawings it will be readily seen that I make a radical departure in the form of construction of the furnace, in that the ordinary stack is dispensed with. This

is done because I intend to have little, if any, waste products of combustion, and therefore its presence is unnecessary.

In Fig. 3, *a* indicates the working-chamber of the furnace.

e indicates the fire (fuel) chamber, which is substantially the same as shown in the patents hereinbefore referred to. Below the level of the working-chamber the diameter of the fire-chamber is gradually reduced, the sides sloping toward each other. No grate-bars are used, and the bottom of the chamber is closed. An aperture, *c*, at or near the bottom, allows the melted clinker to run from the furnace as fast as it accumulates in the bottom of the fire-chamber.

F indicates a blast-tuyere extending through the furnace-flue, its end projecting into the flared mouth of a blast-flue, G, which extends under the working-chamber *a* from the flue to the fire-chamber of the furnace.

H indicates a damper over a flue at the forward portion of the furnace-roof. This damper is adjusted by a spring, weight, or other suitable means, so that it may open when a plenum of gases exists in the furnace, and close when the pressure is relieved. A tight sheet-iron chimney may be provided over this flue, to carry off such excess of gases, if desired.

The operation of my invention is as follows: A fire is kindled in the fuel or fire chamber, and the smoke and products of combustion ascend and begin to fill the upper portion of the furnace. The damper is then closed to confine the smoke and gases in the furnace, and blast is admitted through the tuyere into the conduit, causing a partial vacuum at its mouth and drawing the air, smoke, and gases down from the upper portion of the furnace to supply the deficiency. The smoke and gases rush into the conduit and are driven by the blast into and through the fuel in the fire-chamber, and again pass upward into the furnace, over the metal or working chamber, and down again into the conduit, where they are supplied with fresh oxygen and forced back into and through the fire in the fire-chamber, so that a constant circulation is obtained from the fuel-chamber to the forward part of the furnace, and from the forward part of the furnace, through the conduit, into and through the fuel or fire chamber. As soon as the temperature of the smoke and products of combustion is raised to a sufficient degree, the oxygen of the blast unites rapidly with them, and combustion takes place in the conduit, a high temperature forming CO_2, which is forced into and through the fuel in the fire-chamber and reduced to CO, which passes over the metal chamber and down again into the conduit, where it is provided with a fresh supply of oxygen, again forming carbonic acid, which is again recarburized and changed to carbonic oxide as it is forced through the fuel in the fire-chamber, and this operation is repeated until all the heat not lost by radiation or by escaping through apertures in the sides or roof of the furnace is utilized.

In ordinary metallurgical furnaces the fuel-chamber is the only place where combustion takes place, and in cases where combustion takes place over the metal or working chamber carbonic acid is formed, which rapidly wastes the metal; but in the operation of my invention I produce carbonic oxide in the fuel-chamber, and after utilizing it in the metal-working chamber I supply the gas with oxygen and produce carbonic acid, thus developing a maximum amount of caloric, and then force it into and through the fuel, producing the quality and temperature of gas required in the metal-working chamber.

A distinguishing characteristic of this system of developing caloric from fuel is that combustion proper, in which the efficient caloric is developed, does not take place either in the fuel or over the metal chamber, the fuel or fire chamber being really a reducing-chamber for reducing the carbonic acid to carbonic oxide, no effective heat being developed there; or, in other words, the effective heat is developed in the conduit in the production of carbonic acid. When an oxidizing flame is required the amount of blast is increased, or the depth of fuel in the fire-chamber may be diminshed. When a carburizing flame at a medium temperature is desired the depth of the fuel should be increased and the quantity of blast decreased, so as to produce CO, and if carbonic oxide and some free carbon is required the amount of the blast should still further be reduced and some fresh coal put upon the fire. In any case care must be taken not to blow any more air into the furnace than is required to produce the required quality of gas and to supply the depletion of the same.

The advantages of my invention are, first, it dispenses with the ordinary stack, saving from $200 to $300 in first cost, and lessening repairs to the furnace; secondly, by the use of my invention a plenum or a pressure of the gases is obtained in the furnace which exceeds the external pressure of the air, and consequently the indraft of air through crevices at the door, sides, or roof of the furnace, and waste of the metal is largely prevented.

I am aware that furnaces have heretofore been so constructed that the gases and products of combustion from the working-chamber and stack were conducted back into the fire-chamber above the incandescent fuel; but this resulted in its conversion into carbonic acid, in which condition it passed over the metal in the working-chamber, inducing oxidation or waste of metal. I am also aware that the gases and products of combustion have been drawn from the working-chamber and stack mingled with air or steam, or both, and said admixture forced into the incandescent fuel in the fire-chamber and consumed therein; but such method results in waste of fuel and the production of carbonic acid; and I am also aware that the waste gases from the top of a blast-furnace have been conducted to the tuyeres and consumed in the hearth of the

stack, and this is, in a measure, the same in effect as that last referred to. Therefore I do not claim either of the foregoing methods of utilizing the waste products of combustion; but,

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

1. The method herein described of utilizing and regenerating the waste gases of metallurgical furnaces, the same consisting, essentially, in the following steps: first, supplying a sufficient volume of air thereto to oxidize the same after they leave the working-chamber, and to cause the complete combustion of the waste gases before they reach the fuel-chamber; secondly, passing the carbonic acid and other products of said combustion through a mass of fuel undergoing slow combustion in a closed chamber, in order to regenerate said products or reduce the carbonic acid to carbonic oxide, and thence conducting the highly-heated gases thus obtained through the metal-working chamber, the circulation being continuously maintained, substantially as and for the purpose specified.

2. The combination, in a metallurgic furnace, of the following elements: first, a metal-working chamber and flue leading therefrom to a combustion-chamber; secondly, a conduit or combustion-chamber provided with an air-injector or tuyere of such capacity as to supply sufficient air to insure complete combustion, and connecting with the waste-gas flue of the metal-working chamber; and, thirdly, a closed fuel-chamber interposed between the conduit or combustion chamber and the metal-working chamber, and connecting with both, the several elements relatively arranged as specified, and adapted to operate substantially as specified.

3. In a metallurgic heating or puddling furnace having a working-chamber and a waste-gas flue leading to a combustion-chamber, a relief-pressure valve or damper arranged in the waste-gas flue, and in combination with the metal-working and combustion chamber, substantially as and for the purpose specified.

4. In a metallurgic furnace, the combination of the metal-working chamber *a*, the waste-product flue leading therefrom to the conduit or combustion chamber G, and provided with the weighted valve or damper H, the conduit or combustion chamber G, arranged below and beneath the metal-working chamber *a*, and provided with air-injector or tuyere F, and the closed fuel-chamber *e*, interposed between the combustion-chamber and the metal-working chamber, substantially as and for the purpose specified.

In testimony whereof I have hereunto set my hand this 24th day of March, 1881.

JACOB REESE.

Witnesses:

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