(No Model.) 5 Sheets—Sheet 1.

P. L. WEIMER.

REGENERATIVE HOT BLAST STOVE.

No. 292,188. Patented Jan. 22, 1884.

Fig. 1.

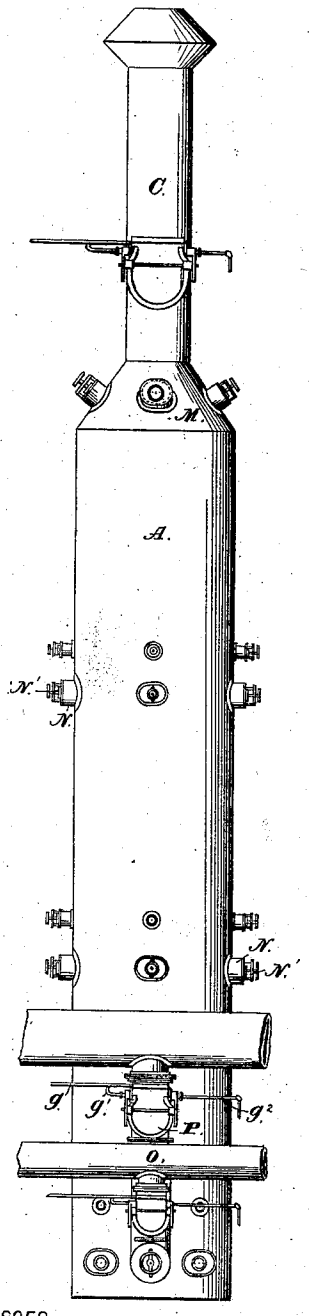
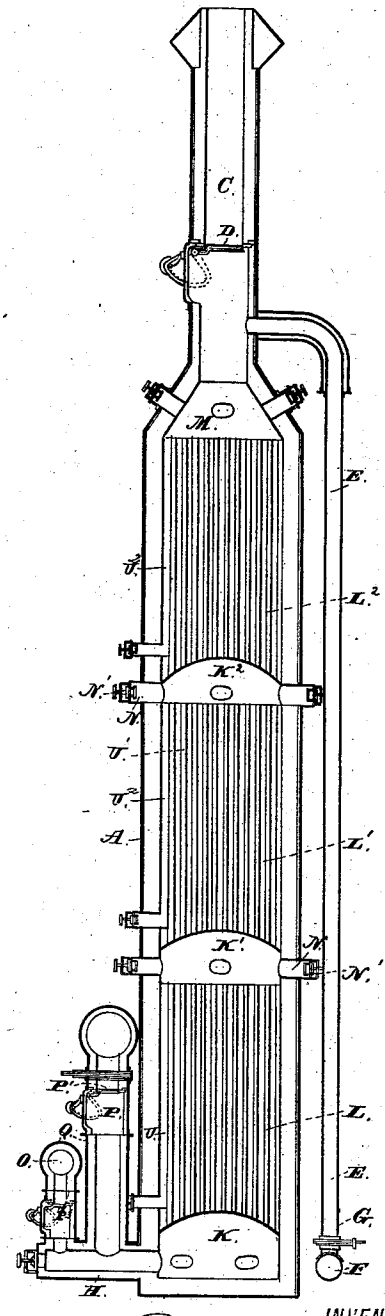


Fig. 2.



WITNESSES

Jas. E. Hutchinson.

Geo. W. Seymour.

INVENTOR

P. L. Weimer

By H. A. Seymour Attorney

N. PETERS, Photo-Lithographer, Washington, D. C.

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Fig. 3.

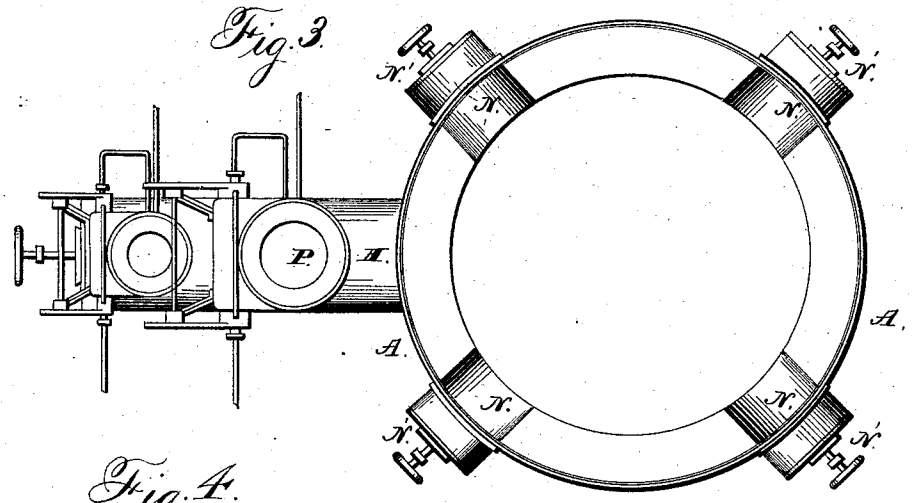


Fig. 4.

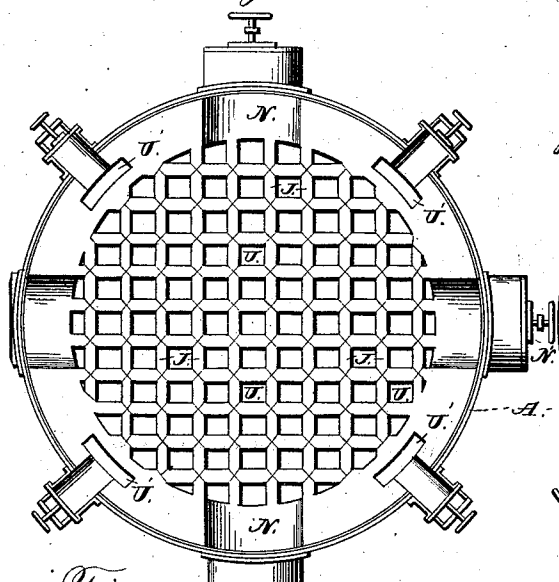


Fig. 5.

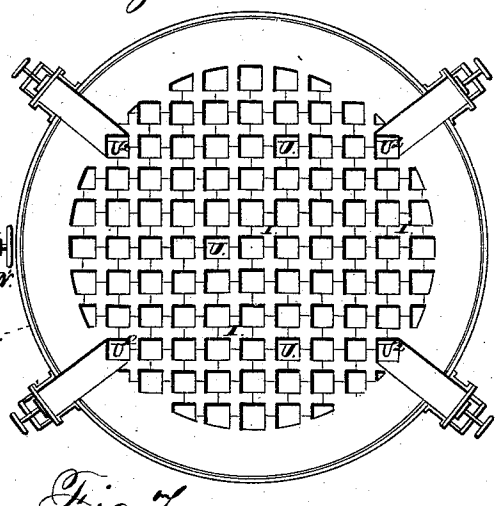


Fig. 6.

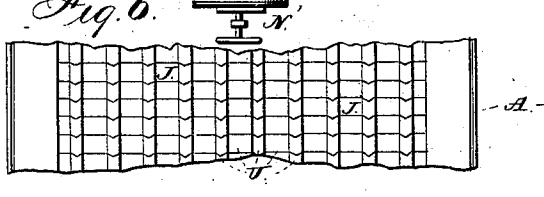
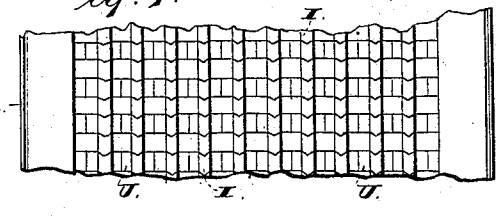


Fig. 7.



WITNESSES

Jas. E. Hutchinson.

Geo. D. Seymour.

INVENTOR

P. L. Weimer

By H. A. Seymour — Attorney

N. PETERS, Photo-Lithographer, Washington, D. C.

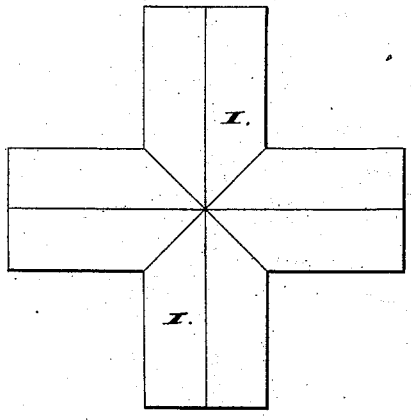
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P. L. WEIMER.

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No. 292,188. Patented Jan. 22, 1884.

Fig. 8.



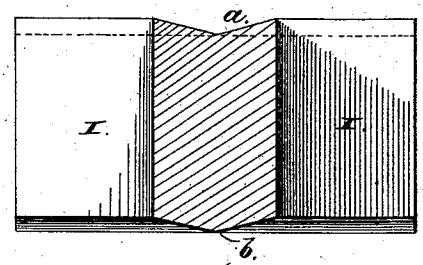
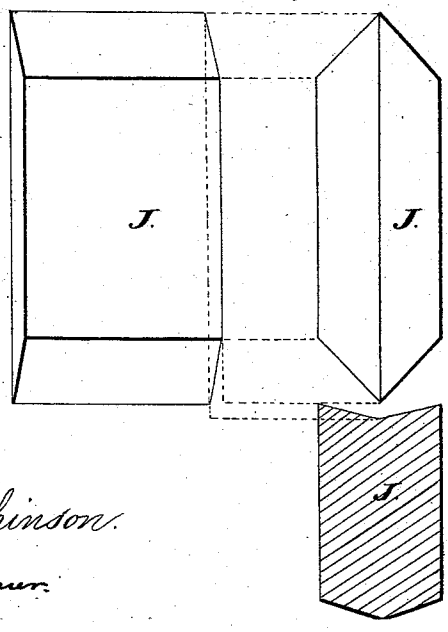


Fig. 9.



WITNESSES

Jas. E. Hutchinson.

Geo. W. Seymour.

INVENTOR

P. L. Weimer

By H. A. Seymour Attorney.

N. PETERS. Photo-Lithographer, Washington, D. C.

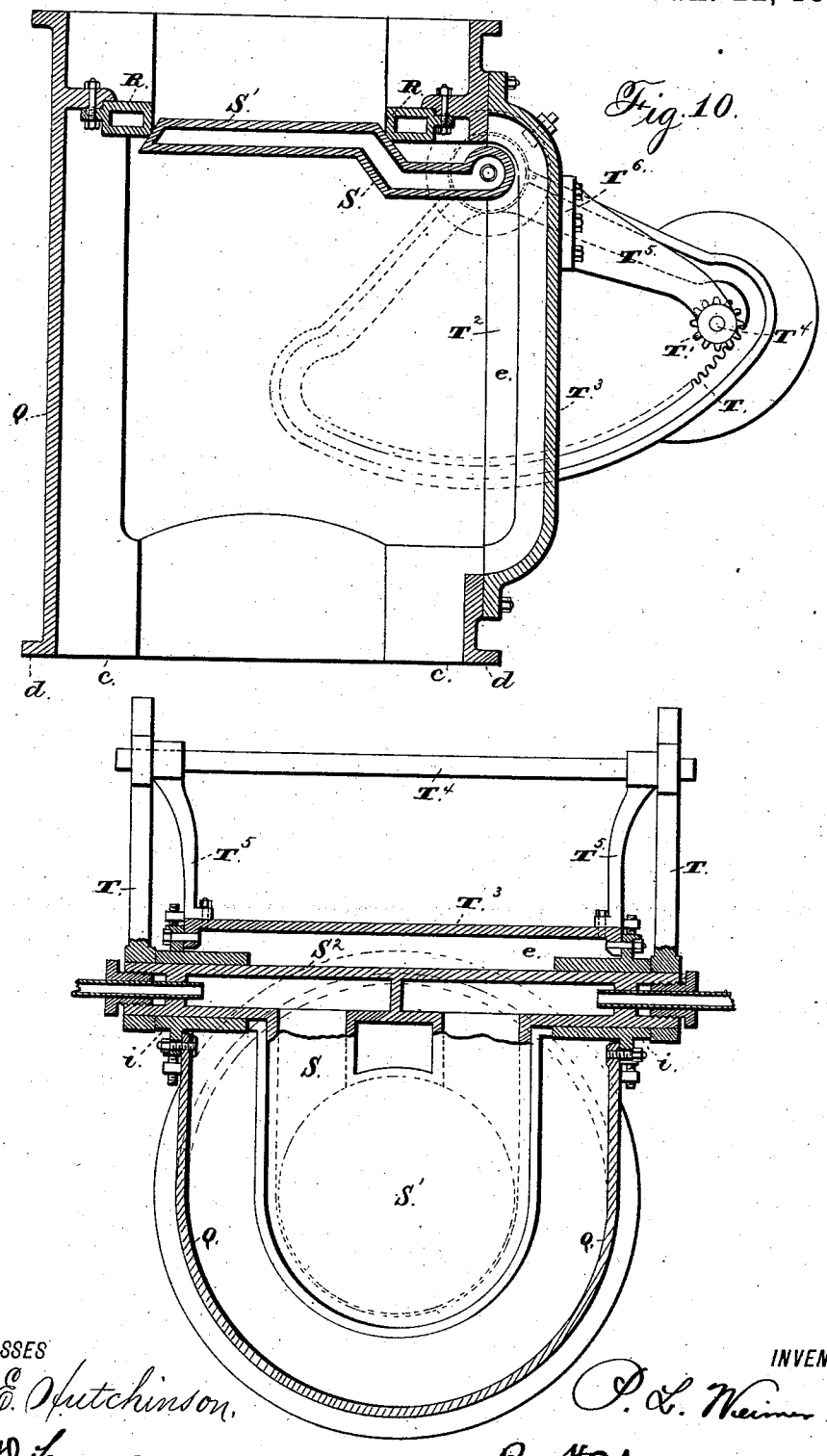
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Fig. 10.



WITNESSES

Jas. E. Hutchinson.

Geo. D. Seymour.

INVENTOR

P. L. Weimer.

By N. A. Seymour. Attorney

N. PETERS. Photo-Lithographer. Washington, D. C.

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P. L. WEIMER.

REGENERATIVE HOT BLAST STOVE.

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Fig 11.

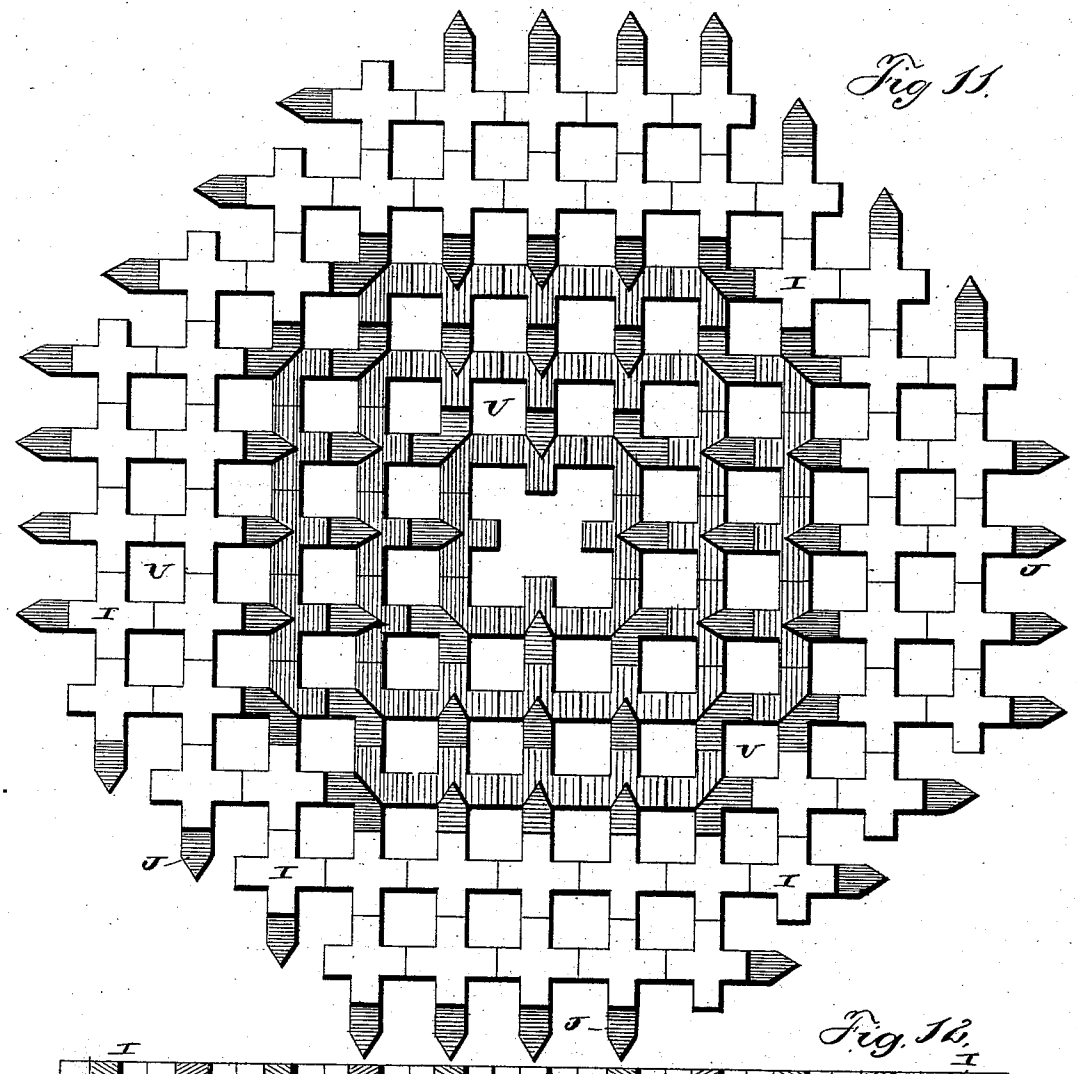
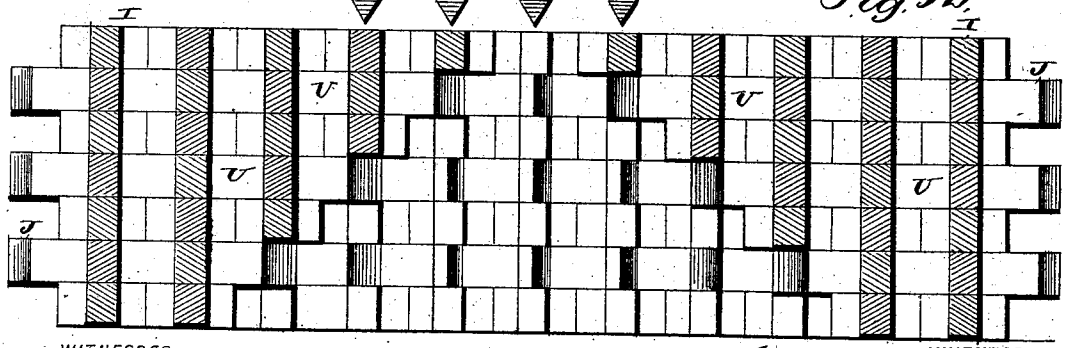


Fig. 12.



WITNESSES

George F. Downing

S. G. Nottingham

INVENTOR

P. L. Weimer

By H. A. Seymour

Attorney

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

PETER L. WEIMER, OF LEBANON, PENNSYLVANIA.

REGENERATIVE HOT-BLAST STOVE.

SPECIFICATION forming part of Letters Patent No. 292,188, dated January 22, 1884.

Application filed August 27, 1883. (No model.)

To all whom it may concern:

Be it known that I, PETER L. WEIMER, of Lebanon, in the county of Lebanon and State of Pennsylvania, have invented certain new and useful Improvements in Regenerative Hot-Blast Stoves; 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 appertains to make and use the same.

My invention relates to an improvement in regenerative hot-blast stoves, the objects of the same being, first, economy in first cost of constructing the plant. A further object is the economy in maintaining the plant, due to the fact that no excessive temperature is required in the combustion-chambers. A further object is to construct the combustion-chambers so that the unconsumed gases will pass through the first regenerator into the second combustion-chamber, receiving thereby an increased temperature to fit them for combustion in this second combustion-chamber, and so on through several regenerators. A further object is to so construct the regenerators whereby a high temperature in the combustion-chamber is rendered unnecessary. A further object is to so construct the stove that the ordinary draft-stack and flues leading thereto are dispensed with. A further object is to provide means for supplying air to the regenerators in such a manner that the combustion of the admitted air and gases cannot take place until it reaches the combustion-chamber. A further object is to provide a cheap and simple brick, which, laid end to end in successive layers, forms the necessary net-work or cells. A further object is to form the combustion-chamber without arching. A further object is to provide improved valves for closing the air and gas pipes, whereby undue expansion is prevented; and with these ends in view my invention consists in the parts and combinations of parts, as will be more fully described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a view in elevation of my improved stove. Fig. 2 is a vertical sectional view of the same on line *x x* of Fig. 1. Fig. 3 is a view partly in plan and partly in section. Fig. 4 is a horizontal sectional view through one of the regenerator-chambers, showing the beveled bricks. Fig. 5 is a similar view, showing the bricks made in the form of Greek crosses. Fig. 6 is a longitudinal sectional view through a portion of one of the regenerator-chambers, showing the beveled bricks. Fig. 7 is a similar view, showing the other form of bricks. Fig. 8 is a detached view of one style of brick employed. Fig. 9 shows the other form. Fig. 10 is an enlarged view of one of the water-cooled valves; and Figs. 11 and 12 show the manner of constructing the arches of the combustion-chamber.

In this stove, instead of causing the current of heated gases in combustion to alternately travel up and down through the stove and finally escape at the bottom into an underground flue leading to the draft-stack, I dispense with the up-and-down travel of the gases, as well as the escape at the bottom, the underground flue, and the draft-stack, and cause the heating-gases to travel in a continuous upward direction. The escaping gases of a blast-furnace, that are usually used for the purpose of heating the regenerative hot-blast stoves and generating the steam are composed, principally, of nitrogen and carbonic acid, with hydrogen and carbonic oxide in the minority, forming a compound difficult of thorough combustion. Two systems are in use for the combustion of these gases in blast-furnace practice, both for generating steam and heating the blast. The one consists in admitting the gases into a combustion-chamber and there consuming them as much as possible, utilizing the resultant heat in the regenerators of the regenerative hot-blast stove, or for heating the iron pipes in the iron-pipe hot-blast stove or the boilers of the blast-furnace. The other system of consuming these gases is to burn them with as much extended a flame as practical. The combustion-chamber is comparatively small, and the gases are fed with air in their passage under the boilers, or through the hot-blast stove at different points, so as to maintain as long a flame as possible.

It is a well-known fact that if the escaping gases of a blast-furnace are highly heated combustion of them will be more thorough. The

nitrogen of furnace-gases, being largely in excess in volume, forms, as it were, a matrix in which the combustible part of the compound is enveloped, and prevents any wasting or slow burning taking place; but by increasing its temperature it appears to impart to the carbonic oxide and hydrogen an increased affinity for oxygen, and when this oxygen is supplied furnishes it with the necessary heat to enter into vigorous combustion. Were the gases only carbonic oxide and hydrogen, the heat carried by the nitrogen not being at hand to raise the temperature of the incoming oxygen, a less active combustion would be the result. In consequence of the presence of this large volume of nitrogen and carbonic acid, considerable room is required for its thorough combustion, and when a greater volume of gas is admitted into this room than can be consumed, the excess passes along with the resultant gases of combustion and takes fire so soon as it reaches an open or enlarged space supplied with oxygen, as is often seen at the top of furnace-chimneys. The escaping gases thus found burning at the top of chimneys does so with great vigor, though but a comparatively small portion of them are combustible. This vigorous burning is no doubt due to the high temperature at which these gases reach the atmosphere, and to the heat carried along by nitrogen and carbonic acid being conveyed to the imparting oxygen, and, as it were, heating the air supplied.

In my regenerative stove I take advantage of the foregoing principles governing the laws of blast-furnace-gas combustion, as will appear hereinafter.

In my system of regenerative hot-blast stoves I provide two, three, or more iron casings, such as are usually used for regenerative stoves, except that I decrease the diameter and increase the height, besides allowing each stove-casing to form its own draft-stack by providing a suitable chimney on each one.

As the stoves are all duplicates, I will described only one of them, as answering for all.

The casing A of my No. 1 stove is preferably fourteen feet in diameter and seventy-seven feet high to where the conical top begins, which latter is preferably six feet high, terminating with a draft-stack or chimney, C, four feet in diameter. This draft-stack is provided with one of my cooled air-tight valves, D, that is closed when the stove is "on air," and opened when "on gas."

The air-inlet pipe E enters the chimney of the stove just below the valve D that opens and closes the draft, and, by preference, I place the main air-pipe F near the ground and run the conducting-pipe E from it to the entrance at the chimney of the stove before mentioned, putting an ordinary cut-off valve, G, near the ground. Near the bottom, on the opposite side of the stove, I, by preference, place the outlet-pipe H for the heated air, and which at the same time forms the inlet-opening for the gases. This opening is provided with a casing and suitable water-cooled valves, which will be more fully described further on.

After the casing has been erected and the various valve attachments made, I proceed to line it with fire-brick in the following manner: I first cover the entire bottom with fire-brick to the depth of about eighteen inches, leaving several inches around the sides to allow for expansion. I next begin the erection of the first combustion-chamber K, the walls of which are preferably eighteen inches thick, placed several inches from the sides of the casing to provide for expansion of the brick, and the side walls of this combustion-chamber are carried up straight about four feet when the first brick-work of the regenerator begins. The regenerator is composed of a net-work of fire-brick, made of alternate layers of block or brick I, formed in the shape of a Greek cross, and straight blocks J with miter ends. By preference I make the Greek-cross brick with arms four inches long, four inches wide, and six inches thick. A series of these brick laid with the ends of the arms joining, will form a net-work in which the openings will be eight inches square and the bars four inches wide. The straight brick J with miter ends are four inches wide, six inches thick, and twelve inches long, and are laid end to end, forming a net-work of the same dimension as the Greek-cross brick, and breaking joints, when laid in alternate courses, with the brick I. The bottom and top of both these shapes of brick are not flat surfaces, but are depressed in the center on one surface, as shown at *a*, and correspondingly raised on the other surface, as shown at *b*. The rise is about a half-inch in the center of the brick with a straight line to edge, the depression being in reverse on the opposite side. The object in thus forming the top and bottom of the brick is that a better interlocking may take place and prevent the brick from sliding or moving out of position after they are laid in the regenerator. By this device of brick I secure a perfect alignment of the openings of flues of the regenerator, with no possibility of getting out of place.

In forming the roof of the combustion-chamber no arches are made, but the regenerator-brick are so laid that each course projects over the one below it until they all meet in the center, forming a dome-shaped roof for the chamber and at the same time the bottom of the regenerator. Alternate courses of regenerator-brick are laid until a height of from, by preference, twenty or thirty feet is attained, which forms the first regenerator, L, and on top of this regenerator we form a second combustion-chamber. The second combustion-chamber, K′, is similar in construction to the first, only slightly lower. This second chamber, K′, is roofed like the one below it, and a second regenerator, L′, built over it of the same height as the first. A third combustion-

chamber, K^2, is now built like the first and second, to be followed by a third regenerator, L^2. A fourth, fifth, or sixth combustion-chamber and regenerator may be added in succession, if necessary. The top of the last-built regenerator forms the bottom of the draft-chimney chamber M, and supports the brick lining of this chamber and the draft-stack C directly over it. Each combustion-chamber is provided with four or more cleaning-doors, N, to be used for cleaning out the dust accumulating in the regenerators, and each door is provided with an air register or regulating device, N′, that is opened for the admission of air when the stove is on gas and closed when on air.

The water-cooled valves D, placed in the draft-stack or chimney C in the hot-air pipe O, and at the gas-entrance P into the stove, are made in the following manner: A casing, Q, is provided, of either wrought or cast iron, of a size sufficient to line out with fire-brick and still maintain the requisite area of central opening. The opposite ends *c* of this casing are usually made round with flanges *d* at the end to fasten it in its intended position. The body portion of the casing is made in sections somewhat resembling the capital letter **D**, with the straight portion *e* open and adapted to be closed by the removable plate T^3. In the upper section of the circular part of the casing, immediately above the **D**-part, I secure a hollow cast-iron circular valve-seat cast, R, through which a stream of water is caused to flow.

The valve proper, S, is also made in the form of a letter, **D**, and provided with the cylindrical seat S′, made conical and turned to fit the seat R, secured in the casing. This valve is cast hollow, and the straight leg S^2 is projected at each end outside of the casing Q, so as to form a hinge or hollow shaft for supporting the valve as well as for operating it. The cooling-water enters one end of this hollow shaft, circulates through the valve, and discharges through the opposite end. On each end of the valve-shaft, and outside of the casing, is rigidly secured a toothed sector, T, into which pinions T′ of the shaft T^4 mesh, for the purpose of partly rotating the valve, and thus lowering it from its seat into the recess T^2 formed in the cover to receive it, or raising it to its seat. The shaft T^4 is journaled in the arms T^5 of the face-plate T^6. By preference I cause the valve to close upward, which prevents any dirt or dust lodging on the seat when the valve is open. When the valve S is in its open position, it stands vertical in the recess T^2, formed to receive it, and when closed, rests in a horizontal position against its seat. The water for cooling first enters the valve-seat R and through the pipe *g*, and, after circulating through it, enters the valve proper through the pipe *g′*, and is discharged opposite its entrance through the pipe g^2. The journals of the valve-shaft are provided with bearings *i*, secured to the side of the casing Q, and so arranged that they can be shifted into any position necessary to secure a good fit of the valve to the valve-seat.

Various forms of regenerator-brick may be used, and the Greek cross may be used alone by setting each alternate one-half its thickness higher than the adjoining brick, or all mitre brick may be used. However, the construction, heretofore described, of alternate courses of Greek crosses and mitre brick will be found to give the best result.

In operating my regenerative stove I first open the chimney-valve D, close the cold-air valve G, and open the gas-admission valve P′ and air-valves N′ in the cleaning-doors. The entering gases from the pipe P are ignited in the lower combustion-chamber, K, and being in excess of what can be thoroughly burned in this chamber, the excess passes through the first regenerator along with the product of combustion of that part of the gas that is burned. On entering the second combustion-chamber, K′, and coming into contact with the freshly-admitted air, another vigorous combustion begins, due in a great measure to the high temperature attained by the gases in passing through the first regenerator. The combustion in the second chamber is not sufficiently thorough to consume all the combustible portions of the gases, and they, like in the first chamber, pass through the second regenerator, L′, into the third combustion-chamber, K^2, where, coming into contact again with freshly-admitted air, another combustion begins, which about exhausts the gases of their burning powers. The product of combustion in the third chamber is not so vigorous as in the second, nor is the second so rapid as the first; hence each successive regenerator absorbs less heat than the preceding one, and the products escaping into the chimney of the stove will be at a comparatively low temperature. In order to further facilitate combustion, I introduce air into one or more of the flues or cells U^2 of the regenerator, the lower ends of the said flues being closed, so that no gases may enter.

The flues U, instead of terminating at their lower ends in the combustion-chambers, pass outwardly through the casing, and are each provided at their outer ends with an air-valve for governing the admission of air thereto. By this arrangement no combustion of the gases can take place in the cell to which air has been admitted. Consequently the air in its passage up through this cell absorbs heat, and is delivered into the combustion-chamber at a considerably high temperature. Instead of closing up the lower ends of one or more of the flues U to form air-heating cells U^2, (shown in Figs. 2 and 5,) these air-heating cells can be formed in the wall of the furnace, as shown at U′, Fig. 4. After the regenerators have absorbed the proper amount of heat, the gas-admission valve P′ and the chimney-valve D are closed, and the cold-air valve G and hot-air

valve P^3 are opened, and the blast from the blowing machinery is caused to pass in an opposite direction through the stove from that pursued by the burning gases, thereby heating it to a temperature of from 1,000° to 1,500° Fahrenheit, as may be desired, and passing out through the pipe H and O. This process of alternate cooling and heating of the stoves is continued in such a manner that a blast of almost uniform temperature is delivered to the furnace.

By my process of heating the regenerators and their manner of construction, with short net-work of brick limiting the travel of the heating-gases to a comparatively-short distance, no excessive temperatures are required in the combustion-chamber, as is the case in the ordinary regenerative stove with only one combustion-chamber; hence less vitrifaction of brick takes place, and their power of receiving and imparting heat is not destroyed.

The flues of the regenerator, being short, are readily cleaned through the cleaning-doors by inserting a movable blow-pipe alternately into each flue and blowing a strong blast of air through them.

A peculiar feature of my blow-pipe, and a new one, is that the mouth of the blow-pipe is the size of the flue in the net-work of the regenerator, and that the entire force of the blowing-engine is concentrated on each flue to be cleaned and a violent blast forced through it.

I am aware that a regenerative hot-blast stove has been described wherein two regenerators are disposed in a horizontal position, one being located over the other, the adjacent ends being connected by an end chamber provided with openings for the admission of scrapers for the removal of dust. In my improved apparatus the regenerators are vertically disposed, one located over the other and connected by a combustion-chamber, thereby forming a continuous straight passage for the gas and air.

It is evident that numerous slight changes in the construction and relative arrangement of the several parts might be resorted to without departing from the spirit of my invention, and hence I would have it understood that I do not limit myself to the exact construction shown and described, but consider myself at liberty to make such changes and alterations as fairly fall within the spirit and scope of my invention.

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

1. In a regenerative hot-blast stove, two or more regenerative chambers arranged vertically one above the other, and a combustion-chamber at the lower end of each regenerative chamber, in combination with an air-inlet pipe communicating with the upper regenerator, and a hot-air-exit pipe connecting with the lower regenerator, substantially as set forth.

2. In a regenerative hot-blast stove, two or more regenerative chambers arranged vertically one above the other, and a combustion-chamber at the lower end of each regenerative chamber, in combination with an air-inlet pipe communicating with the upper portion of the upper regenerator, and a hot-air-exit pipe and gas-supply pipe communicating with the combustion-chamber of the lower regenerator, substantially as set forth.

3. In a regenerative hot-blast stove, two or more regenerative chambers arranged vertically one above the other, and a combustion-chamber at the lower end of each regenerative chamber, in combination with an air-inlet pipe communicating with the upper regenerative chamber, a hot-air-exit pipe and gas-supply pipe communicating with the combustion-chamber of the lower regenerator, and air-valves for supplying air to the combustion-chambers, substantially as set forth.

4. In a regenerative hot-blast stove, two or more regenerative chambers arranged vertically one above the other, and a combustion-chamber at the lower end of each regenerative chamber, in combination with an air-inlet pipe communicating with the upper regenerative chamber, the hot-air-exit pipe and supply-pipe communicating with the combustion-chamber of the lower regenerator, and valves for closing the hot air and gas pipes, and for opening and closing the stove at a point above the air-inlet pipe, substantially as set forth.

5. In a regenerative hot-blast stove, the combination, with two or more regenerative chambers arranged vertically one above the other, a combustion-chamber at the lower end of each regenerative chamber, and a stack located over the upper regenerative chamber, of an air-inlet pipe communicating with the stack, and a valve located in the stack at a point above said air-inlet pipe, substantially as set forth.

6. In a regenerative hot-blast stove, the combination, with two or more regenerative chambers arranged vertically one over the other, of combustion-chambers at the lower end of each regenerative chamber, said combustion-chambers gradually decreasing in size from the bottom upward, substantially as set forth.

7. The combination, with a casing and a series of combustion-chambers and regenerators situated in the same vertical plane, of air-flues U′, passing upwardly through the regenerators, for the purpose of heating the air admitted through these flues before it reaches the combustion-chamber.

8. In a regenerative hot-blast stove, a regenerator formed from brick of Greek-cross shape, substantially as set forth.

9. In a regenerative hot-blast stove, a regenerator formed of alternate layers composed of

Greek-cross brick and straight brick with beveled ends, the brick of said alternate layers being arranged to break joints with each other.

10. In a regenerator hot-blast stove, a regenerator formed of alternate courses of the Greek-cross bricks I and the straight blocks or bricks J, the said bricks being provided with grooves or gutters on one surface, and corresponding projections on the opposite surface, substantially as set forth.

11. In a regenerative hot-blast stove, the combustion-chamber formed by projecting each successive course of brick inwardly until they meet in the center, forming a dome-shaped roof, substantially as set forth.

12. The combination, with a metallic casing, adapted to be lined with fire-brick and provided with a recess or space, and a hollow valve-seat situated within said casing, of a hollow valve pivoted within said casing, the spindles of the said valve being hollow and projecting beyond said casing, and water supply and exhaust pipes communicating with the said valve and seat, substantially as set forth.

13. The combination, with the casing Q, provided with the recess T^2, the hollow valve-seat R, and the pinions T, secured to a shaft, the latter being journaled in arms secured to the casing, of the hollow valve, the segment rack-bars, and water supply and waste pipes, substantially as set forth.

14. In a regenerative hot-blast stove, the combination, with a casing lined with fire-brick and containing two or more regenerative-chambers arranged vertically one above the other and provided with a stack, and a water-cooled valve located within the stack, of an air-inlet pipe communicating with the upper regenerator, a gas-inlet pipe and hot-air-exit pipe communicating with the lower regenerator, and water-cooled valves situated in the hot-air and gas pipes, substantially as set forth.

15. The combination, with the casing, the series of regenerators and combustion-chambers, and the valve D, of the pipe E, valve G, and pipes P and O, substantially as set forth.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

PETER L. WEIMER.

Witnesses:
ELMER E. RANCH,
TOBIAS REINOEHL, Jr.