(No Model.) 2 Sheets—Sheet 1.

N. HARPER.

SMOKE CONSUMER.

No. 512,879. Patented Jan. 16, 1894.

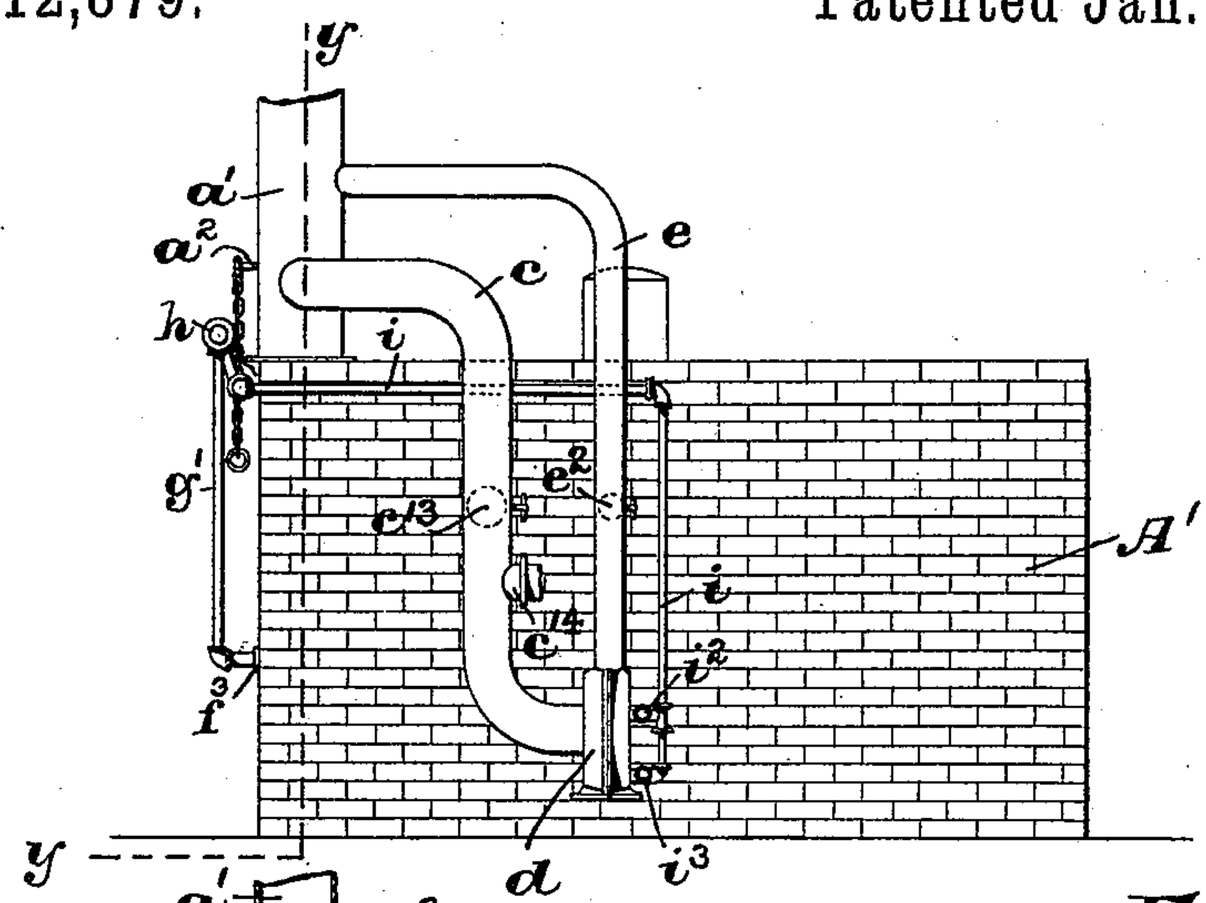

Fig. 1

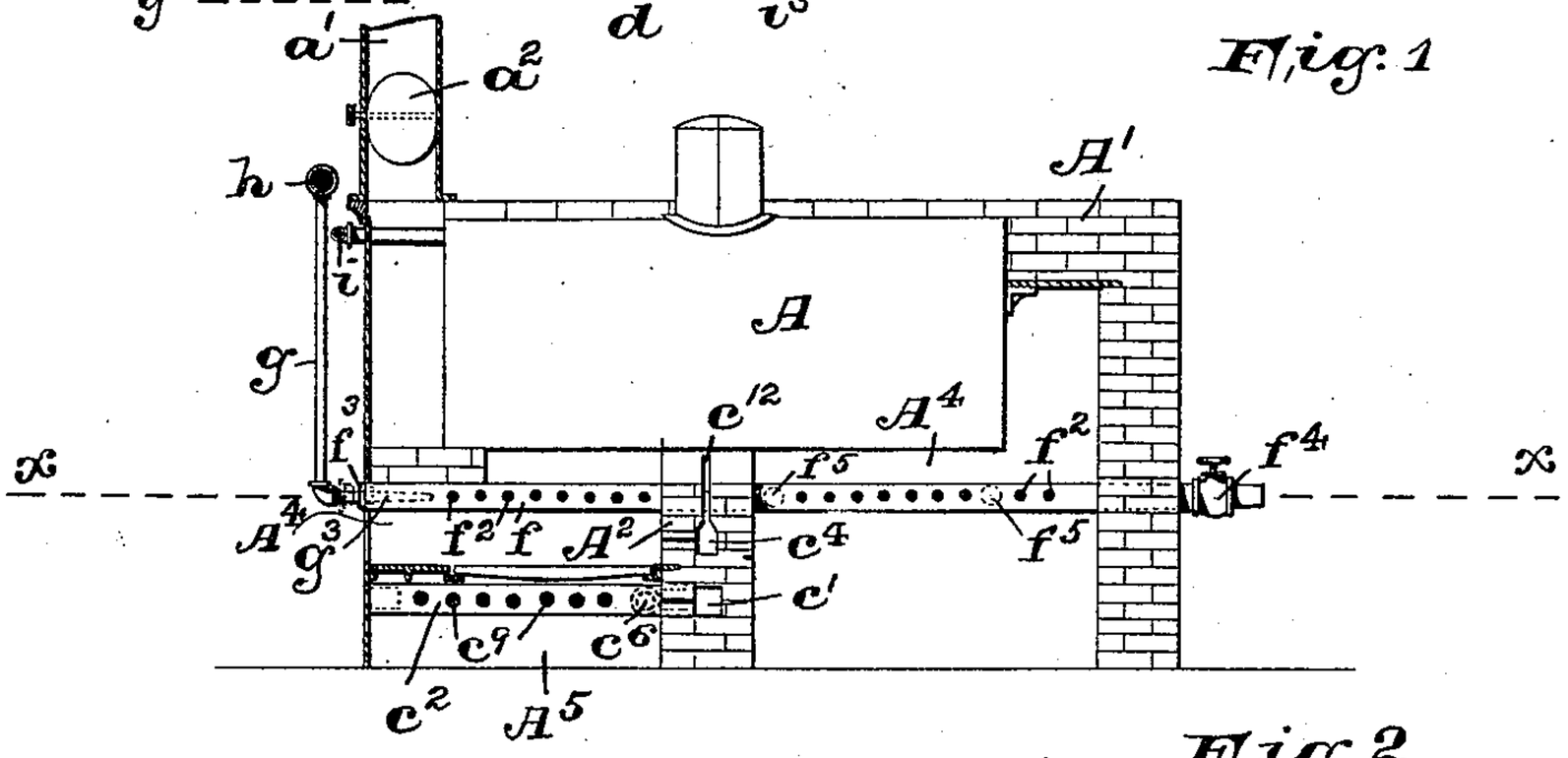

Fig. 2

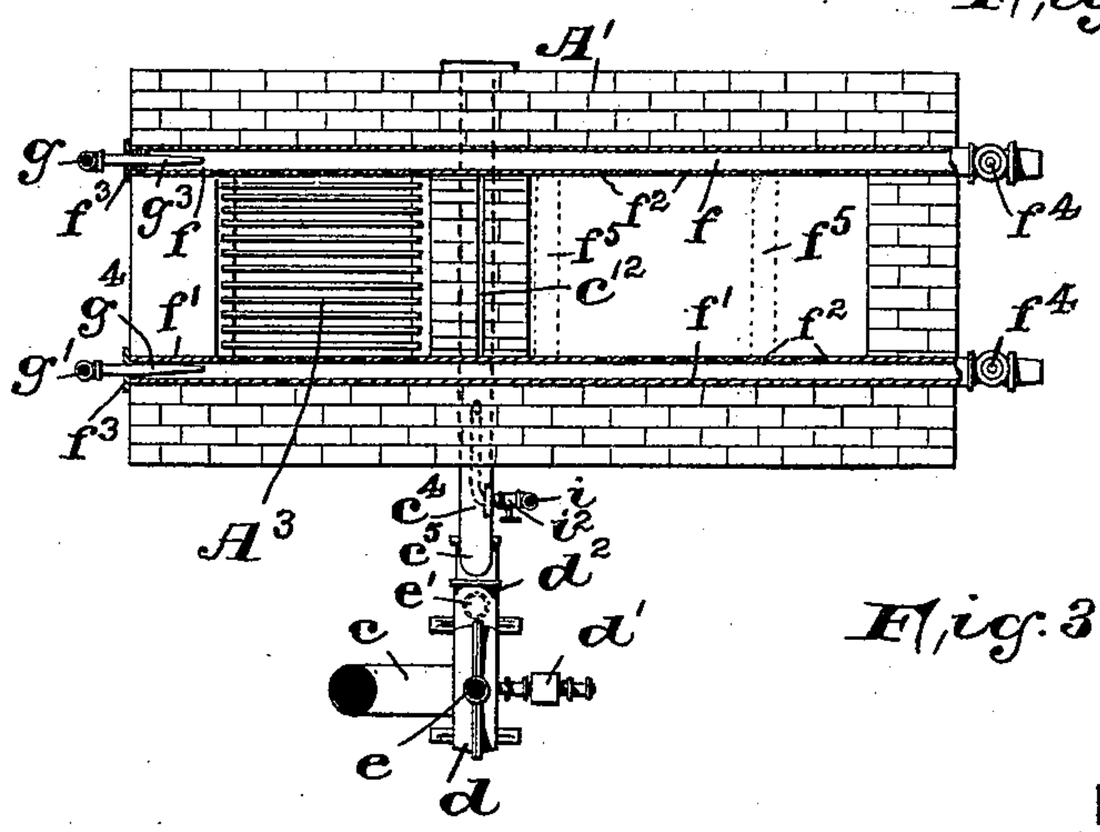

Fig. 3

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(No Model.) 2 Sheets—Sheet 2

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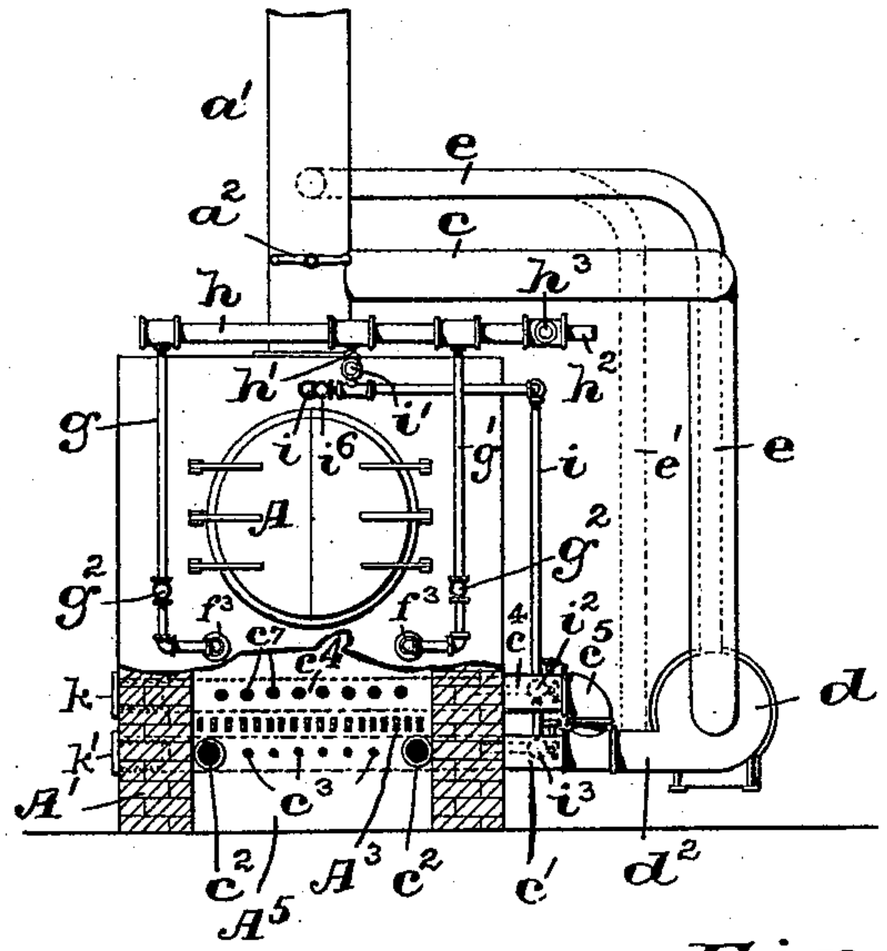

Fig. 4

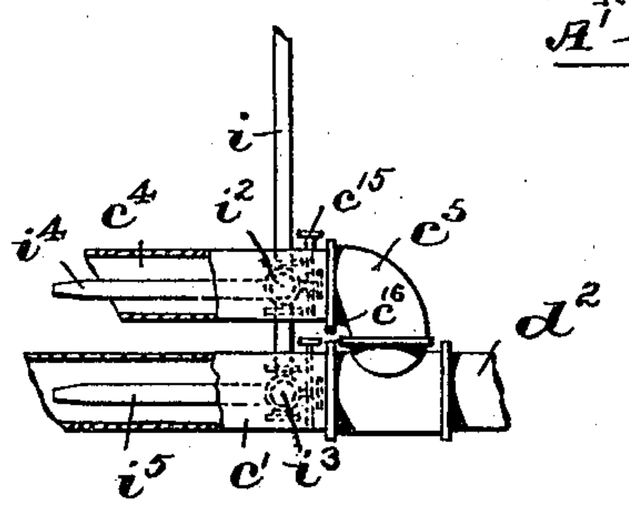

Fig. 6

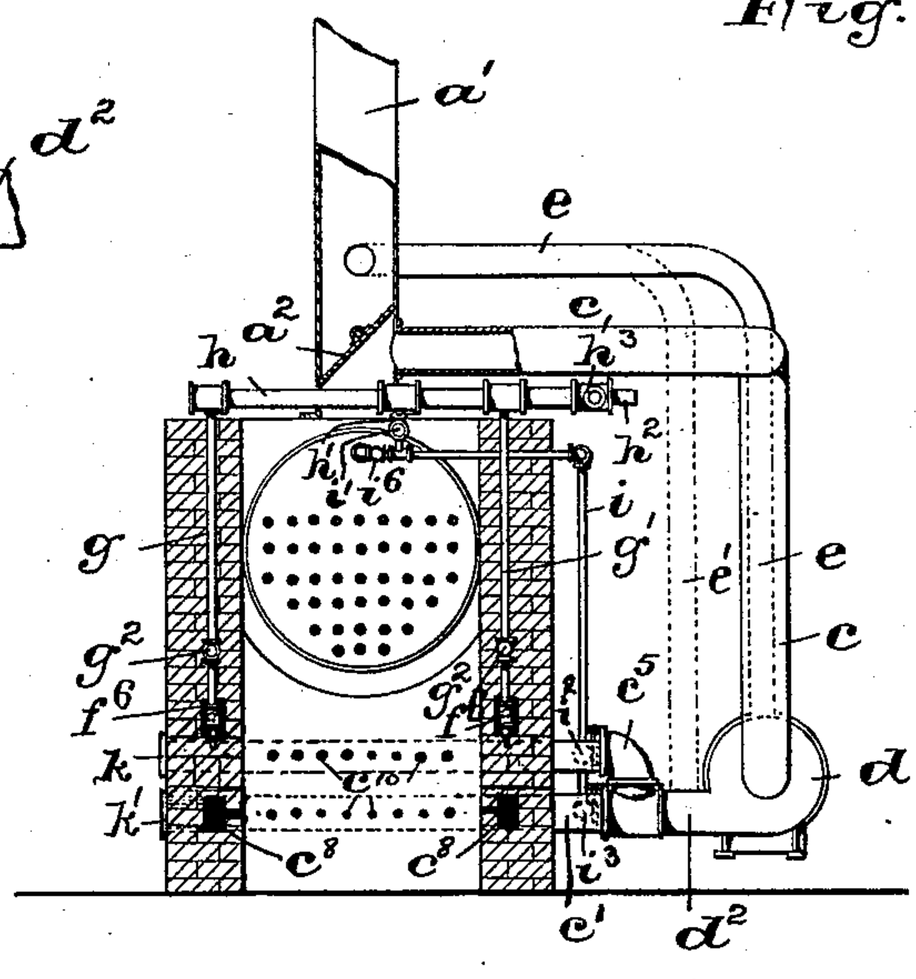

Fig. 5

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UNITED STATES PATENT OFFICE.

NATHAN HARPER, OF NEWARK, NEW JERSEY.

SMOKE-CONSUMER.

SPECIFICATION forming part of Letters Patent No. 512,879, dated January 16, 1894.

Application filed July 11, 1893. Serial No. 480,170. (No model.)

To all whom it may concern:

Be it known that I, NATHAN HARPER, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Smoke-Consumers; 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, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

The object of this invention is to provide a more complete and effective arrangement and apparatus than has heretofore been employed for this purpose, whereby substantially all the smoke and other combustible gases generated in the furnace shall be consumed before they are permitted to escape, thereby largely reducing the quantity of fuel required and also preserving the atmosphere from the contamination induced by the discharge therein of large quantities of unconsumed smoke and gases.

The invention consists of the devices, arrangements and combinations hereinafter set forth and finally embodied in the claims.

In said drawings, Figure 1 is a side view of my improved apparatus as applied to an ordinary furnace and steam boiler. Fig. 2 is a longitudinal vertical section taken through the center of Fig. 1. Fig. 3 is a horizontal section taken on line x, in Fig. 2. Fig. 4 is a front elevation of said furnace and apparatus, with the lower part of said front broken away to show the interior disposition of a portion of the flues, pipes, &c., pertaining to the invention. Fig. 5 is a vertical cross section on line y of Fig. 1, (the grate bars being omitted) and illustrates a modification in the arrangement of part of the flues. Fig. 6 is an enlarged detail view of two steam pipes or nozzles arranged in the interior of the flues leading from the exhauster to the furnace.

Similar letters of reference indicate corresponding parts in each of the several figures.

A, in said drawings, represents the boiler; A′ the wall or casing inclosing the boiler and furnace; A^2 the bridge wall; A^3 the grate bars; A^4 the combustion chamber, and A^5 the ash-pit. A steam pipe h is arranged to receive the exhaust steam from the engine through pipe h^2, controlled by valves h^3. Branch pipes g and g' proceed from pipe h, and are controlled by valves g^2. These branches convey the steam from pipe h to the fresh air flues f and f', and discharge it therein through the nozzles g^3 and g^4, as shown in Figs. 2 and 3. Pipe h may be located at any other point that convenience suggests. Another steam pipe i is connected with the steam space of the boiler at any part preferred, (see Fig. 2) and is arranged to transmit steam therefrom through suitable nozzles, i^4 and i^5, into the interior of flues c' and c^4, the amount of steam admitted through said nozzles being controlled by the valves i^2 and i^3, while valve i^6 controls the inflow of steam into said pipe i. The nozzles i^4 and i^5 are secured to the interior of the flues c' and c^4 preferably by a tight joint which prevents the admission of the external atmosphere. A pipe h' serves to connect pipe i with pipe h, thereby permitting the employment of either live or exhaust steam in any or all of the pipes and flues aforesaid. The transfer of steam between pipes h and i is controlled by a valve i'.

An exhauster or suction fan d is connected by a pipe c either with the boiler breeching or with the smoke stack a' below the damper a^2. Said damper is preferably made oblong in shape, as seen in Fig. 2, whereby when closed it forms a diagonal line across the chimney, as seen in Fig. 5, thereby deflecting the ascending gases crosswise or into the entrance to pipe c. The products of combustion are drawn through the pipe c into the exhauster d, and from there the bulk or principal portion of said products is forced through the main outlet d^2 into the flues c' and c^4 and thus returned to the furnace. A valve or damper c^{13} may be employed in pipe c to reduce the draft without changing the speed of the exhauster, also an inlet valve c^{14} to admit fresh air into said pipe. Power to operate said exhauster may be supplied from any source desired. A belt pulley d' indicates the ordinary method of its application. Rising from the top of the casing of the exhauster is another pipe e, much smaller in diameter than pipe c. The function of pipe e is to separate and expel, by the operation of the exhauster, from the total products of

combustion, the proportion necessary to prevent the accumulation in the furnace of carbonic acid and other gases deleterious to combustion.

Pipe *e* may be connected with the casing of the exhauster at any point desired, or instead of connecting with said casing it may proceed as a branch from any part of the outlet d^2, as indicated in dotted outline *e'*, Figs. 4 and 5. As the waste gases are expelled and driven from pipe *e* by the operation of the exhauster and are therefore independent of natural draft, the outer end of said pipe may terminate in a sewer or anywhere else desired. In the drawings its terminus is in the smoke stack above the damper thereof. With the thorough combustion secured in the combustion chamber by this apparatus and the relatively small volume of gases discharged by the pipe *e*, the amount of heat and smoke that escapes in said discharge is reduced to the lowest minimum.

The flue c^4 is shown in the drawings as running from d^2 through the interior of the bridge wall, but said flue may be placed either in front or on top or at the back of said bridge wall. A valve c^{15}, Fig. 6, controls the flow of the gases from the exhauster into pipe c^4. Said pipe may be provided with perforations or outlets c^7, in any position and of any desired shape to allow the gases to pass therefrom into the combustion chamber; but I prefer that the outlet on the upper side of said flue should consist of a narrow, continuous slit or channel c^{12}, as shown in Figs. 2 and 3, whereby the escaping gases form a thin unbroken sheet occupying all the space between the top of the bridge wall and the under side of the boiler. These gases have a very high temperature when they enter the combustion chamber, and with this form of outlet it is impossible for any of the new products of combustion rising from the fuel to pass over the bridge wall without meeting and commingling with these hot gases and being thereby almost entirely consumed. This flue extends preferably to the outside of the inclosing wall A', and is there provided with a door or stopper *k* to close or open the end and afford access for cleaning. The flue *c'* in like manner extends preferably through said wall and is similarly provided with a door or stopper *k'*. This flue also is shown in the drawings as passing through the interior of the bridge wall, but if preferred it may be located in the rear of the ash pit in front of the bridge wall, as indicated in outline by the dotted circle c^6, Fig. 2. The flow of gases from the exhauster into this flue is controlled by valve c^{16}, Fig. 6. Outlets c^3, of any desired form lead from said flue into the ash pit. Branch pipes c^2 proceed from *c'* along the sides of the ash pit, and are provided with suitable outlets c^9, Fig. 2. These branches may be located either within the ash pit, as shown in Fig. 4, or in the side walls, thereof as at c^8, Fig. 5. By means of these branches in cooperation with flues *c'*, I secure a uniform distribution of the gases over the whole space beneath the grate bars, thereby equalizing the draft through or between all of said bars and so causing a more even and complete consumption of the fuel. In a small furnace the same results may be obtained by using one centrally located branch in lieu of the two side branches.

Flues *f* and *f'* are located above the level of the grate bars and extend preferably the entire length of the combustion chamber, passing through the front and rear ends thereof. They may be constructed either within said chamber, as shown in Figs. 2 and 3, or in the side walls thereof, as illustrated at f^6, Fig. 5. These flues furnish a steady supply of fresh air to the combustion chamber equal in amount to the volume of gases expelled by the exhauster through pipe *e*. They are provided with a series of outlets f^2, of any desired form, leading from said flues into said chamber. If preferred, one or more perforated transverse branches may be connected with said flues, as indicated by the dotted outlines f^5, Figs. 2 and 3. Flues *f* and *f'* communicate with the external atmosphere, which in passing along them becomes very highly heated and in this condition is distributed by the outlets f^2 through all parts of the combustion chamber, thereby furnishing an abundant supply of fresh oxygen at a high temperature to combine with the consumable gases in said chamber and thus insure their complete combustion. Sliding or other dampers f^3 may be provided at the front end of said flues to control the admission of air thereto, and valves or dampers f^4 at the rear end for the same purpose. It is not essential to the function of these flues that they should run through the entire length of the combustion chamber or form continuous channels from front to rear thereof. If desired, said flues may commence in the forward part of the combustion chamber and terminate at any point between the bridge wall and the rear wall of said chamber, or each flue may be replaced by two separate and independent sections, starting from opposite ends of the combustion chamber and terminating at or near the bridge wall.

The manner of operating the improved apparatus is as follows:—When it is necessary to start the fire, the damper in the chimney is opened and the steam valves h^3 and i^6 closed, also valves e^2 and c^{13}. As soon as combustion is slightly established the valves f^3 and f^4 in flues *f* and *f'* are opened, and the external air entering said flues is rapidly heated and distributed through all parts of the combustion chamber, thereby accelerating combustion and consuming a large part of the gases. Whenever the steam in the boiler has acquired a sufficient pressure, the valves in pipe *i* may be opened and said steam will then enter flues *c'* and c^4, carrying with it a large additional supply of air drawn from

pipe c through the inlet valve c^{14}, which steam and air will be distributed beneath the grate bars through the outlets of c' and its branches, and also into the combustion chamber through the outlets of c^4. Should it be desired to still further increase the draft, valve i' may be opened and said steam will then flow from pipe i into pipe h and its branches g^2 and be injected through nozzles g^3 and g^4 into the air flues f and f'. The steam in entering these flues will draw after it into the combustion chamber a very strong current of additional air, while the steam itself, in passing through said flues, will become superheated to a very high temperature and in part decomposed, thereby largely increasing combustion and adding to the intensity of the heat. Whenever the engine commences to run, valve i^6 may be closed and valve h^3 opened, thereby shutting off the live steam from all of said pipes and flues and admitting the exhaust steam from the engine to perform the same functions. By opening valve i^6 and closing valve i' the exhaust steam will flow through branches g and g' into flues f and f', while the live steam will travel through pipe i into flues c' and c^4. It will thus be seen that either live or exhaust steam can be employed in any or all of said pipes and flues; also that both live and exhaust steam may be used simultaneously, separate from each other, in different parts of said apparatus; and likewise that the employment of live steam is necessary only at such times as neither the engine nor the exhauster is running.

Whenever power is available to operate the exhauster, the doors of the furnace both above and below the grate are closed, also damper a^2 and inlet valve c^{14}, while dampers or valves e^2, c^{13}, f^3 and f^4 are opened. The whole of the gaseous products of combustion, or substantially the whole of them, are then continuously drawn through the pipe c into said exhauster. In passing from the exhauster said products are divided and the smaller portion thereof rejected and expelled through a pipe e, while the larger portion is returned to the furnace and again passed through the combustion chamber. The separation and expulsion by the exhauster of a portion of said products cause a corresponding vacuum in the combustion chamber, causing an inflow thereto of an equivalent amount of fresh air through flues f and f'. By these means a specific and known proportion of waste gases may be continuously removed and its place automatically supplied with an exact equivalent of highly heated fresh air, thereby maintaining the combustion at its highest efficiency and reducing waste and loss to its lowest minimum.

Fresh air may be supplied through the exhauster whenever desired by opening the inlet valves c^{14} in pipe c. The draft in said pipe c, and likewise in the furnace, may be reduced at any time without reducing the speed of the exhauster by means of damper c^{13}, and in like manner the proportion of waste gases expelled through pipe e may be reduced by the valve or damper e^2. It will of course be understood that pipe e may be of any preferred size, and that any desired proportion whatever of the total products of combustion may be thereby separated and removed.

From the foregoing description of the invention and its operation, it will be perceived that part of said apparatus may be employed to aid in the consumption of the smoke and gases without the use of steam or an exhauster, and also that either live steam, exhaust steam, or an exhauster may each and all be used either separately or simultaneously in said apparatus. I therefore do not wish to be understood as limiting my invention to the specific form, location or arrangement of the several parts herein shown and described, as said parts may be arranged in a variety of positions and relations to each other, and some of them entirely omitted, without changing the character and scope of my invention.

Having thus described my invention, what I claim is—

1. In a smoke consumer, an exhauster, a pipe or duct adapted to transmit the gaseous products of combustion from the furnace into said exhauster, a pipe or duct adapted to separate and expel a part of said products, a pipe adapted to convey another part thereof into the space beneath the grate bars, and a pipe adapted to transmit steam to said part before it enters said space, substantially as and for the purpose set forth.

2. In a smoke consumer an exhauster, a pipe or duct adapted to transmit the gaseous products of combustion from the furnace into said exhauster, a pipe or duct adapted to separate and expel a part of said products, a pipe or duct adapted to convey another part thereof into the combustion chamber above the grate bars, and a pipe adapted to transmit steam to said part before it enters said chamber, substantially as and for the purposes set forth.

3. In a smoke consumer, an exhauster, a pipe or duct adapted to convey the gaseous products of combustion from the furnace to said exhauster, a pipe or duct adapted to separate and expel a portion of said products, and a pipe or duct divided into branches and adapted to transmit the remaining portion of said products in part to the space below the grate bars of said furnace and in part to the combustion chamber above the grate bars, substantially as and for the purposes set forth.

4. In a smoke consumer, air pipes or ducts communicating with the external air and located above the level of the grate bars, said pipes or ducts extending the entire length of the combustion chamber and being provided with outlets adapted to transmit and distribute said air to the various parts of said chamber both in front and rear of the bridge wall, substantially as and for the purposes set forth.

5. In a smoke consumer, air pipes or ducts communicating with the external air and located above the level of the grate bars, said pipes or ducts extending both in front of and beyond the bridge wall and being provided with outlets adapted to transmit and distribute said air to various parts of the combustion chamber both in front of and beyond said bridge wall, substantially as and for the purposes set forth.

6. In a smoke consumer, air pipes, or ducts communicating with the external air and located above the level of the grate bars, said pipes or ducts extending both in front of and beyond the bridge wall and provided also with steam connections whereby both steam and air may be distributed by said pipes or ducts to the various parts of the combustion chamber both in front and rear of said bridge wall, substantially as and for the purposes set forth.

7. In a smoke consumer, air pipes or ducts communicating with the external air and located above the level of the grate bars, said pipes or ducts extending both in front of and beyond the bridge wall of the furnace, and an exhauster connected with said furnace and arranged and adapted to draw said external air into said pipes or ducts and distribute it therefrom through the various parts of the combustion chamber, substantially as and for the purposes set forth.

8. In a smoke consumer, air pipes or ducts communicating with the external air and located above the level of the grate bars, said pipes or ducts extending both in front of and beyond the bridge wall of the furnace, an exhauster arranged and adapted to draw the gaseous products of combustion from said furnace, to separate and expel a portion of said products, and to cause a volume of air to pass through said pipes or ducts into the combustion chamber equal in quantity to said expelled products, substantially as and for the purposes set forth.

9. In a smoke consumer, the combination of a pipe or pipes adapted to transmit steam from the boiler to the furnace, a pipe or pipes adapted to transmit steam from the engine to the furnace, and an exhauster arranged and adapted to receive the gaseous products of combustion, to separate and expel a portion of said received products and to return the other portion thereof to said furnace, substantially as and for the purposes set forth.

10. In a smoke consumer, the combination of a furnace, an exhauster, a pipe *c* adapted to convey the gaseous products of combustion into said exhauster, a pipe *e* adapted to separate and expel therefrom a portion of said products, a pipe d^2 adapted to return the other portion thereof to said furnace, and pipes c' and c^4 adapted to distribute said return products within said furnace, substantially as and for the purposes set forth.

11. In a smoke consumer, the method of consuming the gaseous products of combustion, which consists in drawing said products into an exhauster, then separating and expelling a portion of said products, then mixing steam with another portion thereof, and returning said mixed portion to the furnace, substantially as and for the purposes set forth.

12. In a smoke consumer, the method of consuming the gaseous products of combustion, which consists in drawing said products into an exhauster, then separating and expelling a portion of said products, returning the other portion thereof to the furnace, and then mixing steam with said returned portion, substantially as and for the purposes set forth.

In testimony that I claim the invention set forth above I have hereunto set my hand this 7th day of July, 1893.

NATHAN HARPER.

Witnesses:
FREDK. C. FRAENTZEL,
WM. H. CAMFIELD, Jr.