4 Sheets--Sheet 1.

E. PECKHAM.

Furnaces for the Manufacture of Iron and Steel.

Patented March 31, 1874.

No. 149,241.

Fig. 1

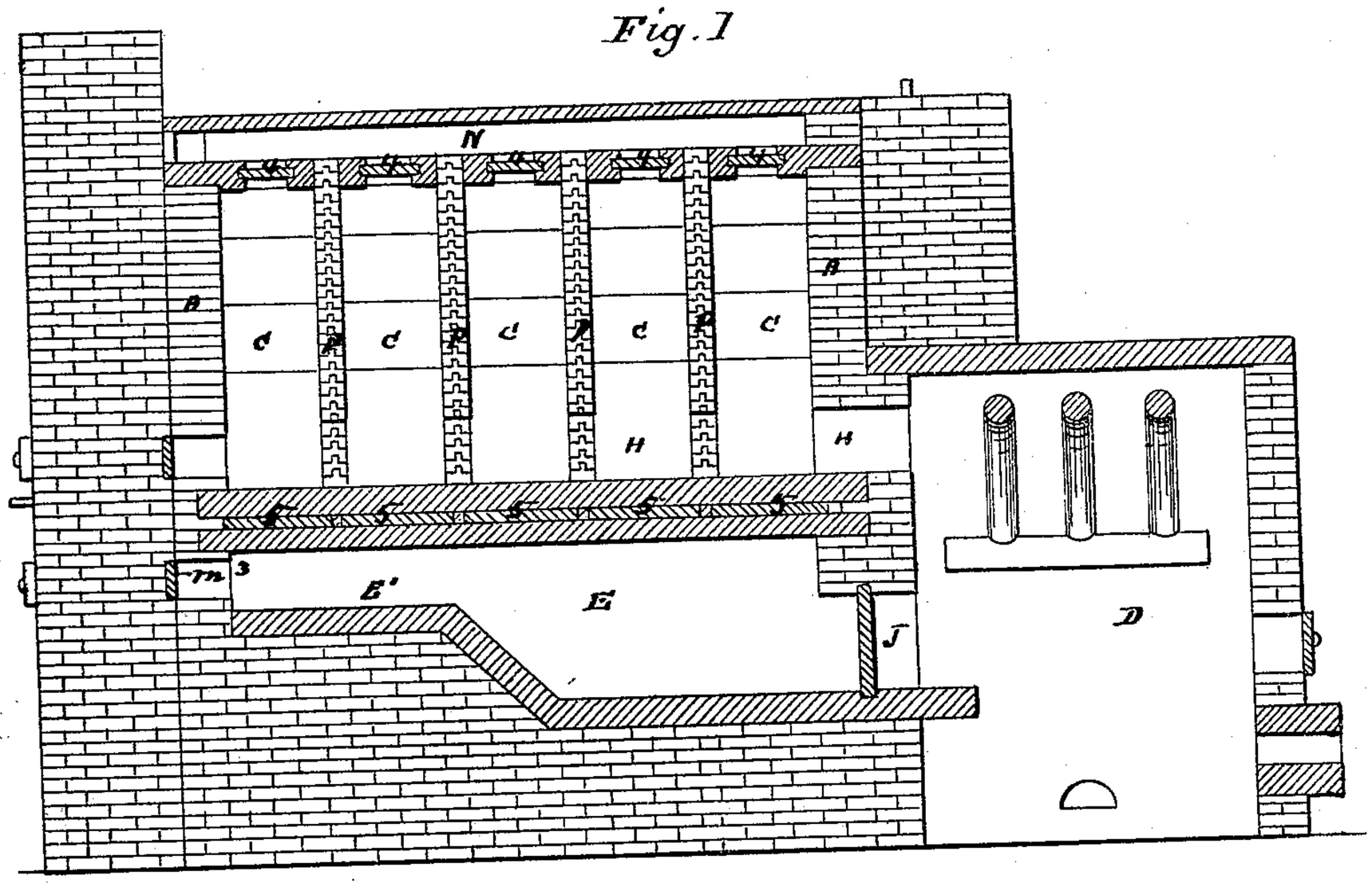
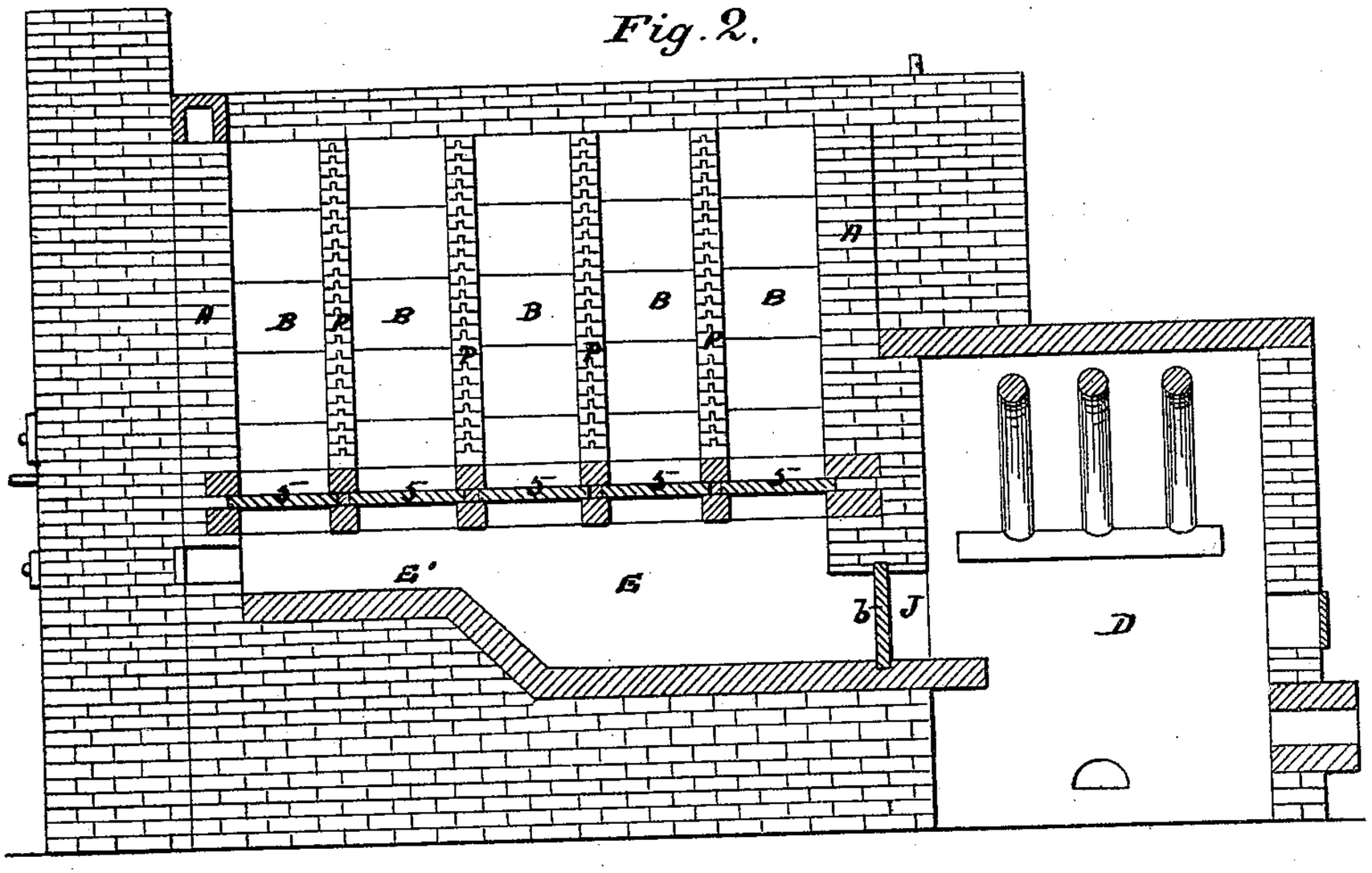


Fig. 2.



Witnesses
Ewell Dick
F. J. Evans.

Inventor
Edgar Peckham
by atty Abbott

E. PECKHAM.

Furnaces for the Manufacture of Iron and Steel.

No. 149,241. Patented March 31, 1874.

Fig. 3.

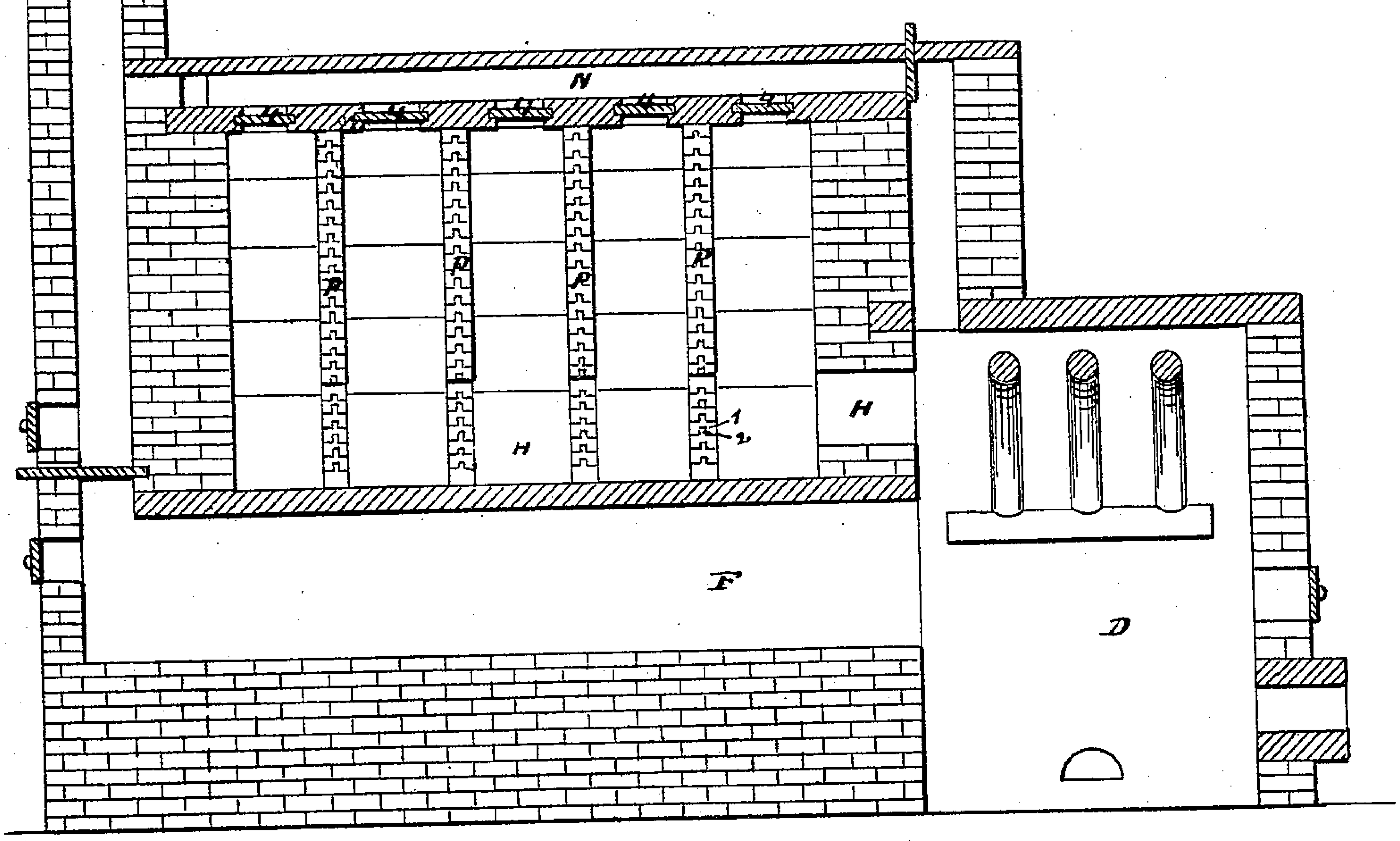
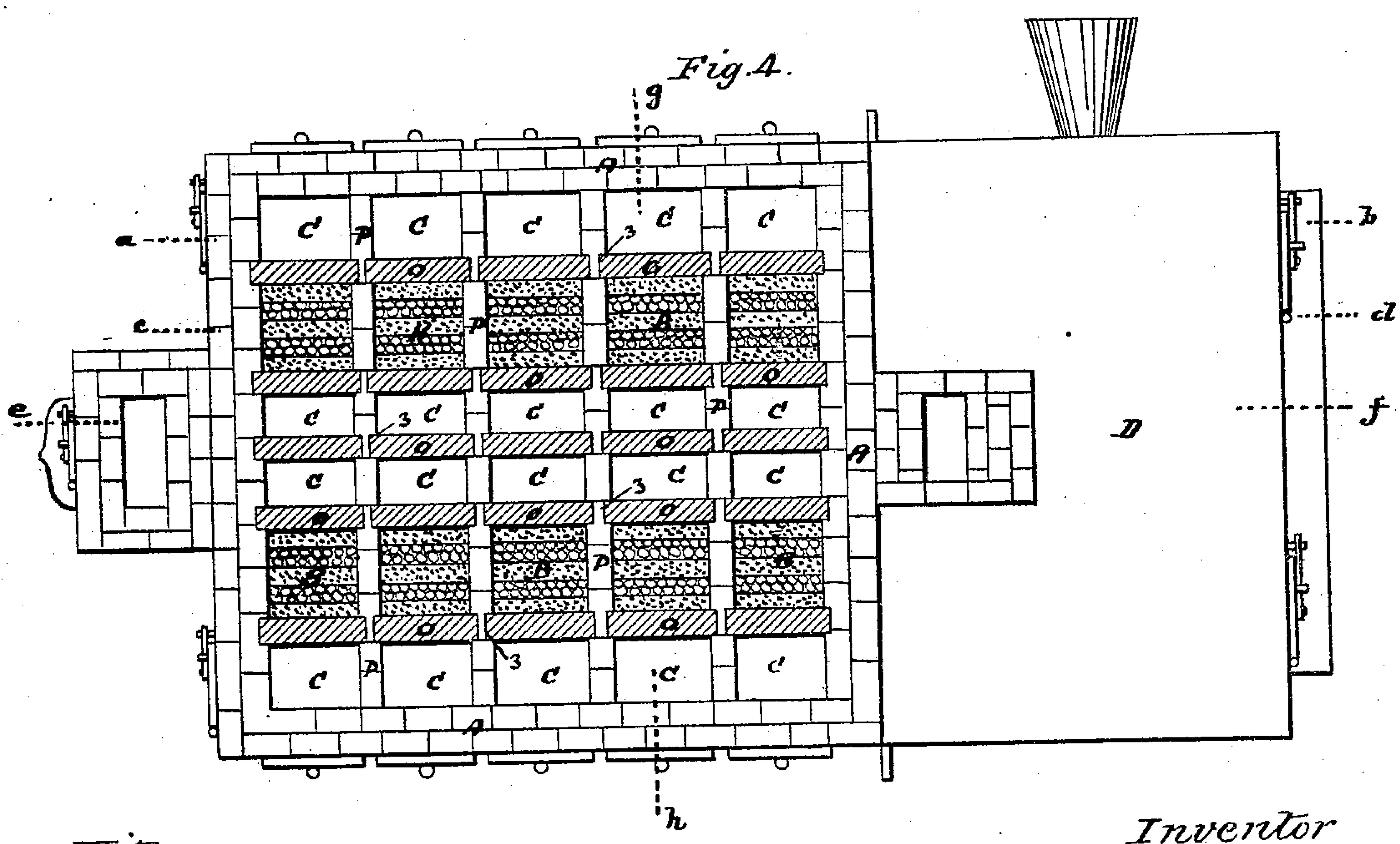


Fig. 4.



Witnesses.

E. Wellsgek

F. J. Evans.

Inventor

Edgar Peckham

by atty A Pollok

4 Sheets--Sheet 3.

E. PECKHAM.

Furnaces for the Manufacture of Iron and Steel.

No. 149,241. Patented March 31, 1874.

Fig. 5.

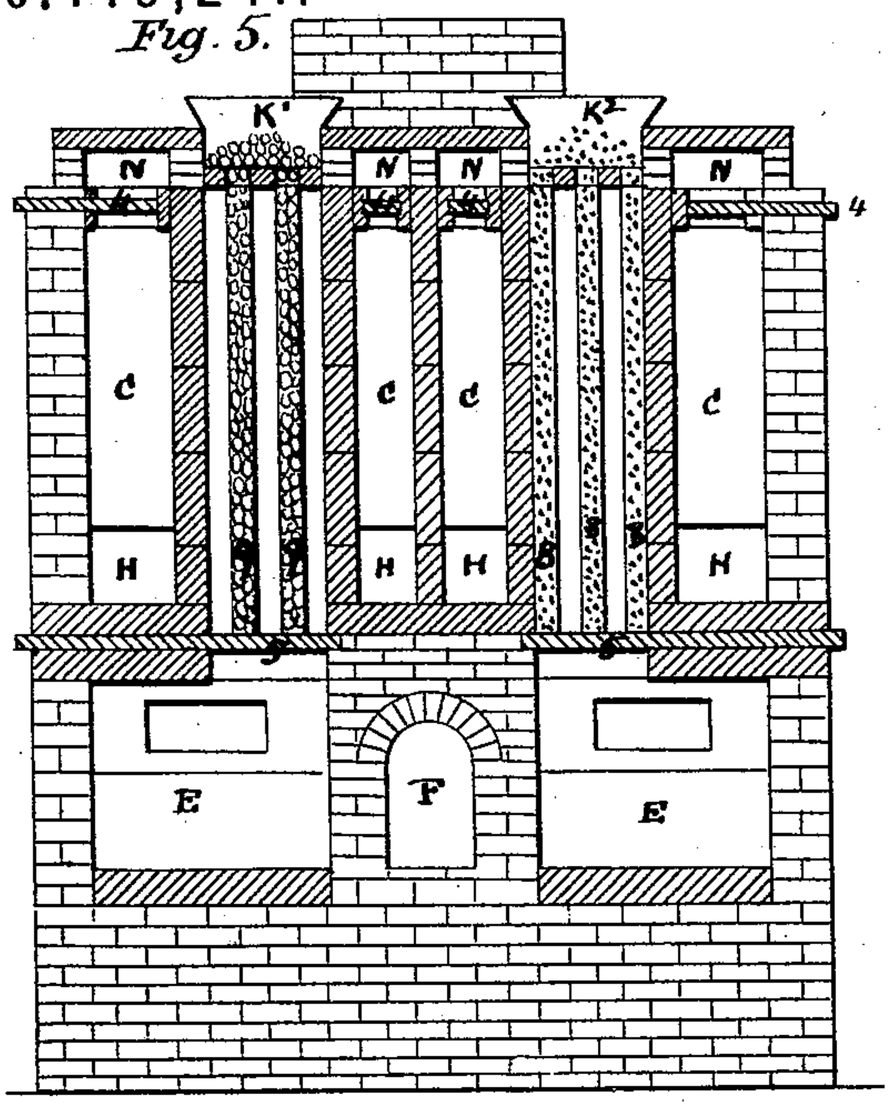


Fig. 6.

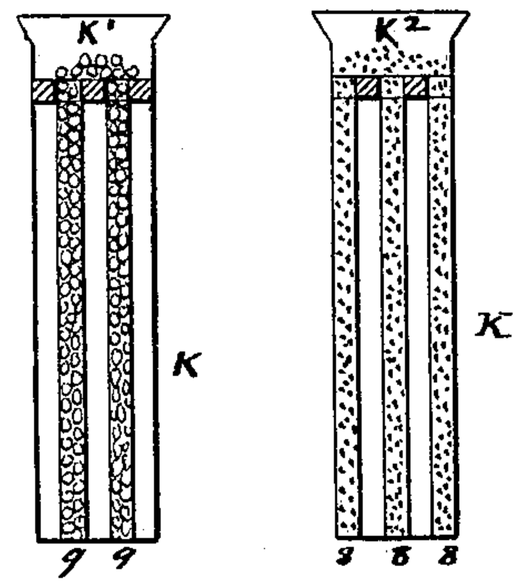
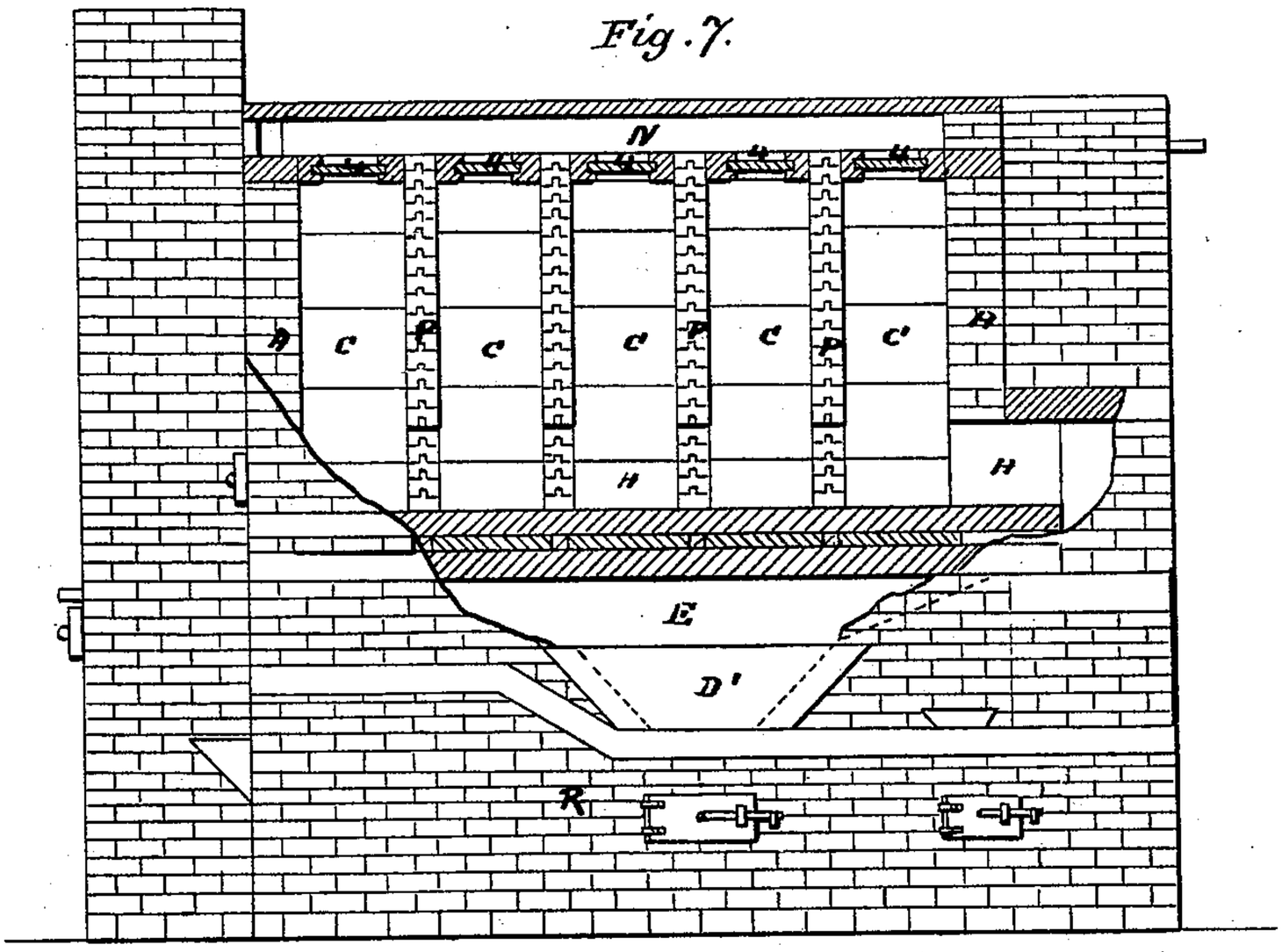


Fig. 7.



Witnesses.
Cecil? Dick
F. F. Evans

Inventor.
Edgar Peckham
by atty, Hollock

4 Sheets--Sheet 4.

E. PECKHAM.

Furnaces for the Manufacture of Iron and Steel.

No. 149,241. Patented March 31, 1874.

Fig. 8.

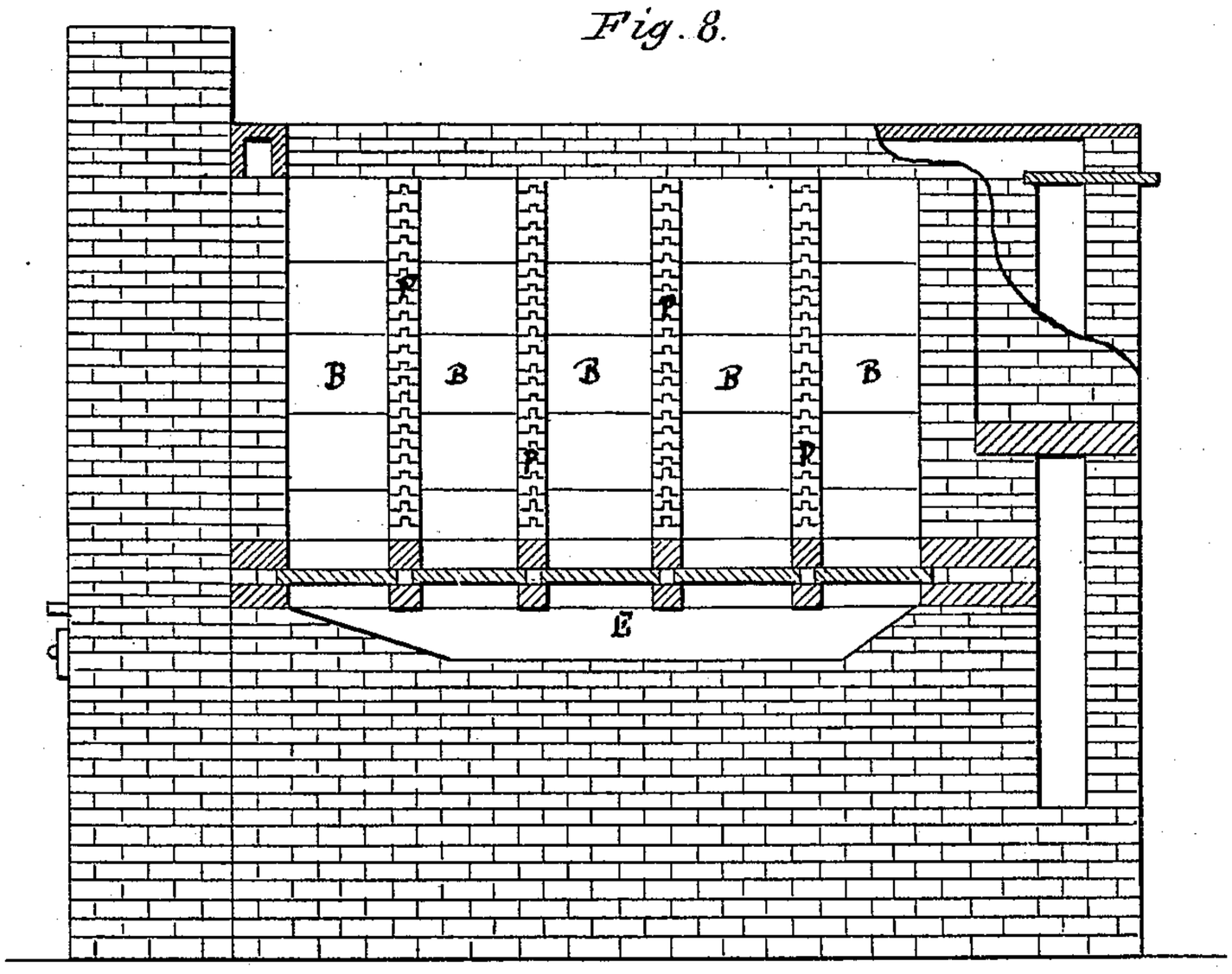
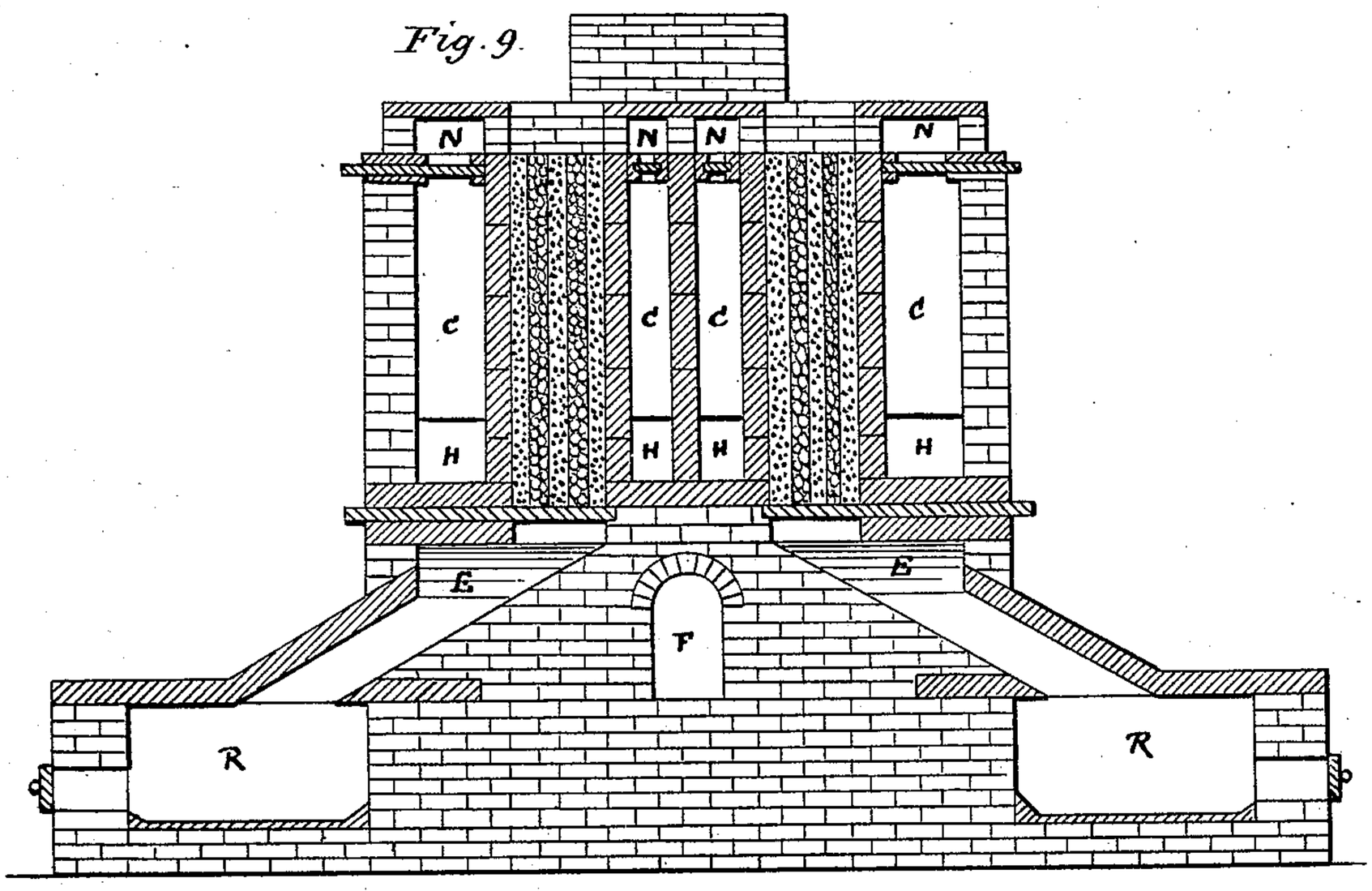


Fig. 9.



Witnesses

Everett Brooks

S. Thrall

Inventor

Edgar Peckham

by atty Pollok

UNITED STATES PATENT OFFICE.

EDGAR PECKHAM, OF ANTWERP, NEW YORK.

IMPROVEMENT IN FURNACES FOR THE MANUFACTURE OF IRON AND STEEL.

Specification forming part of Letters Patent No. **149,241**, dated March 31, 1874; application filed March 6, 1874.

To all whom it may concern:

Be it known that I, EDGAR PECKHAM, of Antwerp, Jefferson county, New York, have invented certain new and useful Improvements in the Manufacture of Iron and Steel, and in Furnaces to be used therein, of which the following is a specification:

This invention is directed to the production of iron and steel direct from the ore.

In order to obtain a uniform quality of iron or steel direct from the ore, by a process which involves the preliminary treatment of the ore with carbon in air-tight retorts, it is necessary, first, that the ore to be treated should be reduced to a uniform size, or very nearly so, and should be evenly and uniformly mixed in the retorts with the required percentage of coal, and in such a manner that the same percentage of carbon, and the same uniformity of mixture can be maintained at each operation; second, that the ore, being thus uniformly mixed with the proper percentage of carbon, should be brought up to the desired temperatures necessary to its deoxidation and carbonization by degrees, and in such a manner that the required temperatures can be steadily and uniformly maintained in the retorts the necessary time required to deoxidize and carbonize it; third, that the ore, being properly treated, should be transferred directly to the reducing fire or furnace, (without coming into contact with any cold air,) and there properly separated from its impurities during its manipulation into iron or steel.

My invention is directed to the realization, in a practical and inexpensive manner, of these conditions; and it consists both in certain processes of charging and treating the ore, and, also, in an improved construction of furnace, adapted to economically carry out said processes.

My invention can best be explained and understood by reference to the accompanying drawings.

I shall first describe the construction of the furnace, and will then detail the processes of charging and treating the ore, to the carrying out of which said furnace is adapted.

In the drawings, Figure 1 is a longitudinal vertical section of the furnace on the line *a b*, Fig. 4. Fig. 2 is a like section on the line *c d*, Fig. 4. Fig. 3 is a like section on the line *e f*, Fig. 4. Fig. 4 is a plan view of the furnace, with top removed. Fig. 5 is a transverse vertical section on the line *g h*, Fig. 4. Figs. 6, 7, 8, 9 will be hereinafter referred to.

A A represent the main walls of the converting-furnace, which may be constructed of brick or stone. P P represent the cross walls or sections of the converting-furnace, and are preferably constructed of fire-brick, having tongues 1 on their upper sides, and grooves 2 on their lower sides to correspond with the tongues; they also have grooves 3 in their sides, at certain stated intervals, to correspond with the thickness of the tiles *o o o*, used for the partition-walls separating the flues from the retorts. The cross-walls P and tile partitions *o* form the upright retorts B. The retorts can be otherwise formed, but the construction just described is advantageous in several respects. The cross-sections of fire-bricks can be laid at the proper distances apart, and the tiles used for partition-walls can be placed from the top into the vertical grooves 3 designed for them in the sides of the cross-walls, thus making the construction of the furnace very simple and economical. And in case the tile of any partition-wall should become broken or burned out, the whole partition-wall can be removed from the top and replaced by new tile without any further repairs to the furnace, and, indeed, without cooling off the furnace. The retorts B are preferably square, or nearly so, in cross-section. They are provided with removable covers, in which small perforations may be made to permit escape of gases evolved from the charges in the retorts. On each side of each retort is a vertical flue, C, the two flues of each retort serving to heat the same. All these flues are entirely distinct and independent of each other, communicating at the bottom with the main horizontal supply-flues H, through which the waste heat from the reducing fire or furnace is conveyed to and distributed among the upright flues, and at the top with horizontal escapes-flues N, leading to the chimney-stack. The communication between each upright flue C and its escape-flue N is regulated and controlled, independently of the others, by a damper or valve, 4, so that the heat in any one retort may be graduated to any degree,

irrespective of and without affecting the others.

Any number of these retorts, with their flues, may be employed. In the present instance, there are ten retorts, arranged in two parallel rows or sets of five each. Beneath each set or row of retorts is a closed receiving-chamber, E, into which the charge from each retort of the row can be dropped, the bottom of each retort being for this purpose closed by a sliding damper 5. The ore is retained in these chambers ready for transfer, as required, to the forge-fire or puddling-furnace connected with the converting-furnace.

When combined with a forge-fire, as at D in Figs. 1 and 2, each chamber communicates with D by a passage, J, through which the prepared ore is transferred directly to the forge-fire, and provided with a damper or slide, *b*, which closes when it is not required to transfer the ore from the chamber. E′ is an elevated rear portion of the receiving-chamber, upon which the ore from the retorts situated above this portion of the chamber is discharged. From this elevated part E′ the ore can be transferred (by operating through the door m^3) to the lower front part of the chamber.

When attached to puddling-furnaces, the receiving-chambers are made as seen in Figs. 7, 8, and 9, each chamber having a depression at about its center, with its sides sloping toward this depression, leading from which is the inclined air-tight chute or passage D′, through which the ore is discharged upon the hearth of the puddling-furnace R. The chute or passage D′ is provided with a damper or slide, by which communication with the puddling-furnace may be cut off, except when it is required to supply the furnace with the prepared ore.

Of the figures just referred to, Fig. 7 is a side elevation, partly longitudinal section, the line of section being through the outer vertical heating-flues. Fig. 8 is a longitudinal vertical section through the row of retorts adjoining said outer heating-flues. Fig. 9 is a transverse vertical section, showing the puddling-furnaces, one on each side.

The converting-furnace shown in these figures is substantially the same in structure as that shown in the figures preceding, the only difference being that it is combined with puddling-furnaces instead of with forge-fires.

F is a horizontal flue located between the chambers E, answering the double purpose of a waste-flue for carrying direct to the main stack or chimney any and all surplus heat not required to heat the retorts, and also to heat the horizontal receiving-chambers. It has a valve or damper, 7, to govern it.

It is very essential, as above intimated, that the ore and charcoal should be charged into the retorts in exact and uniform quantity, and that the two substances should be thoroughly and evenly mixed or distributed through the retorts. For this purpose I employ a charger by means of which I deposit in the retorts alternate vertical layers of coal and ore in any desired proportion, and with exact uniformity, thereby insuring a uniform reduction and carbonization of the ore in the retorts. In Figs. 4, 5, and 6, I have illustrated the charger and mode of using the same. The charger K, shown in Fig. 6 in vertical central section transverse to the partitions which divide it up, is made of light sheet-iron, divided by vertical partitions into spaces or sections of any requisite number, their dimensions depending upon the percentage of carbon to be mixed with the ore in the retorts. The sectional area of the charger is such that it will fit snugly but not too tightly in any one of the retorts in which it may be inserted.

In the charger shown in the drawing there are five sections. The sections 8 8 8 are designed for the coal, and the intermediate sections 9 9 for the ore. The charger is provided with two removable and interchangeable tops or hoppers, K^1 K^2, the former having openings in its bottom corresponding to the ore-sections 9 9, and the latter having openings in its bottom corresponding to the coal-sections 8 8 8. The charger is placed in the retort to be charged. The top K^2 may be first applied, and the coal filled in, occupying the spaces indicated by 8 8 8. The top K^2 is then replaced by K^1, and the ore is then filled in, entering the spaces 9 9. The charger is then withdrawn, and the coal and ore will remain in parallel or vertical layers, as represented, the coal being on the outside next to the sides of the retort. In this way I save much labor and trouble in the charging operation, and insure a uniform mixture of coal and ore in alternate layers of ascertained and determinate quantities and proportions.

My process of treating the ore, which I have hereinbefore mentioned, consists essentially in the treatment of the ore mixed with carbon or coal in air-tight, or substantially air-tight, retorts, at different degrees of temperature, with first a low heat a sufficient length of time to remove its water and open or disintegrate it; then at an increased heat the proper length of time to deoxidize it; and then at a still higher heat, the duration of which will depend upon the percentage of carbon to be taken by the ore. To the carrying out of this process my improved furnace herein described is adapted, and, in connection with said furnace, I shall describe the manner in which the process is carried on, although it will be understood that I am by no means confined to that furnace in practising the process.

When manufacturing iron and steel the operation is conducted in the following manner: The ore should be separated from all earthy matter, and reduced to a uniform size, as near as may be—about the size of coarse shot—and the coal to be used should also be reduced to a uniform size. This being done, the bottom of the retort or retorts to be charged should be covered with coal to about the depth of four inches, when the charger K (having been

previously divided into sections or spaces corresponding with the percentage of coal desired to mix with the ore) should be placed into the retort to be charged, and the top K^2, designed for coal, placed thereon. The coal should then be charged into it until all the spaces in the charger designed for coal are filled. The top K^2 should then be removed from the charger, and the top K^1, designed for ore, placed theron. Ore should then be charged into the top K^1, until all the spaces in the charger designed for ore are filled, when the charger K should be withdrawn from the retort and the top of the retort closed. The charger K being of the same dimensions as the retort, when it is withdrawn the retort will be full of ore and coal in alternate layers. The other retorts should be charged with coal and ore in the same manner. To facilitate the charging, and to save labor, the ore and coal may be taken by means of elevators to separate hoppers or bins, situated above the furnace, each hopper or bin having an inclined adjustable spout or passage leading to the furnace. This being done, and the charger K placed into the retort to be charged, with its proper top placed thereon, and the end of the spout leading from the hopper (corresponding with the top on the charger) placed therein, by turning a valve in the inclined passage leading from the hopper to the charger the coal and ore will flow from the hoppers into the retorts without any manual labor, and a uniform mixture of coal and ore will be obtained. After the retorts have been thus charged, (fire having been previously made in the reducing fire or furnace attached to the converting-furnace,) the valves 4 of flues C should be opened a little, so as to cause sufficient draft to heat the flues (on each side of the retort or retorts charged) to a dark cherry-red heat. This heat should be maintained for about twelve hours, or sufficient time to remove the water from the ore, open its pores, and heat it throughout to a cherry-red. Then the valves 4 should be opened a little more, sufficient to raise the heat to a deep full cherry-red, and this heat should be maintained for about twelve hours, or sufficient time to remove the oxygen, or the greater portion thereof, and deoxidize the ore. When thus deoxidized, it is ready to be made into iron in the forge-fire, or, indeed, in the puddling-furnace as well. But I prefer, on many accounts, whether for the manufacture of iron or steel in the puddling-furnace or the forge-fire, to carry the process still further, and to carbonize the ore, which is done by opening the valves 4 still more sufficiently to raise the heat in the flues to a very bright cherry-red, which heat should be maintained a sufficient length of time to carbonize the ore to the desired extent. It is not necessary to carry the carbonization of the ore so far when it is designed for the forge-fire as when it is designed for the puddling-furnace; and in either case, there should be less carbonization when the ore is to be made into iron than when it is designed for steel. The ore should then be transferred from the retorts to the receiving-chamber underneath, by withdrawing the dampers or slides at the bottom of the retorts, which allows the charges to drop into the chamber. This being done, the dampers or slides should be again replaced, closing the lower ends of the retorts, and fresh charges of ore and coal charged into the retorts and treated at the same temperatures as above specified, and so on, the retorts being emptied and recharged, alternatively, so as to make the process a continuous one. The exact time that the ore should be treated at each stage of heat cannot be given, as it will depend upon the character of the ore employed and percentage of carbon desired in the metal produced.

The temperature of each retort should be regulated in the same manner and the ore all treated at the same temperatures and the same length of time.

The heat of each flue can be ascertained by means of small holes in the covers of the flues, or if greater accuracy is desired when treating ores for steel, a pyrometer or heat-gage may be placed in each perpendicular flue.

When sufficiently treated, the prepared ore should be transferred from the main receiving-chambers E and E, in the manner hereinbefore described, to the forge-fire or puddling-furnace or furnaces attached to the converting-furnace, and there manipulated into iron or steel. The quality of the metal produced will depend upon the length of time the ore was under treatment in the retorts. I prefer to use the improved puddling-furnace, for which my application for Letters Patent is now pending in the United States Patent Office, where anthracite or bituminous coal is employed as fuel; and the ore should preferably be fluxed and purified during its manipulation in the forge-fire or puddling-furnace, according to my improved process of purifying iron and steel, during its manipulation in the forge-fire or puddling-furnace patented October 14, 1873, No. 143,637.

The process of manufacture of iron and steel direct from the ore, involving the preliminary treatment of the ore in air-tight retorts, in the manner above stated, and its subsequent transfer to and manipulation in the forge-fire and puddling-furnace, is a continuous one, and is carried on without necessitating the exposure of the ore at any time to cold air, the transfer from the retorts to the fire or furnace being effected while the ore is hot, and without the exposure to draft, as above stated.

I desire to here say, that if the ore is of such nature as to require its desulphurization prior to its treatment as above described, this can be done in the same retorts, by providing each retort, at or near its bottom, with a pipe communicating with the exterior atmosphere, having a valve or damper for closing or opening it, at pleasure; and providing the retort cover with a short stack or chimney, also having a damper or valve.

The ore, when in the retort, is there prelim-

inarily subjected to about the heat first above specified, which must not in any event be above the fusing-point of sulphuret of iron, and the valves of the two pipes above named are opened, so as to allow air to pass through the retort, thus creating an oxidizing-draft that carries off the sulphur. When the sulphur has been removed, the valves or dampers of the said pipes are closed, the retort is made practically air-tight, and the remainder of the process is conducted as hereinbefore described.

I am aware of Letters Patent No. 126,922, to T. S. Blair, dated May 21, 1872, and would state that I do not claim either the process or the product embraced in said Letters Patent.

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

1. In the manufacture of iron and steel, the process of treating iron ores preliminarily to their after reduction in the presence of carbon, in air-tight retorts at different temperatures, as herein specified.

2. The desulphurization of the ore while in the retort, and before its after treatment therein, substantially in the manner described.

3. The manufacture of iron and steel by first treating the ore in the presence of carbon in air-tight, or practically air-tight, retorts, at different temperatures, and then transferring the said ore while hot and without exposure to draft or cold air to and working it in a forge-fire or puddling or other reducing furnace or apparatus, the whole being a continuous operation, substantially as herein specified.

4. The method herein described of charging upright retorts or furnaces with carbon and ore in alternate parallel vertical layers, and in the desired proportions, substantially in the manner and by the means herein set forth.

5. The charger, formed to fit the retort, and divided into longitudinal parallel sections for the carbon and ore, in combination with its removable and interchangeable tops or hoppers, the one for coal, the other for ore, as herein shown and set forth.

6. In a converting-furnace, the combination of a series of independent retorts, with heating-flues for each retort, distinct and independent of each other, and provided with separate valves or dampers, whereby the passage of heat to each flue may be regulated and controlled, at will, to admit of each retort being brought to any desired heat, without interference with or affecting the others, substantially as shown and described.

7. The combination of a series of independent retorts, each provided with heating-flues independent of the others, and controlled by independent valves or dampers, with common heat-supply flues leading from the forge-fire, puddling, or reducing furnace, or other source of heat-supply, and common discharge or escape-flues, leading to the chimney or stack, substantially as shown and set forth.

8. The combination of a series of upright independent retorts, each having an independent and distinct system of heating-flues and regulating valves or dampers, with a common receiving-chamber, located beneath said retorts and designed to receive their contents, substantially as shown and set forth.

9. The retorts, constructed substantially as herein described, with cross-walls of fire-brick and tile partitions, placed at about right angles to said walls and fitted in vertical grooves formed in the same, substantially as shown and set forth.

In testimony whereof I have hereunto signed my name this 6th day of March, A. D. 1874.

EDGAR PECKHAM.

Witnesses:
EWELL DICK,
M. BAILEY.