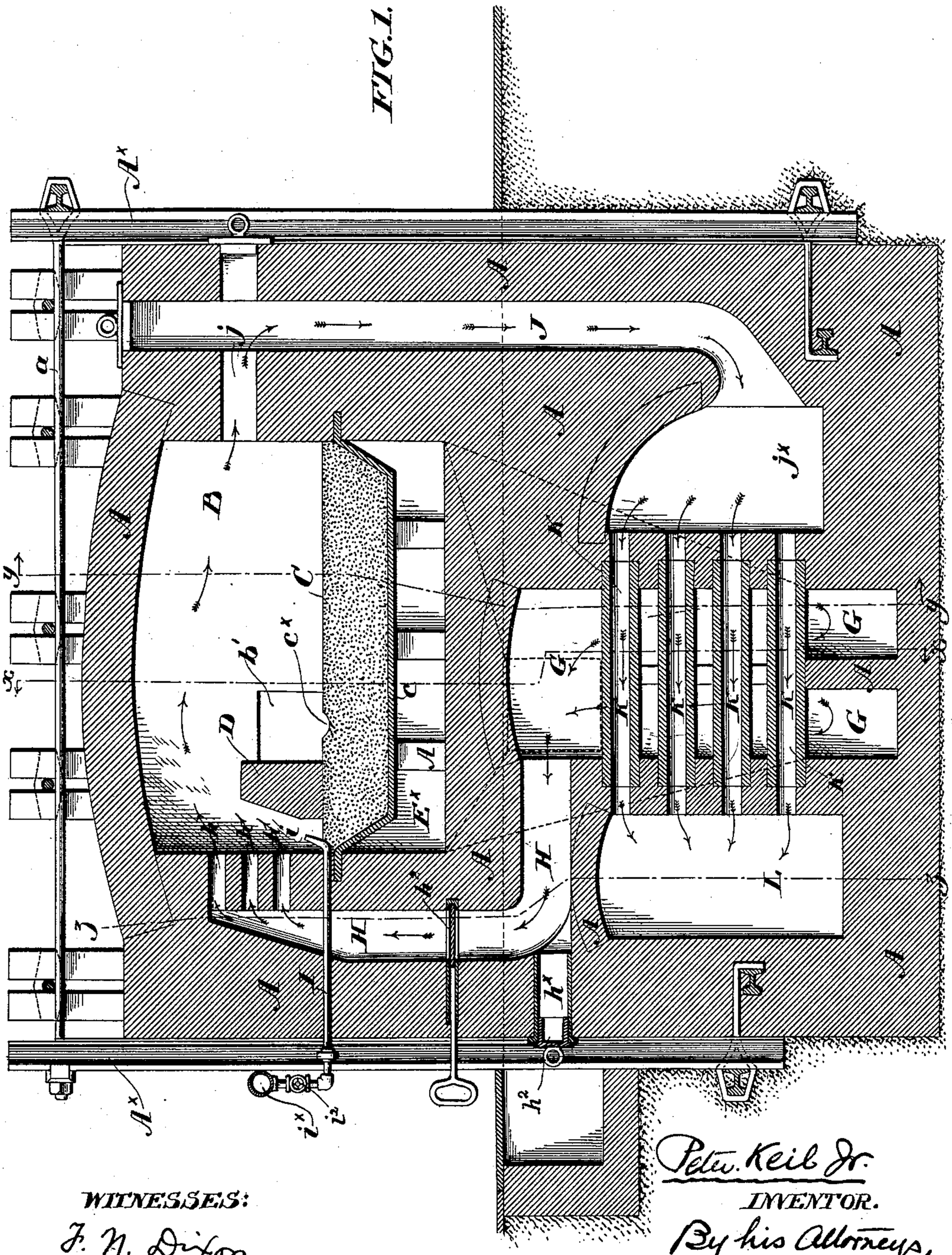
(No Model.) 4 Sheets—Sheet 1.

P. KEIL, Jr.

HEATING FURNACE.

No. 482,363. Patented Sept. 13, 1892.

FIG. 1.



WITNESSES:

F. H. Dixon

Frank Lucius

Peter Keil Jr.

INVENTOR.

By his Attorneys,

Wm C. Strawbridge

Bonsall Taylor

(No Model.) 4 Sheets—Sheet 2.

P. KEIL, Jr.

HEATING FURNACE.

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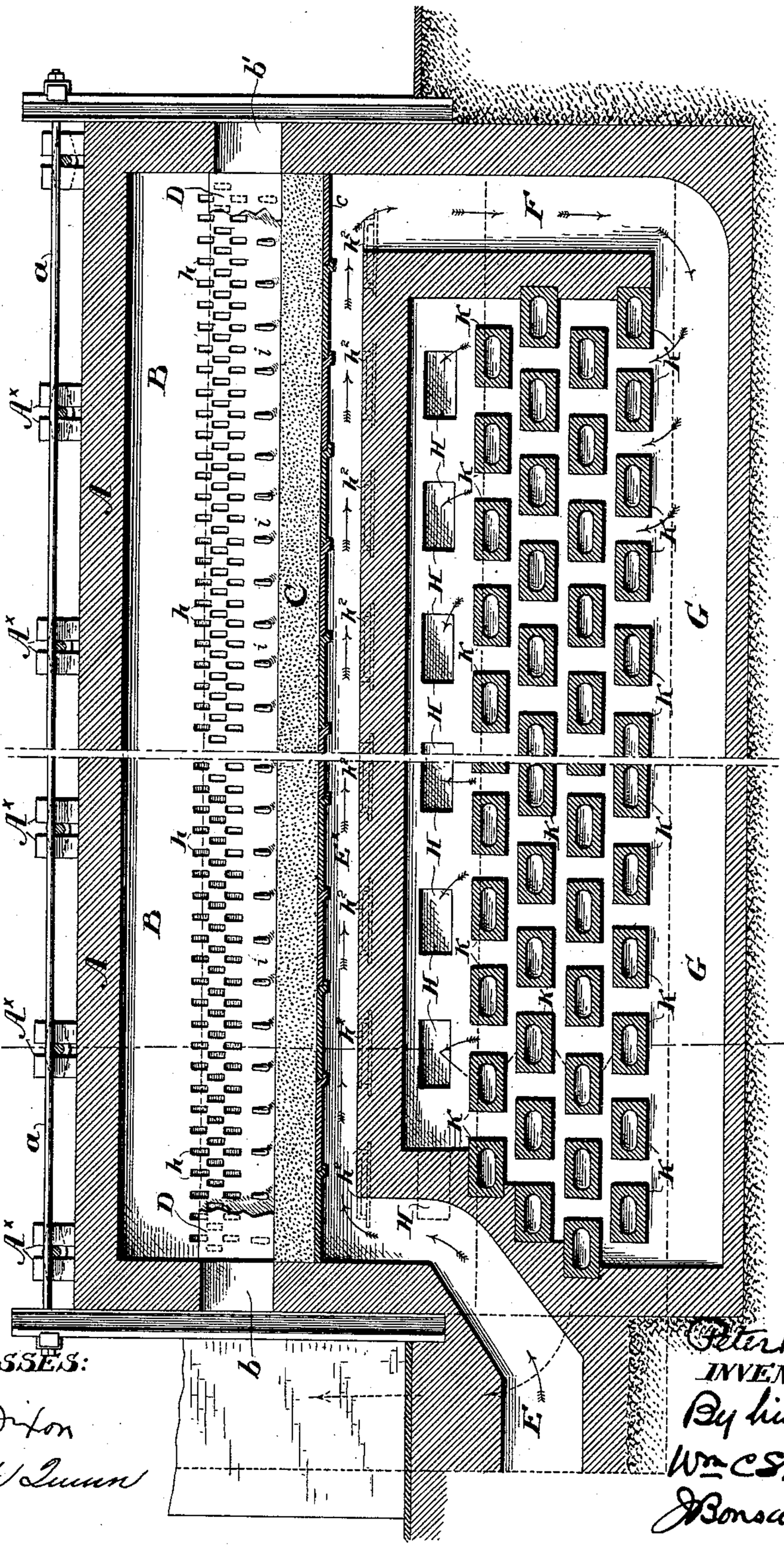
FIG. 2.



WITNESSES:

F. N. Dixon

Frank Quinn

Peter Keil Jr.
INVENTOR.
By his Attorneys
Wm C Strawbridge
Bonsall Taylor

(No Model.) 4 Sheets—Sheet 3.

P. KEIL, Jr.

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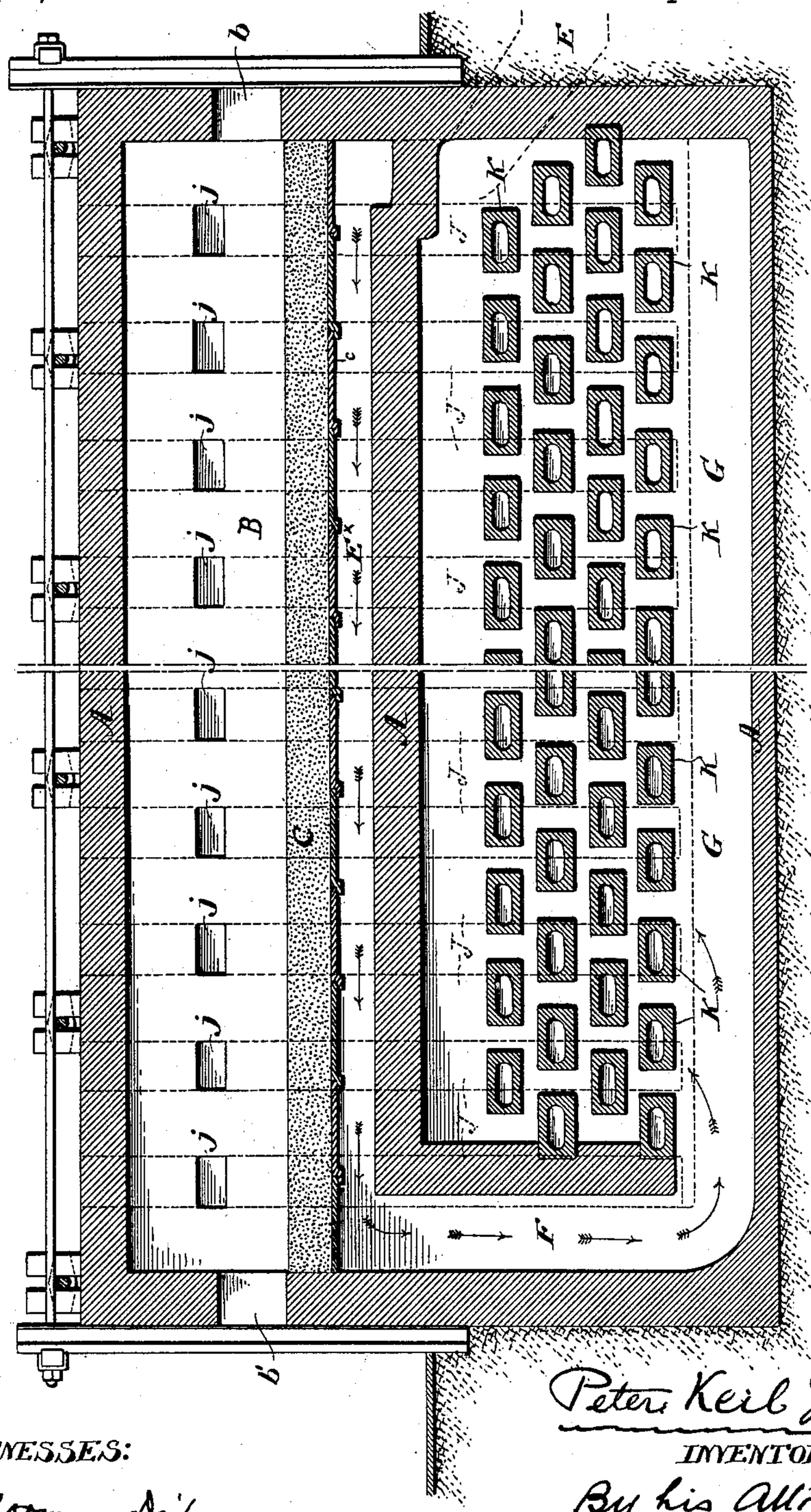


FIG. 3.

WITNESSES:

J. Norman Dixon

Frank Quinn

Peter Keil Jr.

INVENTOR.

By his Attorneys

Wm C. Strawbridge

J. Bonsall Taylor

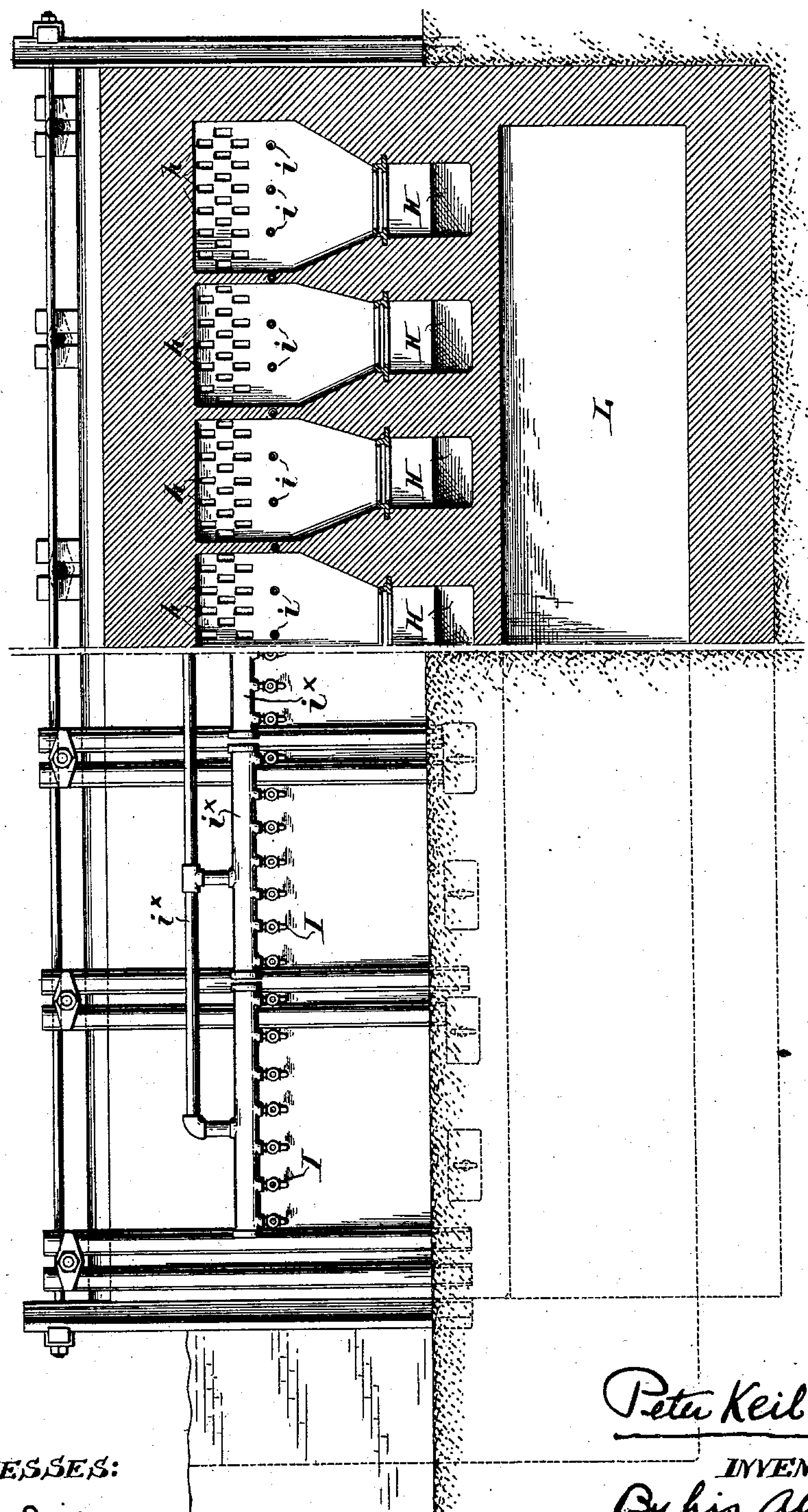
(No Model.) 4 Sheets—Sheet 4.

P. KEIL, Jr.

HEATING FURNACE.

No. 482,363. Patented Sept. 13, 1892.

FIG. 4.



WITNESSES:

F. N. Dixon

Frank Quinn

Peter Keil Jr.

INVENTOR.

By his Attorneys

Wm. C. Strawbridge

J. Bonsall Taylor

UNITED STATES PATENT OFFICE.

PETER KEIL, JR., OF PHILADELPHIA, PENNSYLVANIA.

HEATING-FURNACE.

SPECIFICATION forming part of Letters Patent No. 482,363, dated September 13, 1892.

Application filed December 2, 1890. Serial No. 373,289. (No model.)

To all whom it may concern:

Be it known that I, PETER KEIL, Jr., a citizen of the United States, residing in the city and county of Philadelphia, and State of Pennsylvania, have invented certain new and useful Improvements in Heating Furnaces, of which the following is a specification.

My invention relates to heating furnaces in which the fuel is either a liquid a gas or a vapor, and its object is the construction of an inexpensive and durable furnace, simple of construction and economical in consumption of fuel.

A furnace embodying my improvements is represented in the accompanying drawings, and hereinafter described, the particular subject-matter which I claim as novel being hereinafter definitely specified.

In the drawings, Figure 1 is a transverse sectional elevation through a furnace embodying my improvements, section being supposed in the planes of the dotted line *x x* upon Fig. 2, and sight being taken in the direction of the arrows upon said line. Fig. 2 is a longitudinal sectional elevation through the furnace represented in Fig. 1, section being supposed in the plane of the dotted line *x x* upon said Fig. 1, and sight being taken in the direction of the arrows upon said line. Fig. 3 is a longitudinal sectional elevation through the furnace shown in Fig. 1, section being supposed in the planes of the dotted line *y y* in said Fig. 1, and sight being taken in the direction of the arrows upon said line. Fig. 4 is a side elevational view of the furnace represented in the other figures, viewed from the left hand side of Fig. 1, a portion of said furnace being, however, represented in longitudinal sectional elevation in the plane of the dotted line *z z* in Fig. 1.

Similar letters of reference indicate corresponding parts.

It is proper to state that the furnace represented in the drawings is especially adapted to the heating of skelp, but my invention comprehends a furnace for heating purposes generally and without restriction to any special employment.

In the drawings the letter A, wherever applied, indicates brick work, it being preferable to construct the furnace of bricks.

$A^{\times}$ represent buck stays, and *a* tie rods of any preferred character by the aid of which the brick work is laterally sustained.

B is the combustion chamber, extending longitudinally of the furnace and in the upper portion thereof. The hearth C of this chamber is shown as composed of a bed of sand sustained by a longitudinally-extending metal trough, preferably composed of a series of transversely extended connected hearth plates *c*.

D is a bridge wall extending the length of the combustion chamber in approximate parallelism with and near one of its side walls.

b is the charging door of the furnace, and *b'* the discharging door.

$c^{\times}$ is a hearth gutter of a character employed when skelp is being heated.

E is a cold air inlet preferably leading near the charging end of the furnace into what I term a pre-heating air chamber $E^{\times}$ formed and extending beneath the hearth and terminating in an air down-take F at the discharging end of the furnace which leads down and vents into a recuperating chamber G co-extensive with the length of the furnace within the lower portion thereof and preferably of the general form shown in the drawings.

H are a series of hot air flues respectively leading out from the upper portion of the recuperating chamber and respectively terminating each in a series of hot air ports *h* opening in an approximately horizontal direction into the combustion chamber above or against the outside face of the bridge wall as shown in the drawings. Each of the hot air flues, of which there may be any desired number each terminating in any desired number of ports, is provided with a clean-out $h^{\times}$ of any usual character, and with a valve or damper h^{2}.

I are a series of burner pipes passing in through the side wall of the furnace and terminating within the combustion chamber in burners *i*, disposed to discharge in an approximately vertical direction between the wall of the combustion chamber and the bridge wall and almost right angularly with respect to the direction of the discharge of the hot air ports. Any desired number of these burners is employed and the burner pipes conveniently connect with any preferred system of supply pipes $i^{\times}$ exterior to the furnace. The pipes, of course, convey the gaseous vaporous or

liquid fuel employed and burned at the burners within the combustion chamber, and are supplied with suitable cocks i^2.

j are a series of escape ports leading out from the wall of the combustion chamber opposite to that through which the air ports lead, and leading into a series of draft-down-takes J which pass downward through the side wall of the furnace and conveniently terminate in a draft-down-take chamber $j^\times$ extending longitudinally of the furnace alongside of the recuperating chamber.

K are a series of recuperating tubes passing transversely through and built solidly into the walls of the recuperating chamber in approximate parallelism with each other and preferably in an alternating or staggered disposition as shown in Figs. 2 and 3, and communicating at their respective extremities with the draft-down-take chamber upon the one hand and with a draft discharge chamber L which leads to and is, in effect, the basal portion of the stack.

The recuperating tubes are preferably but not restrictively tiles incased in metal jackets k, which jackets, as indicated in the drawings, correspond to the external shape of, and fit snugly upon, the bodies of the tubes.

Having now described a furnace conveniently embodying my improvements, its operation will be readily understood;—The air from the blast through the cold air inlet in its passage through the pre-heating chamber becomes more or less heated, and in its passage through the recuperating chamber becomes further heated until by the time it is discharged through the air ports into the combustion chamber it is sufficiently heated to support and intensify the combustion of the fuel at the burners, the flames from which it is discharged angularly with respect to. The products of combustion escaping through the escape ports from the combustion chamber traverse the draft-down-takes to the draft-down-take chamber, and in their escape through them heat the recuperating tubes to the extent requisite to cause said tubes to heat the air.

From a consideration of the construction and mode of operation of my furnace, it will now be apparent that it possesses the advantages of both the reverberatory and the regenerative furnaces in that it possesses the continuous and direct action of the reverberatory and the recuperative action of the regenerative.

Further advantages are the following:—That the relative arrangement of the air ports and the burners is such that the air and fuel are respectively injected in attenuated continuous currents into across and against each other, so to speak, so as to become thoroughly intermingled, with the result that the combustion with a given quantity of fuel is very rapid and perfect, the temperature being very rapidly raised;—that by the employment of the valves in the hot air flues in connection with the cocks in the fuel supply pipes, a perfect control of the temperature of the furnace at every point throughout its length is secured;—that every part of the furnace is easy of access for repairs;—that by the employment of the draft-down-takes, in connection with the recuperating chamber and tubes, the heat is very largely extracted from the gaseous products of combustion in their passage from the combustion chamber to the stack, whereby the advantages of the regenerative furnace are secured without resort to checker work and costly valves and without disturbing the action of the furnace by frequent reversings, whereby also a large quantity of the heat is taken from the outgoing gases and restored to the furnace at the point of combustion with the ingoing air as effectually and more cheaply than in the regenerative furnace.

As is apparent without further mention, the furnace is both simple and cheap of construction in comparison with other furnaces employing the same character of fuel, while the consumption of the fuel itself is diminished.

Having thus described my invention, I claim and desire to secure by Letters Patent:

1. In a heating furnace, the following elements in combination:—a combustion-chamber,—a pre-heating air chamber beneath the hearth of the combustion chamber and in communication with a source of cold air supply and with a recuperating chamber,—a recuperating chamber,—flues leading from said recuperating chamber to the combustion chamber and each having a series of independent ports opening into said combustion chamber,—a series of fuel burners opening into the combustion chamber angularly with respect to the direction of discharge of the ports and operating in conjunction with said ports,—a series of independent recuperating tubes traversing the recuperating chamber,—and draft down-takes from the combustion chamber which discharge through said tubes to the stack,—substantially as set forth.

2. In a heating furnace, the following elements in combination:—a combustion chamber,—a pre-heating air chamber beneath the hearth of the combustion chamber and in communication with a source of cold air supply and with a recuperating chamber,—a recuperating chamber,—flues leading from said recuperating chamber to the combustion chamber and each having a series of independent ports opening into said combustion chamber,—a series of fuel burners opening into the combustion chamber angularly with respect to the direction of discharge of the ports and operating in conjunction with said ports,—a series of independent recuperating tubes traversing the recuperating chamber and alternated and staggered in the manner set forth,—and draft downtakes from the combustion chamber which discharge through said tubes to the stack, substantially as set forth.

3. In a heating furnace, the following ele-

ments in combination:—a combustion chamber, a recuperating chamber,—means for supplying air to the recuperating chamber,—flues leading from said chamber and each discharging through a series of valve-controlled ports into the combustion chamber,—valve-controlled fuel burners likewise discharging into the combustion chamber and operating in conjunction with said ports,—a series of recuperating tubes traversing the recuperating chamber, alternated or staggered as set forth, and discharging to the stack,—and draft downtakes leading from the combustion chamber and opening into said tubes,—substantially as set forth.

4. In a heating furnace provided with a combustion chamber, in combination:—a recuperating chamber embodying an air inlet,—a series of recuperating tubes traversing said recuperating chamber, staggered or alternated with respect to each other, non-circular in cross section, and disposed with their major transverse axes in substantially horizontal arrangement,—a draft downtake in communication respectively with the combustion chamber and the recuperating tubes,—and a hot air flue leading from the recuperating chamber to the combustion chamber,—substantially as set forth.

In testimony that I claim the foregoing as my invention I have hereunto signed my name this 26th day of November, A. D. 1890.

PETER KEIL, JR.

In presence of—
J. BONSALL TAYLOR,
F. NORMAN DIXON.