

2 Sheets—Sheet 1.

E. M. MONSANTO, Administratrix.

No. 496,365.

Patented Apr. 25, 1893.

Fig. 1.

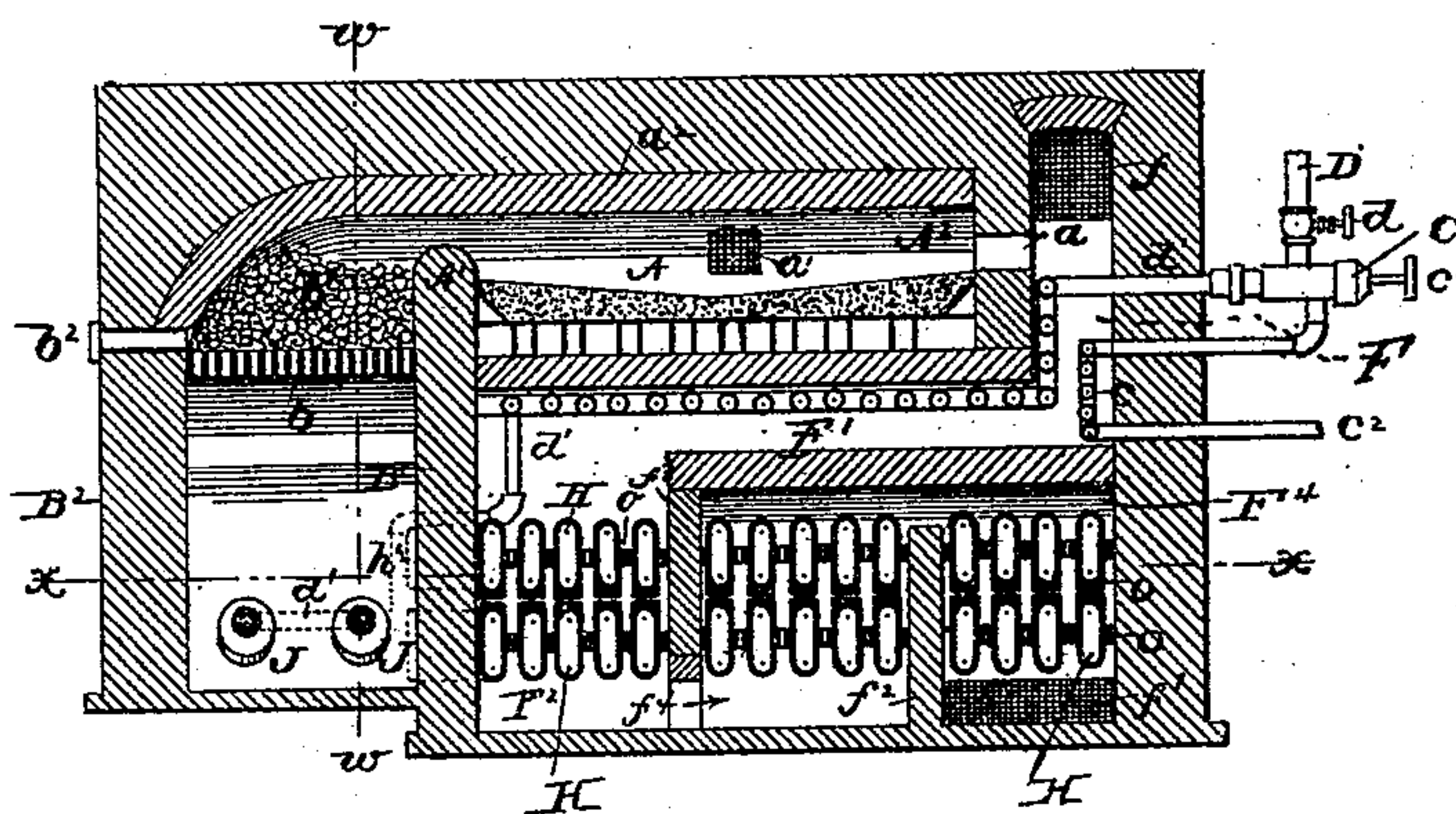


Fig. 2.

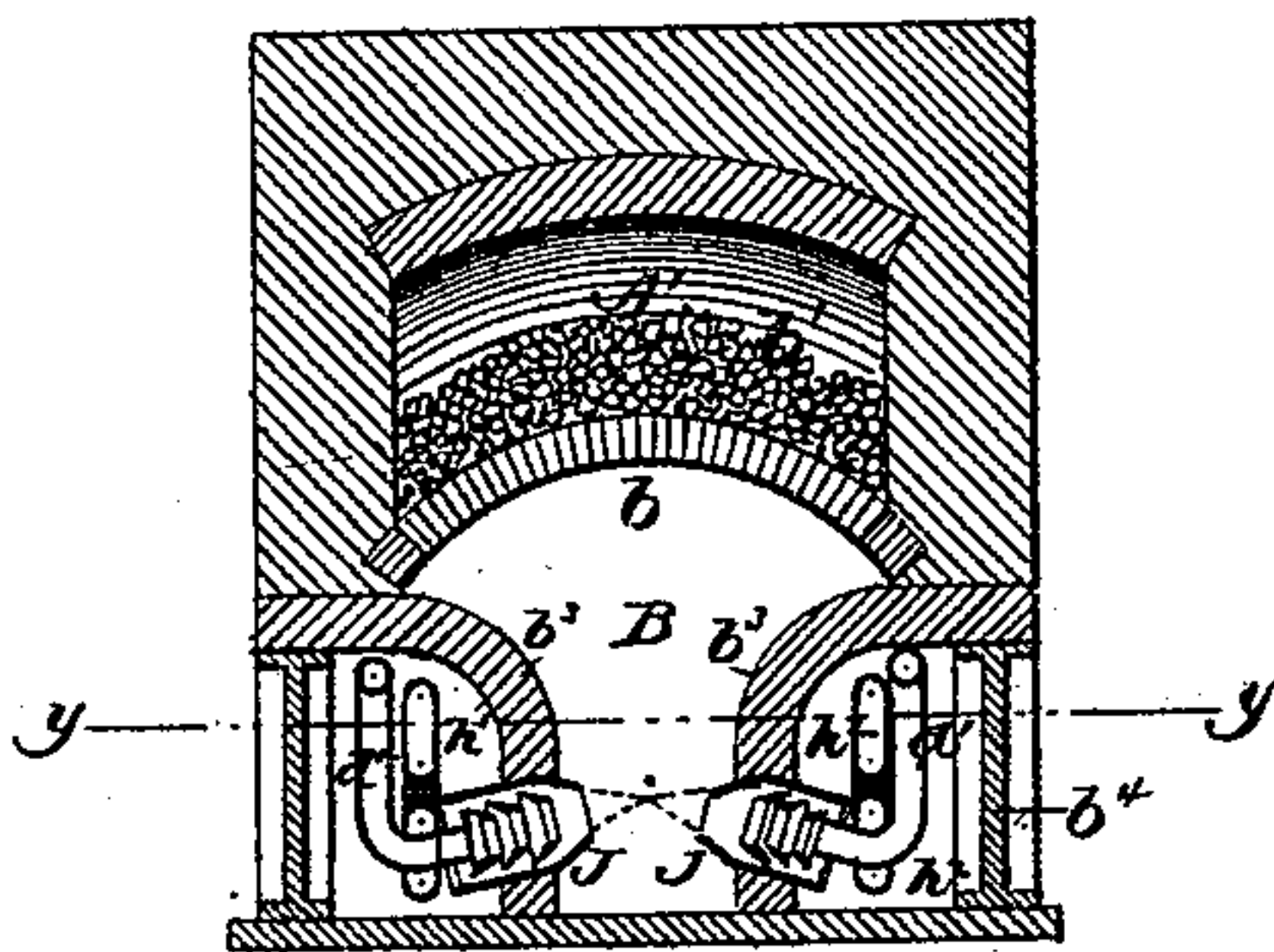
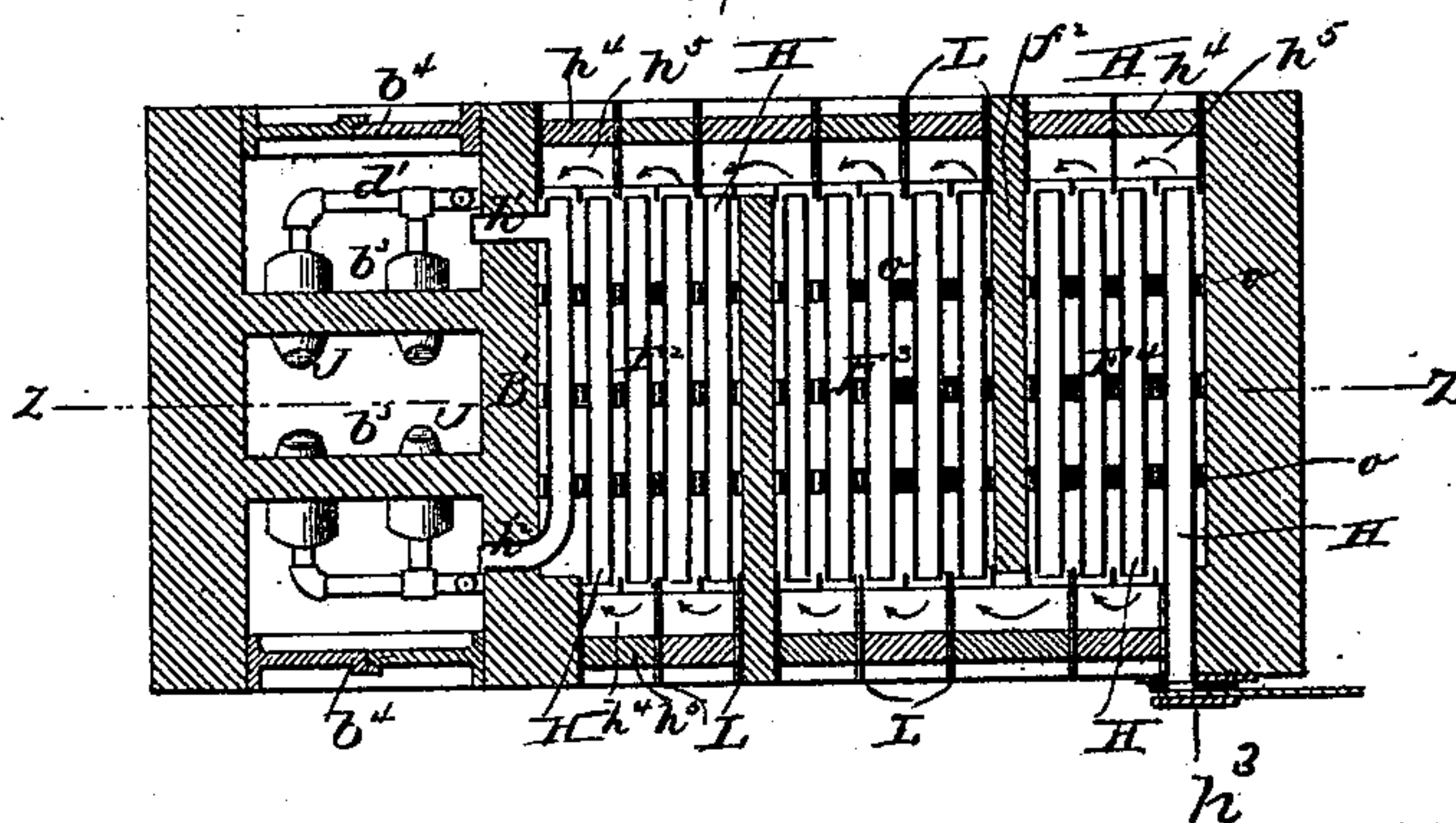


Fig. 3.



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(No Model.)

2 Sheets—Sheet 2.

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REGENERATIVE FURNACE.

No. 496,365.

Patented Apr. 25, 1893.

Fig. 4.

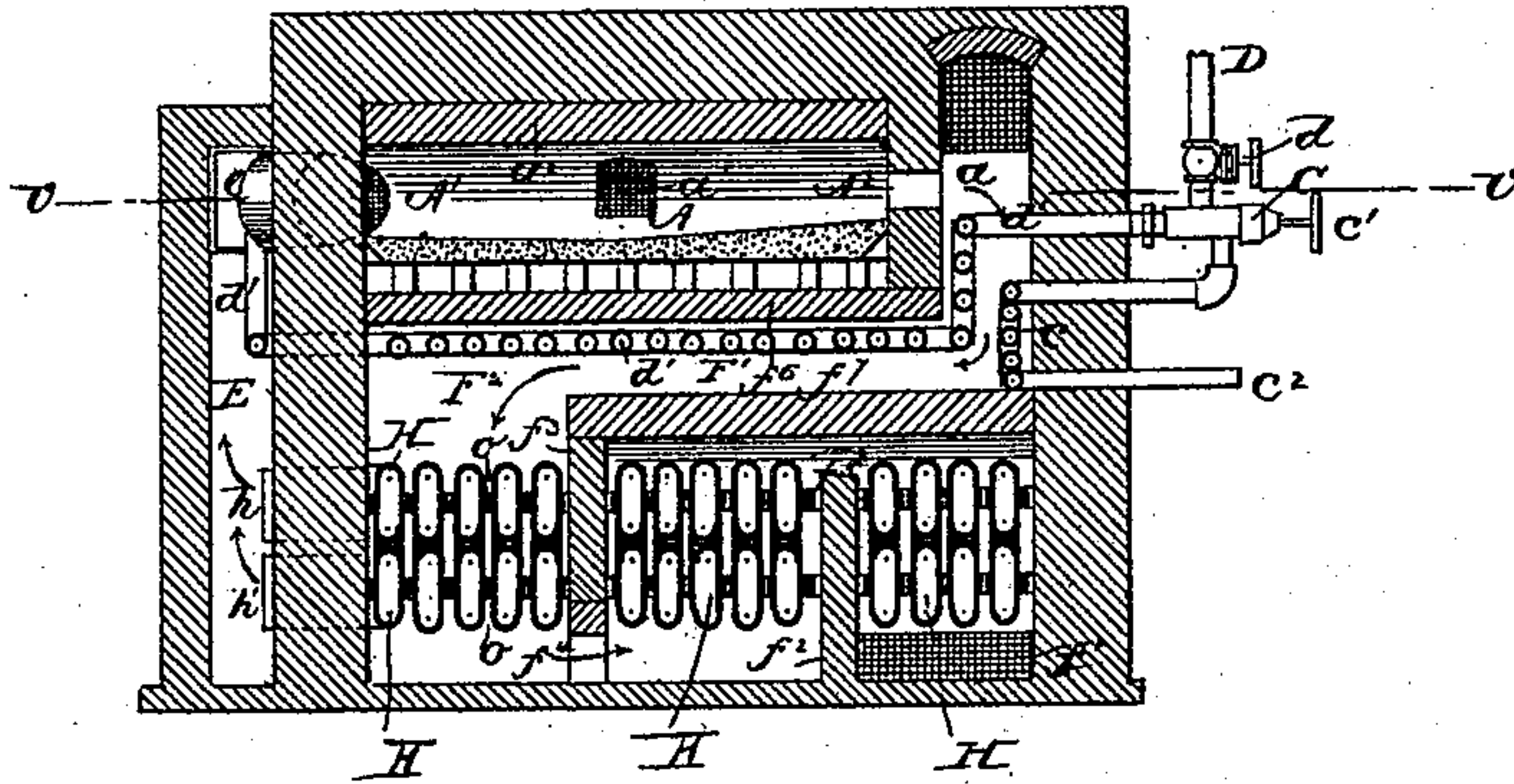


Fig. 5.

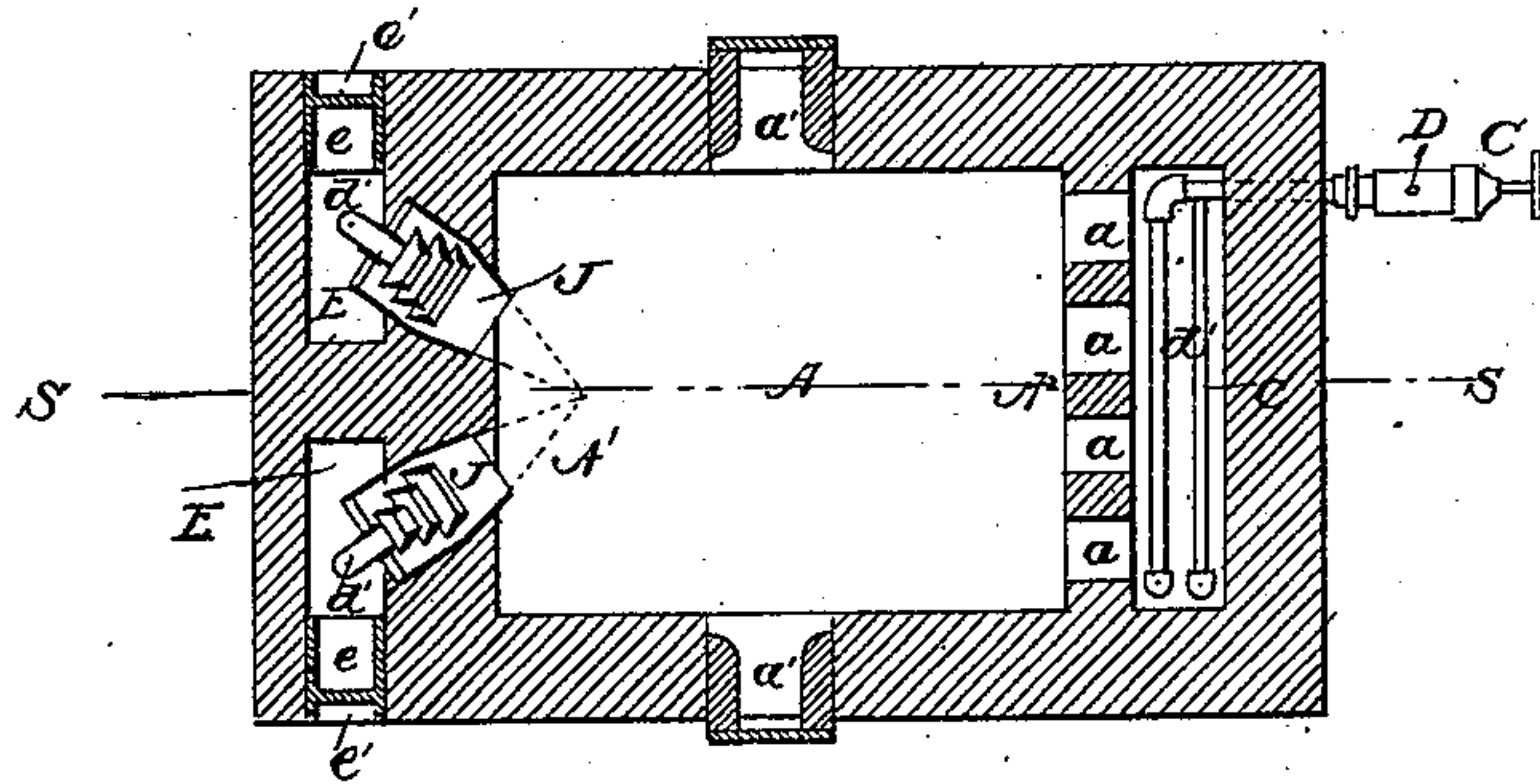


Fig. 6.

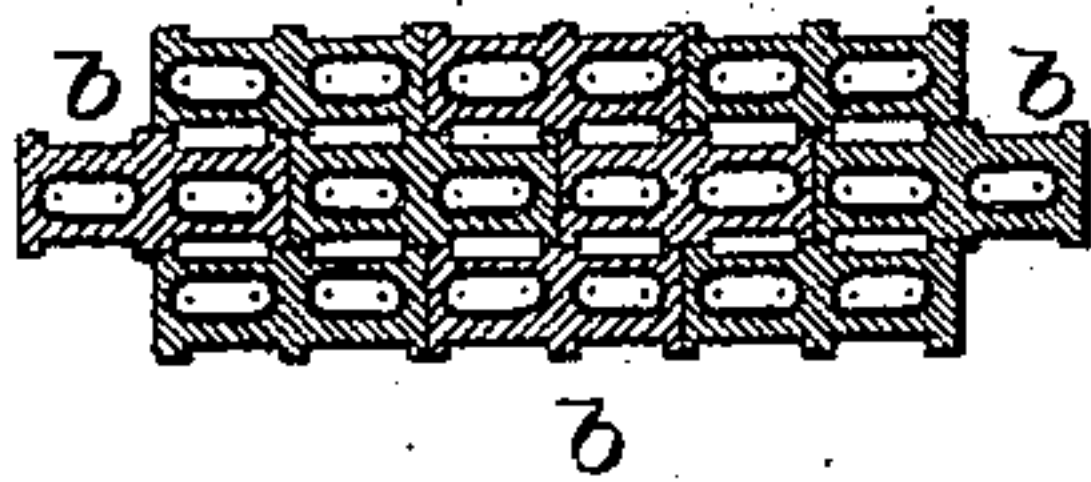
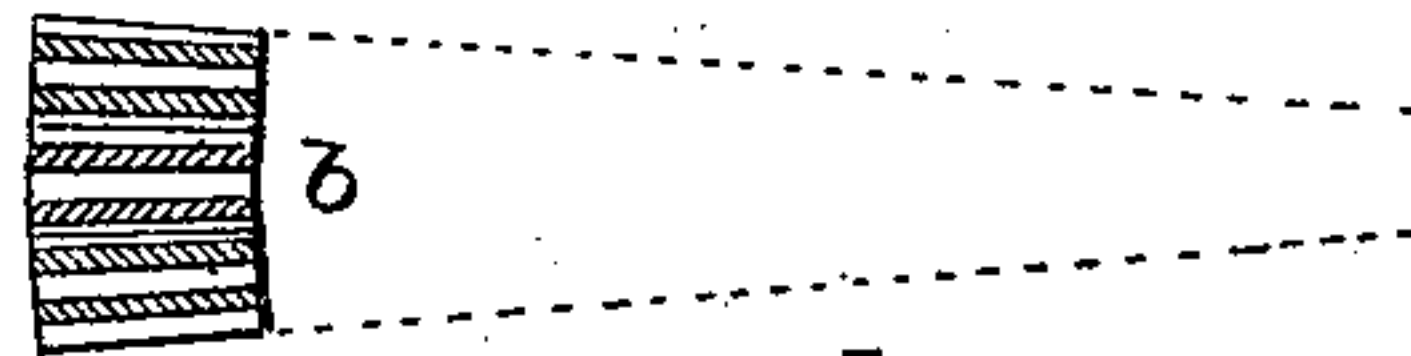


Fig. 7.



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UNITED STATES PATENT OFFICE.

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REGENERATIVE FURNACE.

SPECIFICATION forming part of Letters Patent No. 496,365, dated April 25, 1893.

Application filed December 27, 1886. Serial No. 222,648. (No model.)

To all whom it may concern:

Be it known that I, MAURICIO M. MONSANTO, a citizen of the United States of Colombia, residing at New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Regenerative 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 appertains to make and use the same.

This invention relates to regenerative furnaces.

My invention relates to regenerative furnaces, and it consists in the construction and novel combination of parts as hereinafter set forth.

The advantages of economy of fuel and high temperatures obtained by heating the gaseous fuel, as well as the air, previous to combustion, are universally acknowledged, and it is the object of my invention to effect the heating of the elements of combustion, by means of the waste heat, in a more effective, economical and easy way, than heretofore; said elements being heated in continuous conduits, the flow of which can be regulated, while the said elements are delivered at the point of combustion at the maximum and constant unvarying temperature, and said conduits being easy of access for repairs, cleaning and inspection, and economical in use and in construction.

The combustion of gas fuels is effected more completely when they, as well as the air, are highly heated, because of a resulting greater affinity toward each other to form the necessary chemical union, and as this union is therefore effected in a shorter space and time, than when they are at the ordinary temperature, the heat resulting from the combustion is more intense and centralized at, or near, the point where the gases meet, a condition of great advantage, especially in metallurgical and other operations. Another point of economy consists, by heating the air previous to combustion, in heating of its component nitrogen, which is an inert substance, constituting about four times the volume of its co-component oxygen, whereby the heated nitrogen will fail to abstract from the combustion, and

thereby economize, as much heat as would be required to raise it to the temperature of the furnace, were it at the ordinary temperature of the atmosphere, and, as large volumes of air are required for combustion, and as the heating of the air is effected by the waste heat, which would not otherwise be utilized, the economy resulting is evidently very great.

The recuperator, which constitutes a part of my invention, is applicable to any kind of furnace, and may be placed in the spent heat flue thereof, whereby a great saving of fuel and greater quantity and intensity of heat will be obtained.

In the accompanying drawings, I have shown the furnace as operated by means of liquid fuel, transformed into gaseous form by means of superheated steam, and the combustion is operated by means of converging jets, as shown and described in my application for patent apparatus for the combustion of liquid, gaseous and pulverized fuels, bearing date March 23, (this day) 1886; the superheating of the steam and of the gas fuel, as well as the heating of the air, being effected by means of the waste gases from the furnace.

It is evident that the furnace may be operated by means of any other kind of gaseous fuel, and the recuperator, or air heating apparatus may be applied to furnish heated air for combustion to steam boiler, or other furnaces, said recuperator being placed in the course of the spent heat flue, as, for example, either under the steam boiler, similarly as under a puddling furnace (Fig. 1), as shown beneath the furnace, or near the exit from the steam boiler, between it and the chimney, or in the chimney itself, and may be placed horizontally or vertically, as desired.

In the accompanying drawings, I have shown an improved apparatus, in which the operation of my invention is exemplified.

Figure 1, represents a vertical longitudinal sectional elevation of my improved apparatus, line of section *z, z*, of Fig. 3. Fig. 2, is a vertical cross section thereof, following the line *w, w*, Fig. 1. Fig. 3, is a horizontal longitudinal section, on the line *x, x*, of Fig. 1. Fig. 4, is a vertical longitudinal section of a modification of Fig. 1, following the line *s, s*, of Fig. 5, showing the converging jets oper-

ing the combustion direct into the combustion chamber. Fig. 5, is a horizontal longitudinal section on the line v, v , of Fig. 4. Figs. 6 and 7, represent a detail, in plan and cross section respectively, upon an enlarged scale, of the perforated bricks to be used upon the arch b , in Figs. 1 and 2.

Similar letters designate corresponding parts.

A is a furnace chamber, shown for illustration in the form of a puddling furnace, covered or surmounted by the arch a^2 , but may be of any other description or type, having its forward portion, A' , at which the heated gases of combustion enter over the bridge wall, B' , and having its back portion, A^2 , wherein are placed the outlets a for waste gases, which are discharged into the flue, F , and may be conveyed direct to the chimney through the flue, f , or may be conveyed thereto by the flue, f' , by forcing the gases through the flues, F' , F^2 , F^3 , and F^4 , thereby bringing them in contact with the gas fuel conduit, d' , and with the air in its conduit, H , and steam conduit, c ; both flues, f , and, f' , have dampers to regulate the flow of gases, or to close the conduit, as desired.

a' , is the inlet, or door, to the furnace, A , through which to work, or operate, in the furnace from the exterior.

B , is a mixing chamber, in which the elements of combustion are thoroughly mixed before combustion, by means of the converging jets, J ; the mixed gases enter the combustion chamber, b' , (Fig. 1) by means of the perforated arch, b , which is formed by bricks of refractory material and are made to form hollow spaces, as shown in their construction in Figs. 6 and 7, through which the gases pass upward in a subdivided condition into the combustion chamber, b' , and also prevent the ignition of the gases in the mixing chamber, B , below; but the mixing chamber, B , may also be applied as a combustion chamber. The combustion chamber, b' , is provided with the port, b^2 , having its door, which may be closed when desired, through which a lighted taper, or other device for lighting, may be introduced to ignite the mixed gases arising from the mixing chamber, when the furnace is started, or when desired. I prefer to fill the combustion chamber with pieces of refractory material, which serve to further subdivide the elements of combustion and thus materially aid in the more perfect combustion; at the same time, when this material has become heated, it serves as a regulator of the heat resulting from the combustion, abstracting therefrom when over intense, and delivering to it when to the contrary, whereby the heat entering the furnace chamber, A , may be maintained at a uniform temperature.

In Figs. 1, 2, 3, as representing the furnace operated by means of liquid fuel, is a fuel jet, C , having a steam connection, c^2 , the steam being superheated on its course by means of the superheating pipes, c , placed

within the spent heat flue, F , the inlet of steam into the jet being governed by an interior valve, the stem of which is shown at, c' ; the liquid fuel is introduced by the pipe, D , the flow being governed by the valve, d . As the steam ejects the liquid fuel, imparting its heat, it transforms the liquid into a gaseous fuel, in which condition, it is forced onward by the pressure of the steam, through a conduit, d' , of zig-zag or other form, placed within the spent heat flue, F' , where it becomes highly heated by the waste gases, and is thus delivered to the converging jets, J , where it is mixed with the necessary quantity of air for its perfect combustion.

Instead of liquid fuel, gas fuel may be conveyed, under pressure or otherwise, through the conduit, d' , to be heated by the waste gases, previous to combustion. The form of the conduit, d' , may be cylindrical, as shown, or flattened, as that of the air conduits, H , which will be described hereinafter, and may form a part in the system of the recuperator; or it may be any other suitable form.

H , are air conduits, placed in the spent heat flue, shown in the form of a flattened pipe, but may be of any other suitable section, composed of straight pipes, made of cast iron, fire clay, or other suitable material, and placed in rows above, or, alongside of each other, and placed at suitable distances between each other, forming spaces for the passage of the hot waste gases; they are provided with a gate, h^3 , at the inlet of air, governing the flow of the same; the outlets for the heated air, h' , and h^2 , enter the chambers formed by the arches, b^3 , and having the doors, b^4 , where it is received by induction, or by force, into the jets, J . The conduits, H , are secured at their ends to box-castings, L , connecting a pair of the conduits, which are secured in the side walls, being open outward, and having on their inner side suitable sockets or nozzles, into which the pipes, H , are entered and jointed by luting, cementing, or calking, or in any other suitable way, to allow for expansion and contraction and to prevent the escape of air. When the apparatus is in operation, this chamber, L , is closed outwardly by a removable wall, h^4 , or by a suitable door in lieu thereof, as desired, leaving a space, h^5 , embracing the two conduits mentioned, so that the air passing through one, returns through the other; and as at the opposite side-wall, the chamber, L , connects the pipe, H , through which the air lately returned, with the pipe, H , next to it, and the air being guided forward through the latter one, and so consecutively, the air is made to travel onward, forward and backward, from the inlet, h^3 , toward the outlet, h' , h^2 , in zig-zag form, as is shown by the arrows in Fig. 3. By means of the removable walls, or doors, h^4 , the joints of the tubes, H , with the chamber, L , may be inspected, repaired, or the tubes replaced, when desired.

Instead of employing the box castings, L ,

the pipes, H, may be let into the side-walls, in which the necessary spaces, h^5 , may be provided for the zig-zag circulation of the air. The air may be drawn through the air heating tubes, H, placed in the flue of the waste gases, by the converging jets, J, or by any other device, or it may be forced through the said pipes, H.

In Figs. 1 and 4, are shown two rows of horizontal recuperators, H, but they may be vertical, or may be as many in number as desired, and each may have its separate gate, h^3 , or one gate may be made to operate for a number, or for all, of them, as desired.

The air conduits, H, are provided with projections or blocks, o , which may be part of, and connected with, or separate from, but secured in place between the conduits, H, which determine the distance the conduits, H, will be separated from each other, when brought together; these projections or blocks, o , also serve to stiffen the conduits, H, and sustain them against warping, as they are thus virtually sustained against each other.

The flue, F, which carries off the hot waste gas, is returned, as shown at, F' , under the furnace, A, being separated therefrom by the arch, f^6 ; then again, the flue is divided by the arch, f^7 , and having the dividing wall, f^3 , which closes the lower portion of the flue at the termination of the arch, f^7 , and having openings, f^4 , at the base, through which the waste gases are made to pass; and having the dividing wall, f^2 , which has similar openings, f^5 , at the top thereof, between, f^2 , and, f^7 , for the passage of the gases to the outlet, f' , into the chimney. As many more of these division walls may be employed, as desired.

It will be seen that the hot waste gases pass out from the furnace, A, through the openings, a , into the flue, F, and F' , where they impinge upon, and heat the steam in pipe, c , and the gas fuel in pipes, d' ; then the gases dip down the portion of the flue, F^2 , up into and through, F^3 , and down into and through, F^4 , to the outlet, f' , into the chimney, coming into consecutive contact with the air heating pipes, H, placed in the lower part of the flue, in all the chambers, F^2 , F^3 , and F^4 , heating the air circulating through them; the temperature of the waste gases being evidently higher at, F^2 , than at, F^3 , and here higher than at, F^4 , and so on. Now, the air travels in a contrary direction to that of the waste gases, so that, as it moves forward in zig-zag form, it becomes gradually heated, and comes consecutively in contact with the increasing temperatures of waste gases, until it discharges at, h' , h^2 , highly heated, the result produced being a constant flow and constant or continued temperature of the heated air, and the heat of the waste gases being efficiently and economically abstracted by the air, allowing the gases to escape at, f' , comparatively cool; thus recuperating the greater part of the heat of the waste gases, and returning it in the elements of combustion, back to the furnace.

Figs. 4 and 5, represent a modification of the apparatus described, the modification consisting in generating the combustion in the furnace chamber, A, the fuel jets being placed converging forward horizontally above the bed of the furnace, while the heated gas fuel conduits are led within the inclosures, E, and are suitably connected to the jets, J; the heated air also passing upward through the inclosures, E, to the jets, J, and said inclosures being provided with doors, e' , for inspection of the jets, or as desired.

The recuperator may be situated anywhere within the flue, or within the chimney, and may be applied to recuperate the heat lost in waste gases of any kind of furnace, by abstracting it by means of the air employed to support the combustion therein, as described.

I am aware that the Siemens regenerative furnace has been described, in the operation of which previously heated air was introduced to support the combustion of the gas producing fuel; and being provided with two pairs of recuperators filled with pieces of refractory material, one for the gas and the other for the air, with corresponding conduits, the said recuperators being alternately heated by the waste gases from a furnace, and alternately used for heating the gas and the air respectively, each chamber or regenerator, therefore, being alternately filled and heated by the waste gases, and then the course of the waste gases changed to the adjoining conduit and chamber, the first chamber then having gas or air made to pass through the heated contents from which to absorb heat on their way to the combustion; this operation of changing being repeated from one chamber to the other. But it is evident that the course of the waste gases through such conduits or chambers for the purpose of heating it, when it is changed to the adjoining conduit, leaves the incombustible gas in such conduit at the time of changing off the current from the heating to that of heat absorbing process, and that such gases must be delivered into the flue leading to the furnace, where it deteriorates the combustion. Besides the deterioration resulting from the admixture of the elements of combustion with the incombustible waste gases, so remaining in the heated chambers, a great defect of this described process, consists in the varying temperatures of the heated elements, ranging between the temperatures of the intensely heated regenerator and the subsequent cooling off caused by the passage through, and abstraction of heat by, the cold elements, until too cold for effective operation.

I am also aware that a recuperator the Pousard furnace has been described for heating the air for combustion, in a chamber filled with specially designed hollow bricks, which fit each other, forming continuous inner channels for the current of air, while the waste gases heat the bricks outwardly and the air contained therein. The joints between the

bricks are very difficult of keeping tight, resulting in leaks and admixture of the waste gas and air.

In my invention the gas, as well as the air is heated by waste gases in independent continuous conduits, having no liability to leakage, nor to resulting admixture of the heating elements of combustion with the combustible waste gases; the construction allowing of a large and effective heating surface, and the air and waste gas currents moving in contrary direction to each other, whereby the air is gradually heated in its course and comes consecutively in contact with higher temperatures from the waste gases, resulting in an economical and effective absorption of heat, in highly heated and undeteriorated elements of combustion, and in a constant, continuous and uniform temperature thereof.

I do not desire to confine myself to the precise construction of parts, as set forth and described, for these constructions may be modified in many ways to produce like results, without departing from the spirit of my invention.

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

1. In a regenerative furnace, the combination with the spent heat flue having the vaporizing fuel-heating conduit, and the air heating conduits therein, of the mixing chamber, and the bridge-wall dividing the said spent heat flue and mixing chamber, substantially as described.

2. In a regenerative furnace, the spent heat flue having the vaporized fuel-heating conduit and the air-heating conduits arranged therein, a mixing chamber, and a bridge wall dividing the spent heat flue and the mixing chamber in combination with the furnace for supplying heat to the vaporized fuel-heating conduit and the air heating conduit, so that the heat circulates around the air heating pipes in the direction opposite to that which cool air enters the said pipes whereby the air is discharged in the mixing chamber in a highly-heated state, substantially as described.

3. In a regenerative furnace, the spent heat flue divided into three compartments, communicating with each other having the air-heating conduit arranged in the said compartments, and the vaporized fuel-heating tubes and steam superheating conduit arranged above said air heating conduit, the vaporized fuel-heating pipes being connected

with converging jets discharging into the mixing chamber and the air heating pipes entering chambers on the sides of the mixing chamber, the said mixing chamber being divided from the said chambers by arch walls b^3 and the mixing chamber being divided from the spent heat flue by the bridge-wall B' , substantially as described.

4. In a regenerative furnace, the combination with the spent heat flue, of the mixing and combustion chambers divided therefrom by a bridge wall, said mixing chamber being divided from the hot air chambers by arch walls b^3 and said hot air chambers being provided with doors, substantially as described.

5. In combination with the waste heat flue of a furnace, the dividing walls $f^2 f^3$ provided with the exit ports $f^4 f^5$ at alternate ends, the outlet for the products of combustion, said flue containing the recuperator composed of the pipes H provided with the projections or blocks o and entered and jointed into the chambers L , having the doors h^4 thereby forming a continuous conduit provided with air inlet gates h^3 and outlets h' and h^2 for the passage of the heated air into the combustion chamber of the furnace, substantially as set forth.

6. A regenerative furnace operated by means of liquid fuel having the vaporizing jet C , the super-heated steam conduit c , the liquid fuel connection D , the vaporized fuel heating conduit d' , the continuous air heating conduits H , connected to circulating chambers L , all of which conduits are placed in a spent heat flue, F, F', F^2, F^3, F^4 , containing the dividing walls $f^2 f^3$, provided with exit ports f^4, f^5 , the mixing chamber B , the perforated arch b , the combustion chamber b' , provided with port b^2 and filled with pieces of refractory material, the bridge wall B' , the exit ports a , and the spent heat flue F , substantially as set forth and described.

7. The combination in a regenerative furnace of a mixing chamber B , provided with an air and gas supply and with a combustion chamber b' above the same, and the perforated arch b , composed of hollow arch bricks between said chambers and adapted to support refractory material, as and for the purpose set forth and described.

In testimony whereof I affix my signature in presence of two witnesses.

MAURICIO M. MONSANTO.

Witnesses:

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WILLM. SMITH.