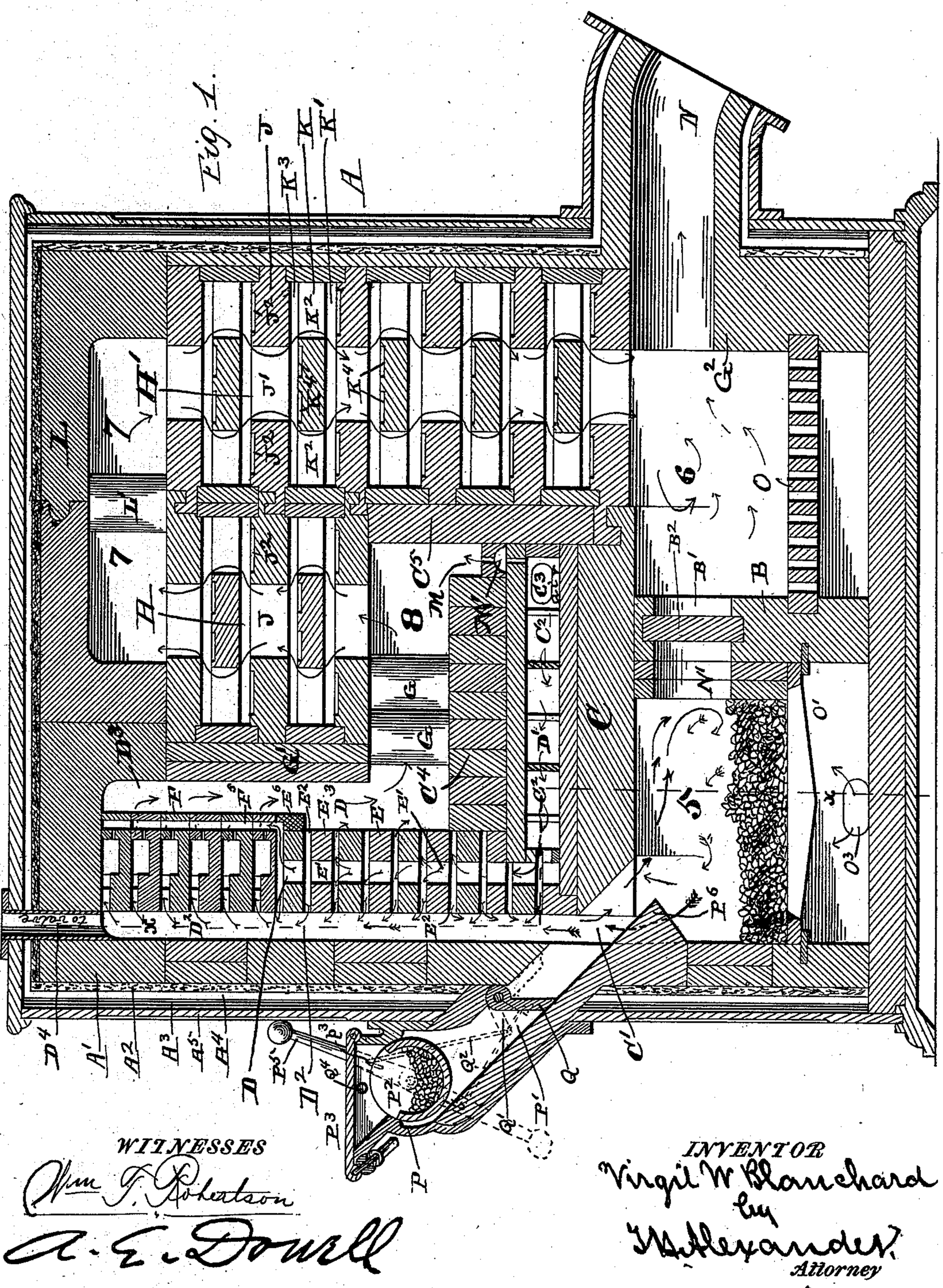
(No Model.) 3 Sheets—Sheet 1.

V. W. BLANCHARD.

FURNACE.

No. 413,927. Patented Oct. 29, 1889.

Fig. 1.



WITNESSES

Wm. F. Robertson

A. E. Dowell

INVENTOR

Virgil W. Blanchard

by

W. Alexander

Attorney

(No Model.) 3 Sheets—Sheet 2.

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Fig. 2.

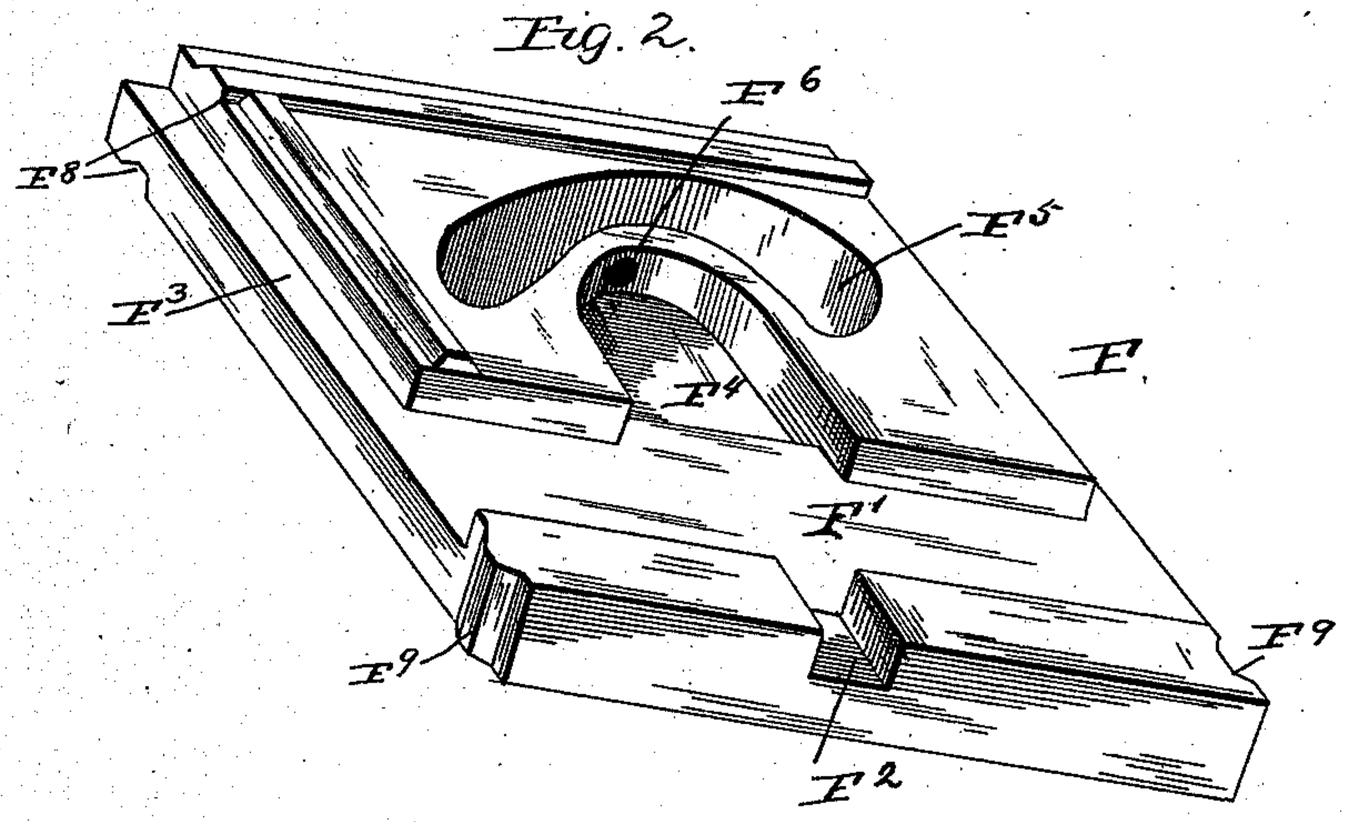


Fig. 3.

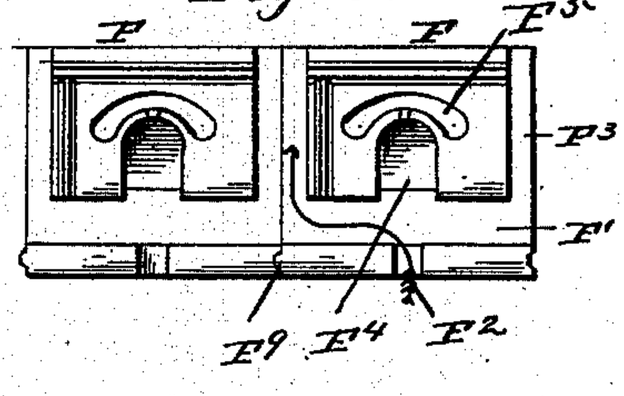
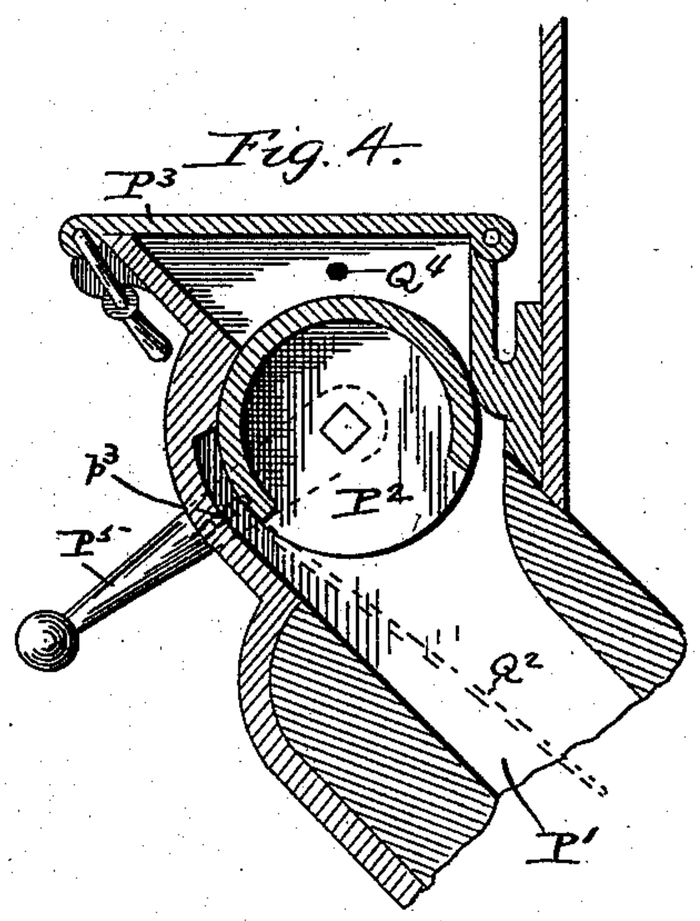


Fig. 4.



WITNESSES

Wm T. Robertson

A. E. Dowell

INVENTOR

Virgil W Blanchard

by

Wm Alexander

Attorney

(No Model.) 3 Sheets—Sheet 3.

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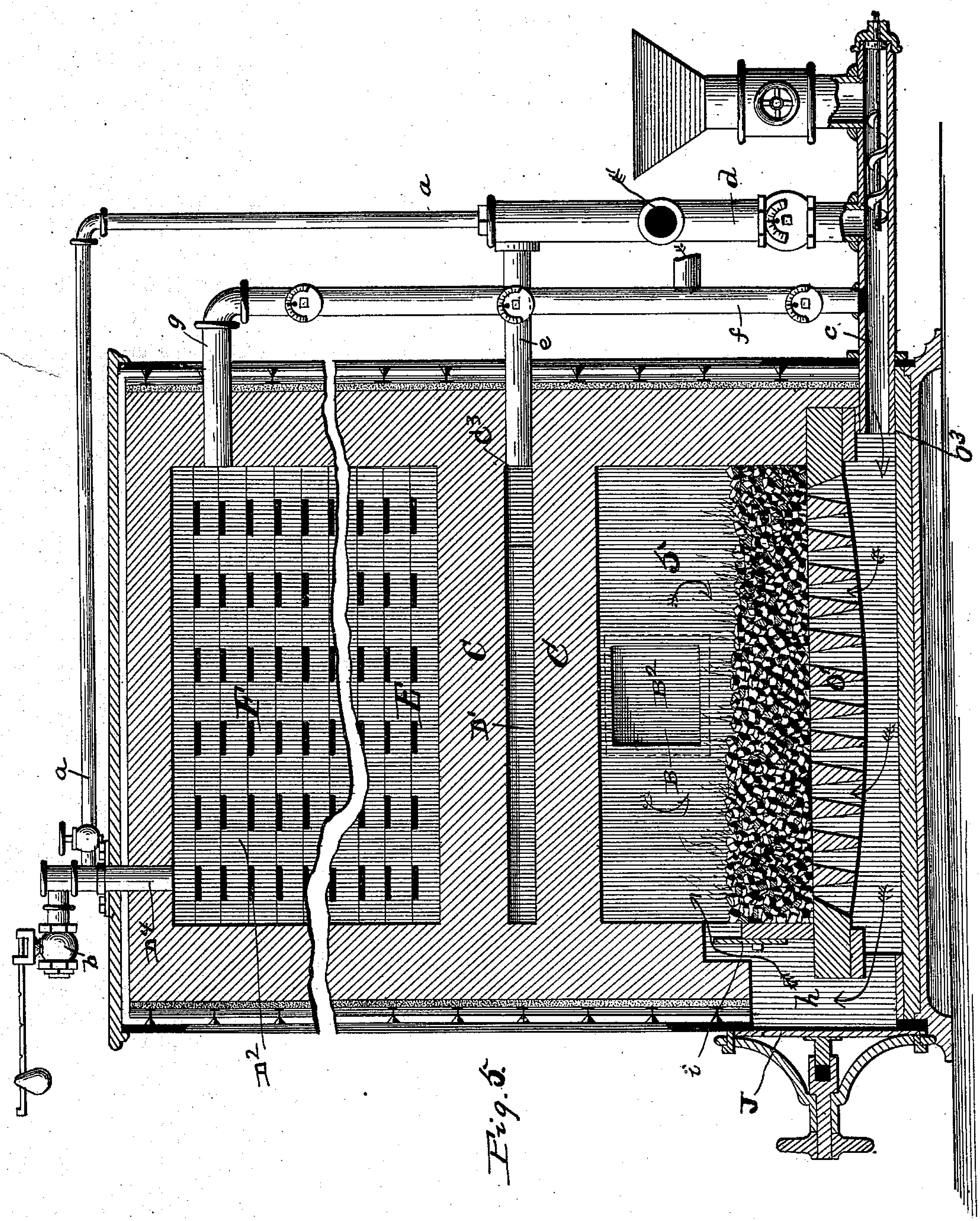

Fig. 5.

WITNESSES

Walter H. Pumphrey

A. E. Dowell.

INVENTOR

Virgil W. Blanchard

by

H. A. Alexander

Attorney

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

UNITED STATES PATENT OFFICE.

VIRGIL W. BLANCHARD, OF NEW YORK, N. Y., ASSIGNOR TO JOSEPH A. DAVIS, OF SAME PLACE.

FURNACE.

SPECIFICATION forming part of Letters Patent No. 413,927, dated October 29, 1889.

Application filed April 17, 1889. Serial No. 307,614. (No model.)

To all whom it may concern:

Be it known that I, VIRGIL W. BLANCHARD, of New York, in the county and State of New York, have invented certain new and useful Improvements in Furnaces; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form part of this specification, in which—

Figure 1 is a central vertical section through my improved furnace Fig. 2 is a perspective view of one of the fire-bricks used in constructing the gas-mixing chambers therein. Fig. 3 is a detail plan view of the mixing-chambers. Fig. 4 is a detail sectional view of the feeding device. Fig. 5 is a transverse vertical section on line *x x*, Fig. 1.

This invention is an improved furnace for the production of intense heat; and its objects are to so construct the furnace that all the combustible gases and elements contained in the fuel and in the air supplied to the furnace—such as hydrogen, oxygen, carbon, &c.—will be thoroughly consumed, together with the particles disassociated from the fuel and usually carried off into the atmosphere and lost, so that there is no waste of fuel whatever, and the highest attainable degree of heat produced with a very slight quantity of fuel.

Another object of the invention is to provide an auxiliary fire-chamber, whereby the furnace fire may be kindled properly without the aid of an auxiliary engine or artificial draft. I also provide means for feeding the fuel into the furnace fire-chamber proper without the admittance of cold air thereto or the escape of gases therefrom.

The invention consists in the peculiar and novel construction of the mixing chambers or passages in the furnace through which the gaseous products of combustion are compelled to pass, and also in the novel arrangement of air passages and flues, whereby the interior of the furnace just above the grate is used as an air-heater, and whereby the air is supplied to the several chambers into which the gases pass, and in certain other novel details of construction and arrangements of parts hereinafter set forth, all of which will be clearly understood from the following description and claims.

Reference being had to the accompanying drawings by letters, A represents the furnace, preferably rectangular in cross-section, the side walls of which are composed of non-heat-conducting materials, preferably having an inner wall of fire-brick or refractory material A′, exterior to which is a layer of porous fire-brick A^2, then a layer of asbestus paper or fiber A^3, and then an exterior metal shell or casing A^5. Between the asbestus and the other portions of the wall is left an air-space A^4. By this construction the intense heat developed in the furnace does not injure the wall thereof, and very little heat is lost by radiation. The bottom of the furnace is also lined interiorly with the fire-brick, as is also the top, which latter is, and the bottom may be, constructed like the side walls.

The lower part of the furnace is divided centrally by a partition B into two chambers 5 and 6, which communicate near their top through a horizontal flue B′ in partition B, near the top thereof, which is closed by a fire-brick damper B^2, which can be operated from the exterior of the furnace.

C designates a fire-brick imperforate roof over chamber 5 and projecting partly over chamber 6, as shown in Fig. 1, leaving a narrow vertical flue C′ at the front of the furnace for the escape of gases from chamber 5. Upon said roof is arranged a series of rows of bricks C^2, so laid as to form a tortuous or zig-zag passage D′ for the passage of an air-current which enters the opening C^3 in the wall of the furnace. Upon bricks C^2 is laid a heavy fire-brick flooring C^4, which closes the top side of the tortuous air-passage.

C^5 designates an imperforate wall rising from the inner edge of roof C above chamber 6, and about half-way to the top of the furnace, and hereinafter referred to.

At the front of the furnace and supported on roof C rises a vertical fire-brick partition D, which is built up of chambered fire-bricks E and F. Bricks E, which compose about one-half the partition in height, are formed with a central air-passage E′ and with small

lateral jet-passages E^2. The passages E′ in the lowermost bricks communicate through enlarged openings with the air-passage D′, as indicated.

The bricks F are of peculiar construction, (shown clearly in Fig. 2,) each having a lateral channel F′ in its upper face near its front edge, which opens by a short passage F^2 on said edge, and directly opposite said passage F^2 is formed a depression F^4, which forms a cinder-trap, and in rear of said trap is a vertical opening F^5 through the brick, communicating by a horizontal perforation F^6 with trap F^4.

F^3 are side channels or depressions in the sides of the bricks, extending from channel F′ to the rear thereof.

The bricks are formed with dovetail grooves and tongues F^8 and F^9, as shown, so that they can be laid in interlocking rows, superimposed one upon the other. When so laid, as shown in Figs. 1 and 3, the passages F^2, F′, and F^3 form tortuous broken zigzag channels, through which the heated gases must pass in passing from a front rising flue D^2, communicating with flue C′, to a rear diving flue D^3 on opposite sides of partition D, as shown clearly in Fig. 1.

The uppermost brick E is provided with a rearward extension E^6, having an angular channel therein communicating with channel E′ and with the openings F^5 of the bricks F superimposed thereon, as clearly shown in Fig. 1, by which the soot-traps in the bricks F are provided with air-jets communicating with the air-passages D′.

G G designate fire-brick supports resting on flooring C^4, about centrally between wall C′ and partition D, and upon these supports is built an imperforate fire-brick wall G′, which is opposite the bricks F and the upper layers of bricks E, and to the inside of wall G′, and resting upon supports G and the wall C^5, are a vertical series of fire-brick mixing-chambers H, which extend nearly to the top of the furnace, and on the opposite side of wall C^5 or rear of the furnace is another vertical series of mixing-chambers H′ similar to chambers H, but extending down to and communicating with chamber 6, being supported upon an abutment G^2 of the furnace-wall and the projecting edge of roof C, as clearly shown in Fig. 1. The two series of mixing-chambers are separated, however, so that the gases must rise through chambers H and descend through chambers H′. These chambers H H′ are made up of fire-bricks J K, laid alternately, the bricks J having a central passage J′ and depressions J^2 on each side thereof, which depressions are traps to catch and hold cinders and other particles carried off with the products of combustion until consumed. The bricks K have a bottom longitudinal passage K′ and side vertical passages K^2 K^2 and top longitudinal passages K^3 and traps K^4 K^4, as shown. If properly laid, the products of combustion pass through the central opening in brick J, thence diverge outwardly to pass inward to rise through the central opening in the superimposed brick J, and so on throughout the entire series, being thereby alternately compressed and expanded in passing through the passages in the alternate bricks. These bricks are preferably laid with interlocking joints, as indicated in the drawings, to prevent leakage or passage of gases, except through the described openings therein.

Above the mixing-chambers H H′ is a fire-brick arch or dome L, as shown, which may be centrally supported by a pillar L′, this arch forming a chamber 7 above said mixing-chambers closed at the top.

Between the bottom of mixing-chambers H and the roof C^4 is a chamber 8, in the bottom of which, adjoining wall C^5, is a depression or trap M, which communicates, through perforations M′ in the fire-brick, with the air-supply to passage D′, as is evident.

The tops of flues D^2 D^3 are closed by a heavy fire-brick arch, as shown, through which is or may be a vertical passage D^4, communicating with an air-supply pipe *a*, and with a pressure-valve *b*, if desired, by which the pressure in the furnace can be regulated.

The chamber 6 has a suitable outlet N, which may connect with a steam-boiler or other casing wherein the heat generated in the furnace can be utilized. In chamber 6 is a grate O, which is preferably made of perforated fire-brick; and in chamber 5 is a grate O′, the full area of which may be varied by means of fire-bricks N′, which are placed thereon at the sides, as shown in Fig. 1. Below said grate is an air-inlet O^3.

P designates a hopper secured to the front wall of the furnace and communicating, through an inclined chute P′, with the top of chamber 5, said chute being lined interiorly with fire-brick to prevent radiation or loss of heat. In said hopper is journaled horizontally a semi-cylindrical bucket P^2, which fits closely in the hopper and closes the mouth of the flue, as indicated in the drawings.

P^3 designates a tightly-closing cover for the hopper, which should be capable of being closed gas-tight.

P^5 designates an arm attached to the end of the bucket and exterior to the hopper, by which the bucket can be turned.

Q designates a fire-brick valve placed in the throat of chute P′, near the lower end thereof, and having a beveled lower edge adapted to make a close joint with the side and bottom of the chute and prevent the heating of the bucket unduly by the gases rising from the combustion-chamber 5. The lower end of the chute has a projecting portion P^6, designed to more evenly distribute the fuel upon the grate below. The stem of valve Q is provided with a crank-arm Q′, to which is connected one end of a rod Q^2, the other end of said rod engaging a slot p^3 in arm P^5 in such manner that when the bucket is turned,

so as to empty its contents into the chute, valve Q is opened, as indicated in dotted lines, Fig. 1, and when the bucket is turned back the valve is closed.

In feeding fuel the cover P^3 is raised and fuel placed in the bucket. The cover is then lowered and closed, and when desired the bucket is turned, as indicated in Fig. 4, its contents falling into chute P′, and descending therethrough onto the grate in chamber 5. In some instances fuel might be supplied through the opening in the top of flue D^2 instead of having chute P′. The chute P′ is provided with an air-pipe Q^4, if desired, communicating with an air-forcing engine, by which the bucket is kept from injurious heating and the gases forced back into the furnace.

c designates a fuel-feeding pipe entering opening O^3 and provided with a worm-conveyer and hopper, as indicated, by which pulverized fuel can be forced into the furnace.

d is an air-blast pipe communicating with pipe *c*, and connected with an air-forcing engine and heater, preferably.

e is a branch from pipe *d*, leading into opening C^3, the said pipes being suitably valved, as shown, so that the amount of air passed into opening C^3 or O^3 can be regulated. The pipe *a* also connects with pipe *d* and is properly valved.

f designates a pipe entering pipe *c* and connecting with a gas-trap in the chimney or uptake of the furnace and with a suitable engine, (not shown in the drawings,) by which, if desired, part of the gases rising in the uptake may be drawn back and forced into the furnace. *g* is a branch of said pipe leading into the upper end of the furnace, as indicated. Both of said branches are properly valved.

A fire is kindled on the grate in chamber 5 and a wood fire in chamber 6, the damper B′ being opened, so that there is a direct draft to the outlet N. The fire in chamber 6 causes a sufficient draft to kindle the coal on the grate in chamber 5, and when this has become sufficiently heated damper B′ is closed and a forced draft of heated air is introduced through openings O^3 and C^3. The air is admitted from pipe *d* into opening O^3 below the grate, part passing up through the bed of fuel thereon and part passing up through an opening *h* at the side of the grate, as shown by the arrows in Fig. 5. This opening may be regulated by an adjustable piece *i*, or entirely closed, if desired, access being had thereto through a tightly-closing door J. The oxygen in the air passing through the bed of fuel, after the latter has been heated to incandescence, first takes to itself two quantities of carbon, forming carbonic acid; but as the latter ascends through the bed of fuel (which should be several inches in depth) it becomes carbonized back into carbonic oxide. This gas, together with the hydrogen evolved in the combustion of the fuel, rises in combination with an ascending current of vaporized carbon into flue D^2. A portion of these gases will, however, be consumed by the oxygen derived from the air admitted through the bricks E as it rises in flue D^2. The gases at the top of said flue, as the pressure is increased, are forced into and through the channels in bricks F, wherein they are commingled and mixed, and any solid particles of carbon are caught in traps F^4 and retained until consumed or volatilized by the oxygen of the jets of heated air issuing through perforations F^6. From these bricks F they enter the descending flue D^3, being therein subjected to jets of air from the channels in bricks E, and from flue D^3 they enter chamber 8, where, under the forced draft, any solid particles capable of combustion still remaining among the gases may be caught in trap M and consumed. From chamber 8 the gases rise through the mixing-chambers H, wherein they are compressed and expanded, mixed, and agitated until they rise into chamber 7, the hydrogen being caught in said chambers and in the upper parts of flues D^2 D^3 and retained until consumed, thereby creating the most intense heat. From chamber 7 the gases descend through mixing-chambers H′ into chamber 6, from whence they escape. In their passage through mixing-chamber H′ the gases necessarily have to descend, and this unnatural course of the gases and the tortuous course they are compelled to pursue materially aids in mingling, triturating, and combining the gases and insuring their complete oxidation, and the numerous traps in the chambers H H′ receive and retain solid particles that they may be consumed or volatilized, and should there be any particles carried down through the chambers by the fierceness of the draft they descend upon the grate in chamber 6, where they remain until they are volatilized or consumed. It would be almost impossible to create a draft through the mixing-chambers H′ sufficient to drive the light hydrogen gas therethrough; hence this gas is held and retained by its specific gravity in the upper portion of the furnace until the oxygen contained in the air jetted therein can oxidize the same, thereby producing the most intense heat attainable. The same is true in less degree of the carbonic oxide. By means of valved pipe *a* fresh air can be supplied to the hydrogen in the top of the furnace without passing it through the passage D′, and by means of pipe *g*, I can introduce a portion of the gases therein, whereby the heat of the furnace will be tempered and reduced. The lower portion of the fuel on the grate in chamber 5 is kept comparatively cool by the incoming air and gases; but the upper portion thereof is raised to an intense incandescent heat, sufficient to permit the gases admitted below the grate to pass through the fuel and be recarbonized without cooling the fire below a desirable intensity. The chamber 5 is partly supplied with air from the

jets in bricks E, which air, in consequence of its greater specific gravity, passes down the side of partition D and into the fuel-chamber 5 above the grate, as indicated by the arrows 2 in Fig. 1, the air supplying oxygen to support the combustion on the grate. By this construction I utilize every available element to generate the heat, and utilize the carbonic-acid gas as a vehicle for picking up additional atoms of carbon from the fuel and conveying them to the mixing-chambers, where they are oxidized, thus saving the fuel by preventing oxidation thereof by contact with a large supply of air and only permitting sufficient air to contact with the fuel on the grate to support the combustion necessary to enable the carbonic-acid gases to be put therethrough. I am also able to equalize and regulate the temperature of the furnace by regulating the quantity of air or gas admitted thereto and the points of such admission, as described.

The air-blast from pipe *c* can be turned on sufficiently strong at intervals to blow the pulverized fuel and ashes into the furnace and up through opening *h* onto the bed of fuel in chamber 5.

Having thus described my invention, I claim—

1. In a furnace, the combination of the fire-chamber, a compartment in the furnace above the chamber, a partition dividing the said compartment into an ascending and a descending flue, said ascending flue communicating with the fire-chamber, and the descending flue communicating with the outlet-passages, the said partition having in its lower portion a vertical air-passage with a series of lateral jet-openings leading therefrom, and in its upper portion a series of independent transverse mixing-channels leading from one flue to the other, substantially as and for the purpose described.

2. In a furnace, the combination of the ascending flue communicating with the fire-chamber, the descending flue, the partition between said flue having air-passages and jet-openings, and the ascending series of mixing-chambers communicating with the descending flue, and the descending series of mixing-chambers communicating with the ascending series and with the outlet, substantially as described.

3. The combination, in a furnace, of a primary fire-chamber communicating with a series of flues, and mixing-chambers in the upper part of the furnace communicating with the flues and with an outlet, a secondary fire-chamber communicating with said outlet, and a damper between said fire-chambers, as and for the purpose specified.

4. The combination of the primary fire-chamber, the ascending and descending flues above the same separated by a partition having air-passages and jet-openings, substantially as described, the secondary fire-chamber, and a series of ascending and descending mixing-chambers communicating with said secondary chamber and with said descending flue, substantially as described.

5. In a furnace, the combination of a fire-chamber, the roof above the same, the ascending flue communicating with the fire-chamber, and descending flue above said roof separated from the ascending flue by an intermediate partition having air-passages and jet-openings, substantially as described, with the tortuous air-channel in said roof communicating with the air-passage in said partition and the air-supply thereto, all substantially as set forth.

6. In a furnace, the combination of an ascending flue communicating with the fire-chamber and a descending flue, with a partition between said flues, the lower portion of which has a central air-passage and lateral jet-openings leading therefrom, and its upper portion having vertical air-passages connecting with said central air-passage, and also having transverse gas channels or passages communicating with the ascending and descending flues, substantially as and for the purpose described.

7. The combination, in a furnace, of a fire-chamber having a closed roof in which is a tortuous air-heating passage, a pair of vertical flues above said passage communicating, respectively, with the fire-chamber and with passages leading to the outlet, and a partition separating said flues having air-passages communicating with the said tortuous air-heating passage, jet-openings, substantially as described, a series of mixing-chambers communicating with the lower end of the inner vertical flue, and a series of mixing-chambers communicating at top with the aforesaid chambers and at bottom with an outlet, said chambers having soot-traps, substantially as described.

8. In a furnace, the combination of the fire-chamber, the ascending and descending flues, closed at top and separated by a partition having air-passages, perforations, and channels, substantially as described, and a safety-valve connected to the top of one of said flues for regulating the pressure of gases therein, substantially as and for the purpose described.

9. The combination of the primary fire-chamber, the ascending flue above the same communicating therewith, the descending flue, and the partition between said flues, channeled and perforated for the passage of air and gases, and a gas-supply pipe leading from the outlet or uptake of the furnace and communicating with one of said flues, substantially as and for the purpose described.

10. The combination of the fire-chamber, the ascending flue communicating therewith, and the descending flue above said chamber, separated from the ascending flue by a partition channeled and perforated for the passage of air and gases, substantially as described, the tortuous air-passage formed in

the roof of said fire-chamber and communicating with the air-channels in said partition, the air-supply pipes communicating with said passage and ash-pit, and the gas-supplying pipes, all substantially as set forth.

11. The combination of the fire-chamber, the vertical flue communicating therewith, the descending flue separated from said vertical flue by a partition having passages, channels, and soot-traps, substantially as described, and the tortuous channel in the roof of the fire-chamber communicating with the air-passages and with a supply for heating the air supplied to the passages in said partition, substantially as set forth.

12. The combination of the fuel-chamber, the vertical ascending flue communicating with the fire-chamber, the descending flue, the partition between said flues having air-passages, channels, and jet-openings, substantially as described, and the air-heating channel in the roof of the fire-chamber communicating with an air-supply and with the passages in said partition, the air-supply pipe *a* *c*, and gas-supplying pipes *f* *g*, all substantially as and for the purpose set forth.

13. The combination of the furnace having a primary fire-chamber 5, an auxiliary fire-chamber 6, a closed roof formed with an interior air-heating channel D′ over chamber 5, the vertical ascending flue communicating with chamber 5, and the descending flue, and the vertical partition separating said flues having air-passages and perforations, substantially as described, with the series of mixing-chambers H, the trapping-chambers 7 and 8, and the descending series of mixing-chambers H′, communicating with the chambers 6 and 7, the outlet from said chambers, and the air and gas supply pipes, all substantially as described.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

VIRGIL W. BLANCHARD.

Witnesses:

ALEX. S. STEUART,

A. E. DOWELL.