3 Sheets—Sheet 1.

W. L. McNAIR.

Open Hearth Furnace.

No. 229,443. Patented June 29, 1880.

Fig. 1.

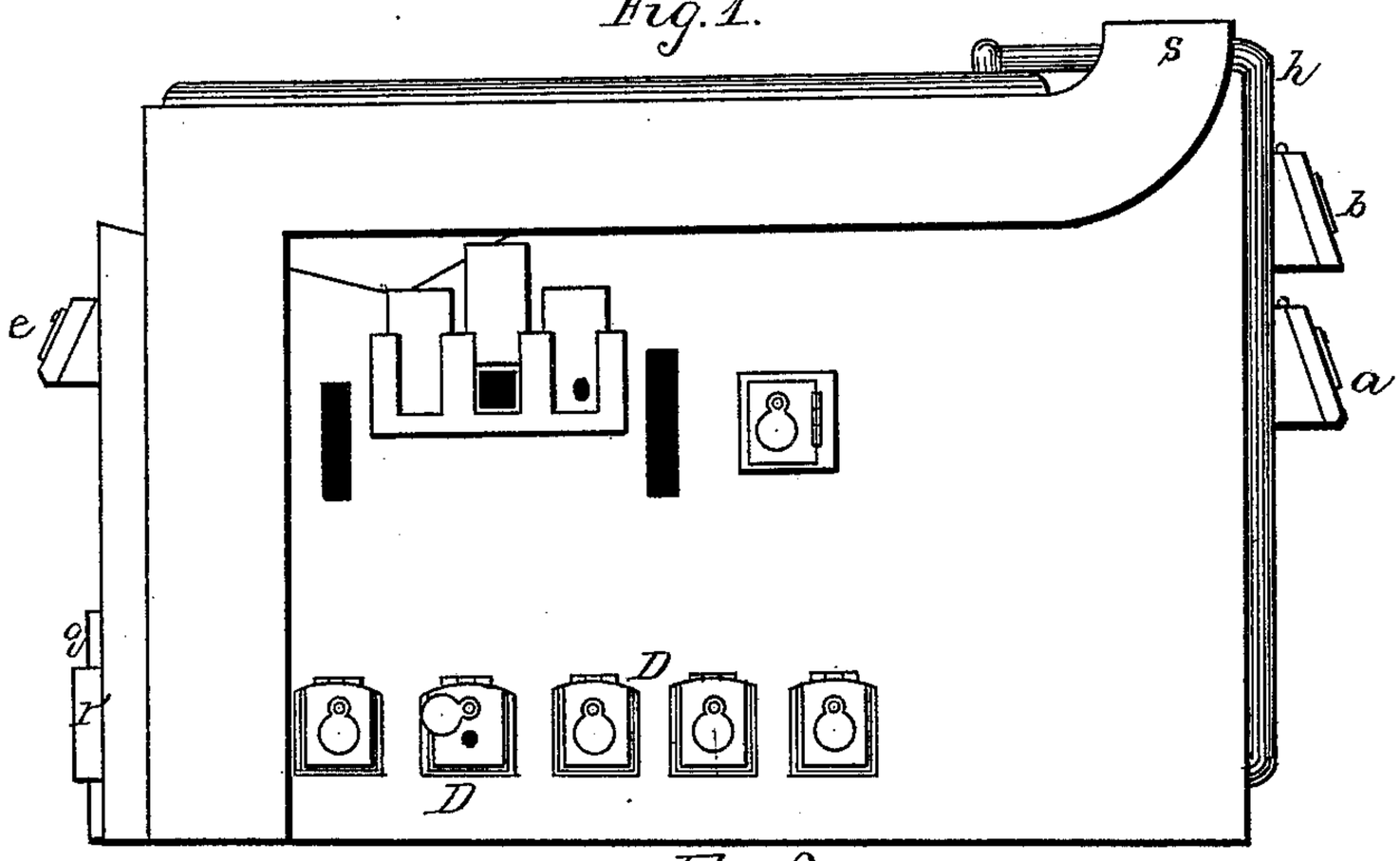


Fig. 2.

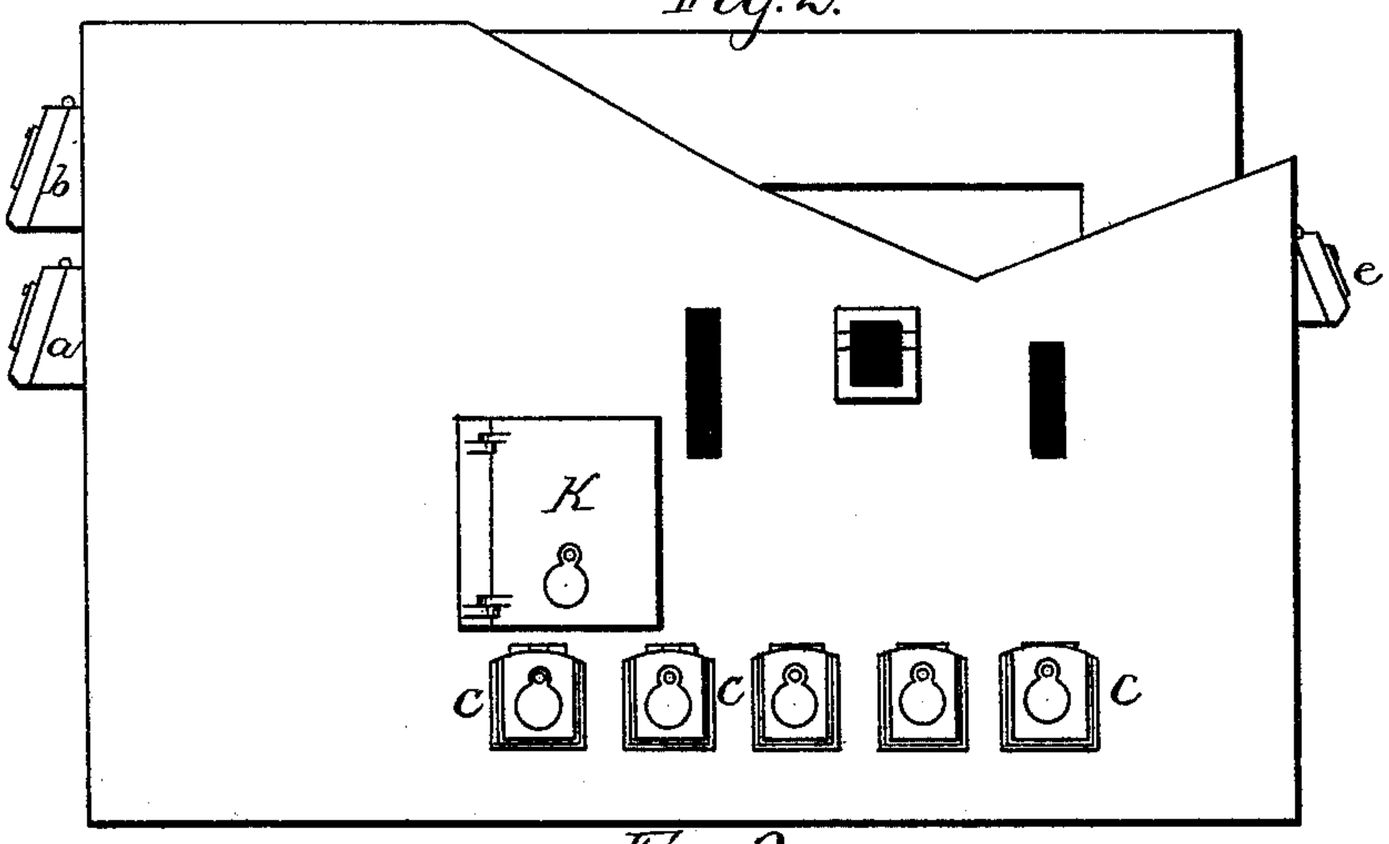
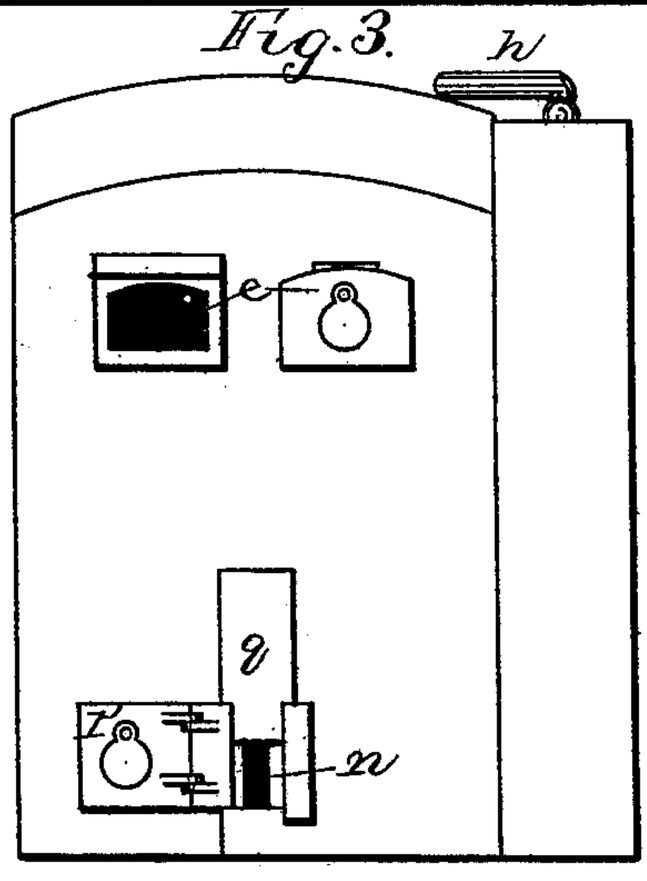


Fig. 3.



Witnesses:

J. W. Garner Jr.

W. L. D. Haines

Inventor:

W. L. McNair,

per

F. A. Lehmann,

atty.

3 Sheets—Sheet 2.

W. L. McNAIR.

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Fig. 4.

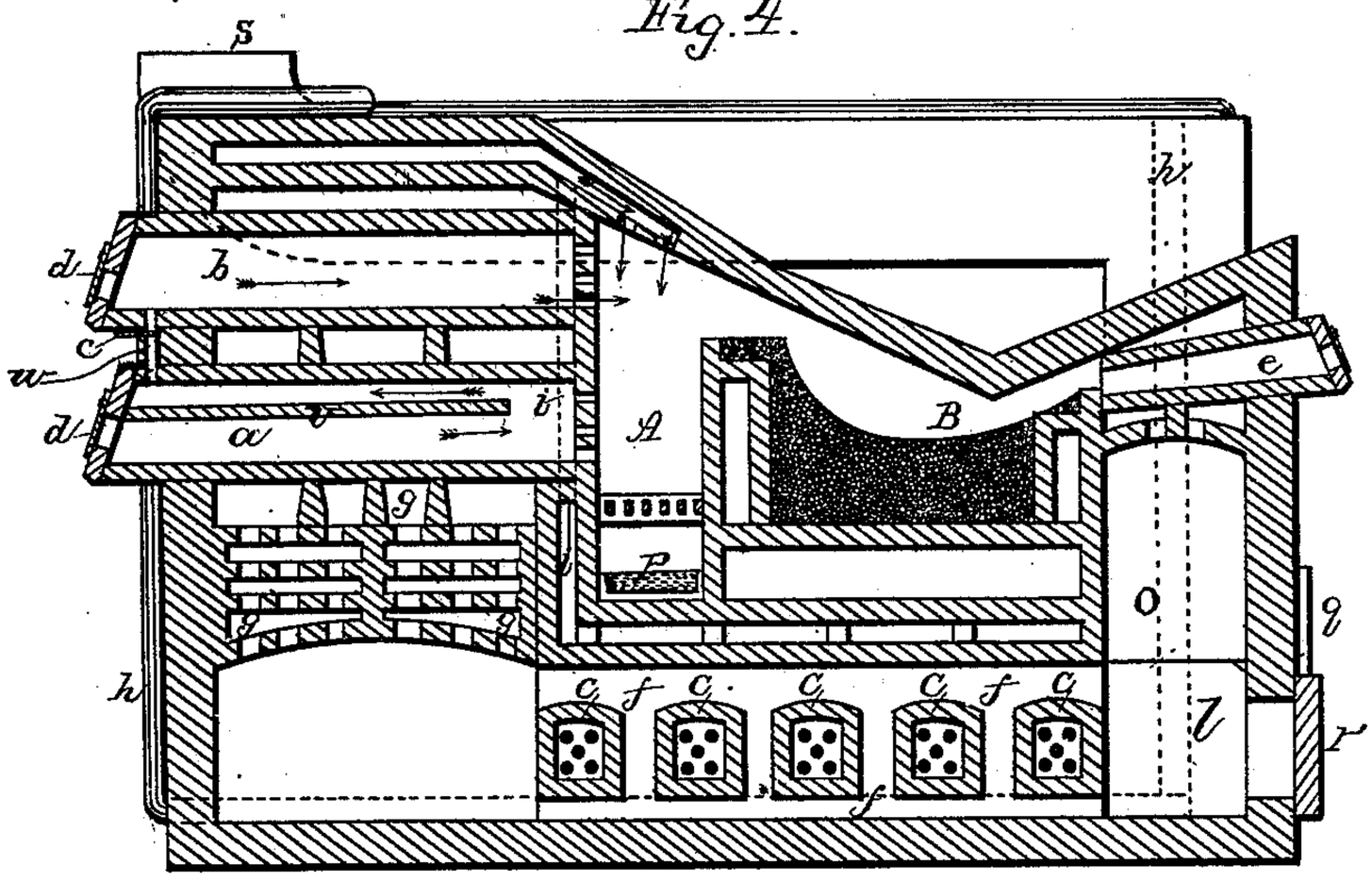


Fig. 5.

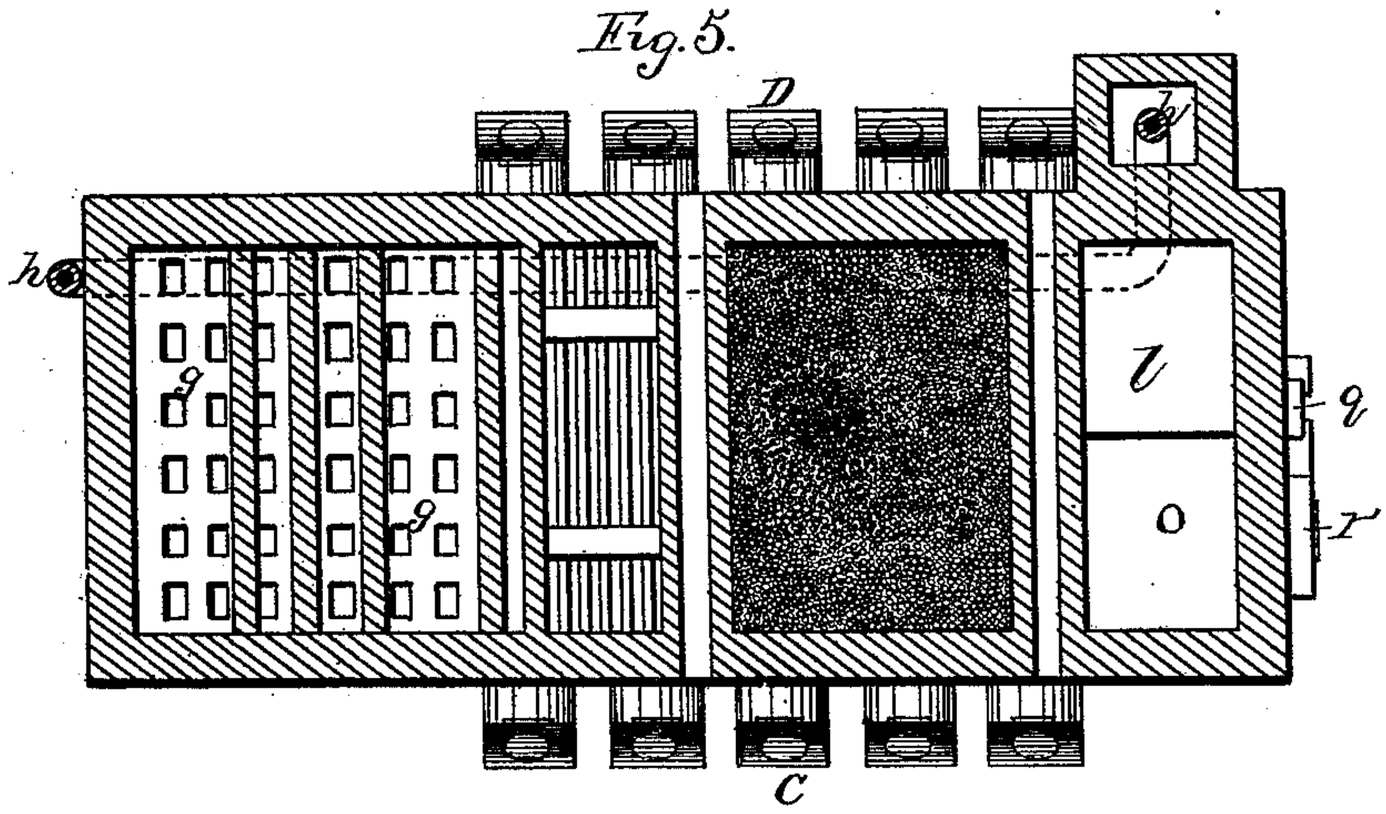
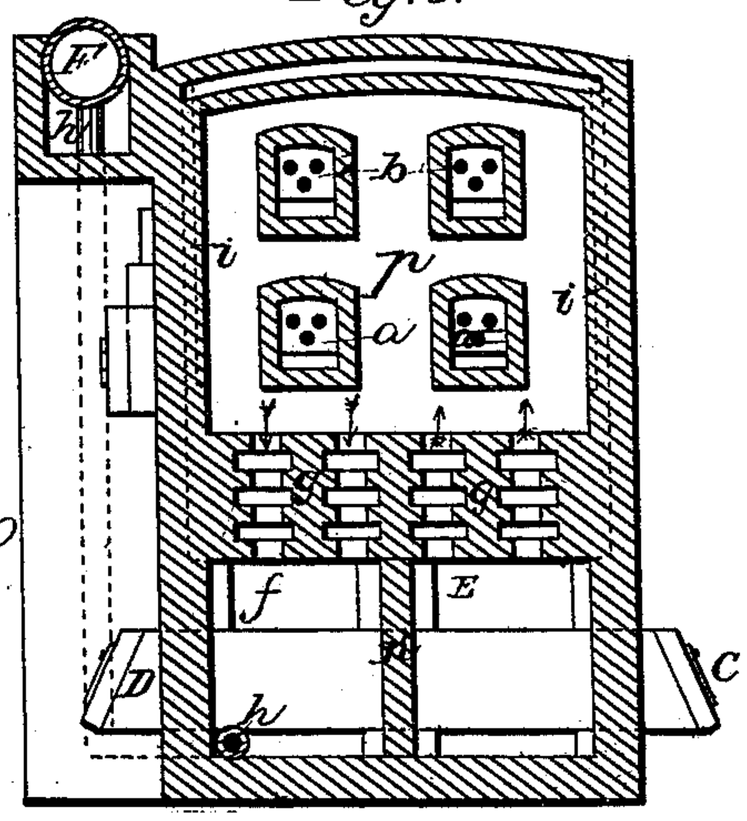


Fig. 6.



Witnesses:

J. W. Garner.

W. L. D. Haines

Inventor:

W. L. McNair.

per

F. A. Lehmann,

atty.

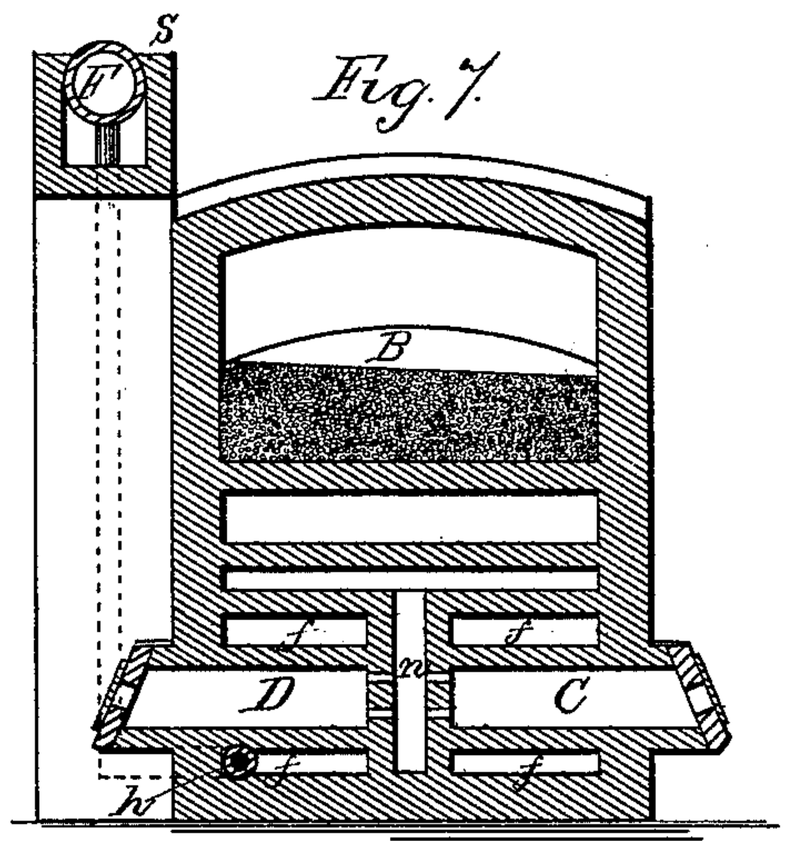
3 Sheets—Sheet 3.

W. L. McNAIR.

Open Hearth Furnace.

No. 229,443. **Patented June 29, 1880.**

Fig. 7.



Witnesses.

J. W. Garner
W. S. D. Hamus.

Inventor:
W. L. McNair,
per
F. A. Lehmann,
Atty

UNITED STATES PATENT OFFICE.

WILLIAM L. McNAIR, OF ALLEGHENY, PENNSYLVANIA.

OPEN-HEARTH FURNACE.

SPECIFICATION forming part of Letters Patent No. 229,443, dated June 29, 1880.

Application filed April 25, 1879.

To all whom it may concern:

Be it known that I, WILLIAM L. McNAIR, of Allegheny city, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Open-Hearth Furnaces; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use it, reference being had to the accompanying drawings, which form part of this specification.

My invention relates to an improvement in open-hearth furnaces; and it consists in so constructing the flues that the products of combustion first pass to the front end of the furnace, up through a chamber in which distilling-retorts are placed, over to the other side of the furnace, and thence back to the rear end, retorts being also placed across the two main flues to generate gas or heat the ore, as will be more fully described hereinafter.

The accompanying drawings represent my invention.

Figures 1, 2, and 3 are side and end views of my furnace. Fig. 4 is a longitudinal vertical section. Fig. 5 is a longitudinal horizontal section; and Figs. 6 and 7 are vertical cross-sections of the same.

A represents the combustion-chamber, in which the fire is started the same as in a reverberatory furnace. In the bottom of this chamber is the water-tank P, from which steam is constantly arising after the fire is started, and this steam not only protects the grate-bars and prevents the clinker from running in one solid mass on the bars, but, after having been decomposed, adds to the fuel.

The products of combustion pass over the hearth B and down the flue O, and from this flue into the horizontal flue *f*, over and under the chambers C. The lower part of the furnace is divided by the central wall, *n'*, into two separate and distinct flues, *f* E, one serving to conduct the products of combustion to the front end of the furnace and the other to carry them to the stack S. At the rear end of the furnace these two flues are separated by the wall *l*. This partition *n'* is only of a single thickness from the rear end of the furnace to the first retorts, and then the partition is made of a double thickness, leaving the flue *n* between them, which flue extends the full length of the two rows of retorts C D.

Extending through the rear end of the furnace are any suitable number of chambers, *e*, which are heated by the products of combustion. Into these retorts or chambers are charged the ores, preferably pulverized and mixed with charcoal, coke-dust, or other carbonaceous fuel to reduce the oxygen in the ore. The percentage of oxygen in the ore is first ascertained, and then the necessary proportion of carbonaceous fuel is added, so as to reduce the oxygen in the ore and leave it in the state of metallic sponge, ready to be transferred into the furnace. The doors of the retorts or chambers *e* are provided with registers, so as to regulate the amount of air that is admitted.

As the products of combustion leave the flue *f* they pass up through the brick-work into the chamber *p*, where the retorts *a* and *b* are heated, and then the products pass down through the brick-work on the other side of the furnace into the flue E, and after passing over and under the retorts D the products escape up the stack S.

The two sets of retorts *a b* extend from the front end of the furnace back through the chamber *p* to the combustion-chamber A, and both sets have holes through their rear ends for the escape of gas into the chamber. The lower retorts, *a*, are divided into two parts by the horizontal partitions *v*, which do not extend all the way back to the rear ends. The fuel, of whatever kind that is to be converted into gas, is charged into the lower parts of the retorts and pushed back against the holes in the rear ends, so as to prevent the too free escape of gas into the chamber A. The upper parts of the retorts serve to conduct the gas that has been distilled to the small pipes *w*, which connect the retorts *a* with the ones *b*. In this pipe *w* is placed the valve *c*, which must always be closed when the door *d* of the retort *a* is opened to charge in new fuel, or for any other purpose, so as to keep out the air. After the gas rises to the retort *b* it becomes highly heated, and escapes into the chamber A through the small holes in the back end of the retort.

Should the valve *c* be left open while the door of the retort *a* is open, an unlimited supply of air would rise into the retort *b* and make the gas highly explosive. These retorts *a b* are made of fire-brick or any other suitable material, and all of them have their outer ends project through the end of the furnace, and are provided with the iron doors *d*. These doors are provided with registers, so as to admit a certain amount of air, which renders the gas more inflammable. The mixture of air and gas being fed into the furnace is there consumed and creates an intense heat.

The object of passing the gas, as it is generated, along the heated walls of the retorts is to cause a destructive distillation and convert the volatile matter into fixed gases, so that when they enter the combustion-chamber they do so in the proper condition to combine with the currents of air coming up through the grate, causing immediate combustion at the point of contact.

When the fuel is distilled, and nothing remains but coke, the coke is fed into the combustion-chamber and consumed.

The two sets of retorts or chambers C D, which are heated by the products of combustion, have their inner ends perforated, and these ends are separated from each other by a narrow flue, *n*, (shown in Fig. 7.) Connected with this flue *n* is the flue *i*, which has its upper end opening into the top of the combustion-chamber A.

The retorts C D are intended for either one of two uses: Ore may be placed in them for the purpose of being converted into metallic sponge before being charged into the chamber B and thus effect a great saving of time and fuel. By reducing iron to sponge by means of carbonaceous fuel in these retorts, as the carbon takes up oxygen it is converted into carbonic oxide, and, passing out into the flues *n i*, it is fed into the combustion-chamber A, where it is supplied with another equivalent of oxygen, and thus adds its portion to the fuel. If so desired, these retorts may be charged with anthracite coal, which, being distilled, forms large quantities of gas, which is consumed in the combustion-chamber. Each of these retorts has a projecting end, and has its door provided with a register for the admission of a suitable quantity of air.

In working my furnace for the open-hearth process, the hearth is charged with pig metal, and when this metal is melted the metallic sponge is drawn from the retorts *e* and charged into the melted pig metal. The pig metal containing a large percentage of carbon, and the metallic sponge little or none, the amount of carbon in the sponge can be regulated to any desired amount. By this means the cost of steel can be materially reduced as compared with the ordinary method of reducing with scrap-iron, as the difference of cost of scrap always exceeds the cost of ore.

To prevent the bath in the furnace from being oxidized, the bath is covered with a glassy slag. When the ore or metallic sponge is charged into the bath it is mixed with lime or whatever fluxes may be required to remove the base matter in the ore that usually forms the slag; but should it not form the required amount, slag may be added. When the bath is sufficiently reduced the slag is tapped off from the spout at the highest point, and the steel is drawn off at the lowest point into the ladles.

When ores that contain sulphur require to be desulphurized, they are charged into the retorts C D, where heated currents of air are allowed to pass over the ore until the sulphur is oxidized, when the ore is ready to be charged into the hearth. These retorts thus save an auxiliary roasting-furnace and the ore required to run it.

The construction above described effects a great saving in fuel, and enables such fuel as slack, fine coal-dust, sawdust, and other such materials to be used by converting them into a gaseous form by means of the waste heat. It also enables iron ore to be reduced from an oxide to metallic sponge by the waste heat.

Having thus described my invention, I claim—

1. In a reducing-furnace, the combination of the flue O, the flue *f*, leading forward to the front end of the furnace, chamber *p*, having the retorts extending through it, and the flue E, leading back to the rear end of the furnace, substantially as shown.

2. The combination, in a reducing-furnace, of the downward flue O, flue *f*, extending forward to the front of the furnace, checker-work *g*, for changing the direction of the products of combustion, and flue E, extending back to the rear end of the furnace, with the retorts C D, extending across the flues *f* E, and having their ends connected with the flue *n* in the dividing-wall *n'*, substantially as set forth.

3. The combination of the retort *a*, having the division-wall *v*, connecting-pipe *w*, and valve *c*, with the retort *b*, these retorts communicating by means of perforations with the furnace A at their inner ends, and extending through the chamber *p*, so as to be heated by the products of combustion, substantially as specified.

In testimony that I claim the foregoing I have hereunto set my hand this 5th day of April, 1879.

WILLIAM L. McNAIR.

Witnesses:

SAML. DIESCHER,

T. F. LEHMANN.