W. E. HAGAN.

METHOD OF BURNING FUEL FOR GENERATING HEAT, PREVENTING SMOKE, AND DESULFURIZING THE PRODUCTS OF COMBUSTION.

No. 41,897. Patented Mar. 8, 1864.

Fig. 12

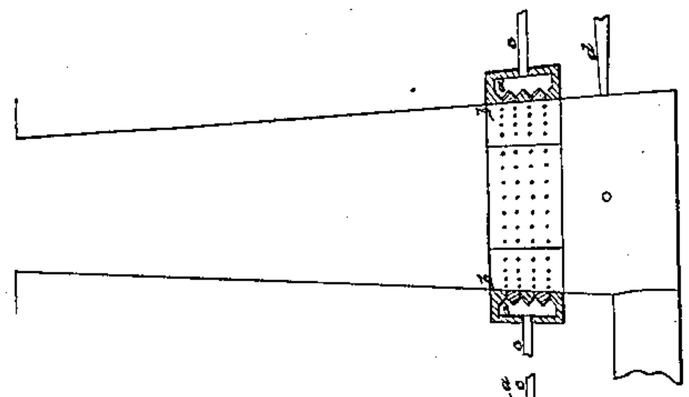


Fig. 11

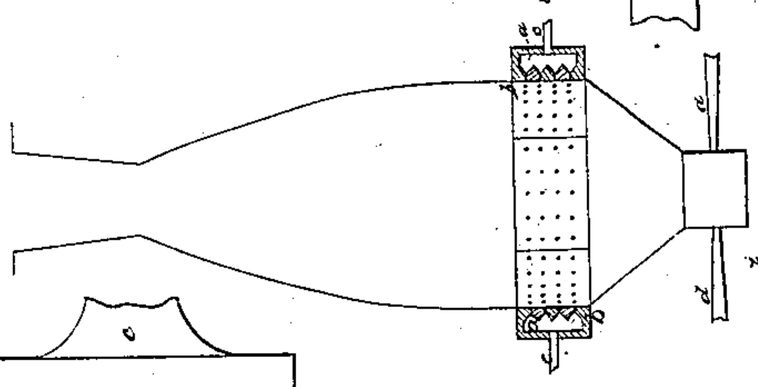


Fig. 6

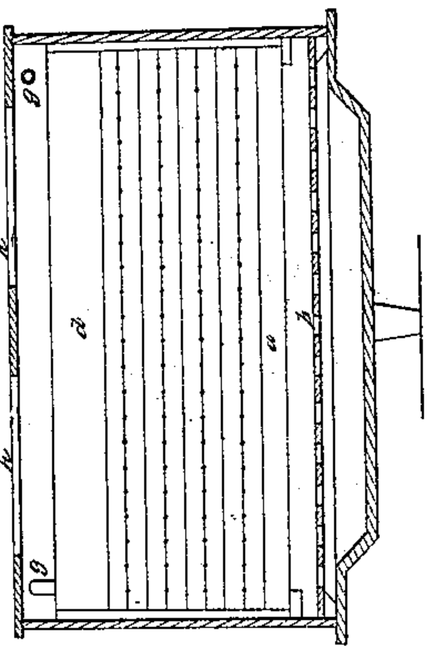


Fig. 8

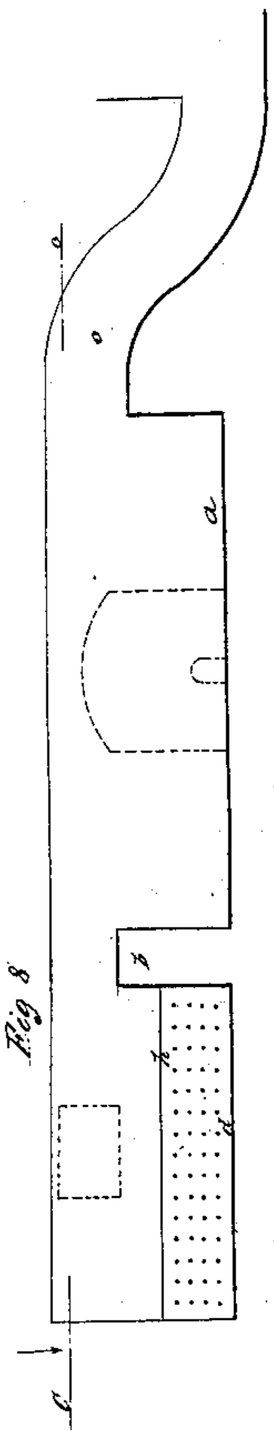


Fig. 9 C. c.

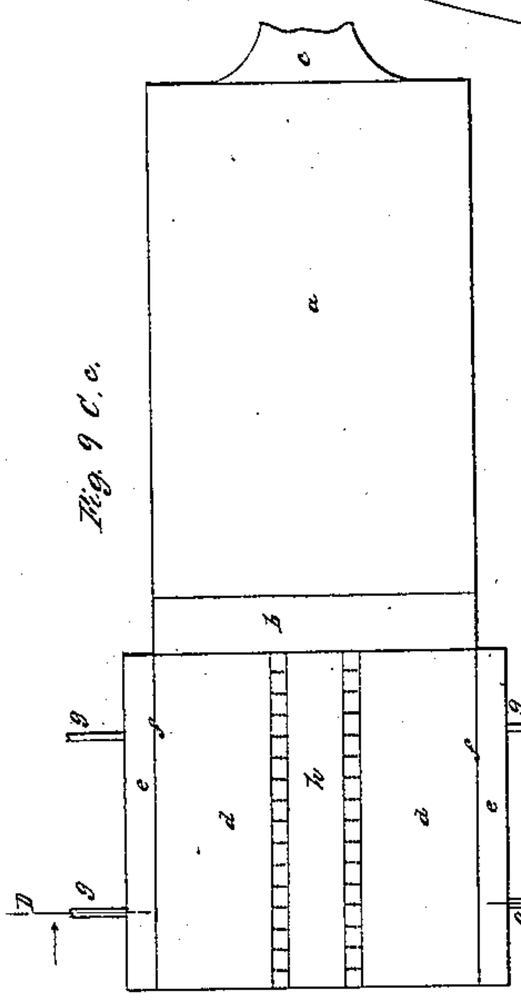


Fig. 10

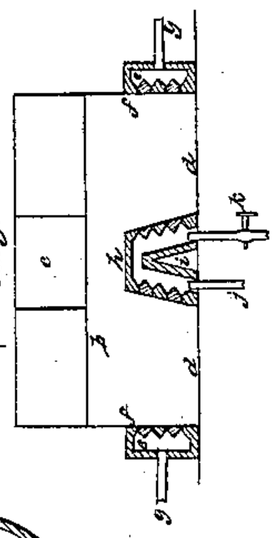


Fig. 7

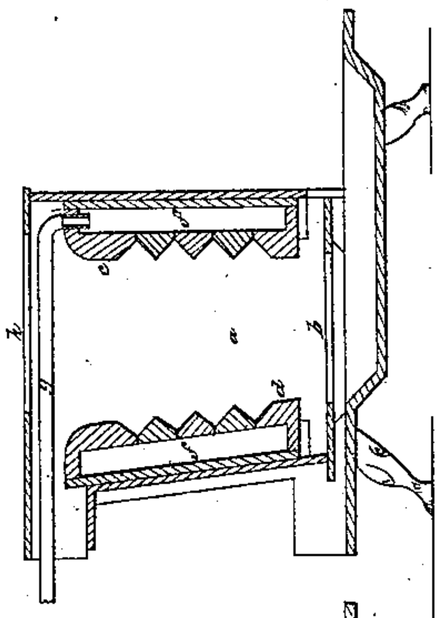


Fig. 4

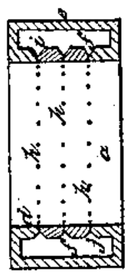


Fig. 5

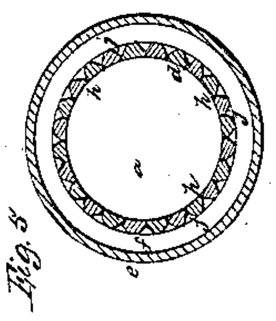


Fig. 2 A, a

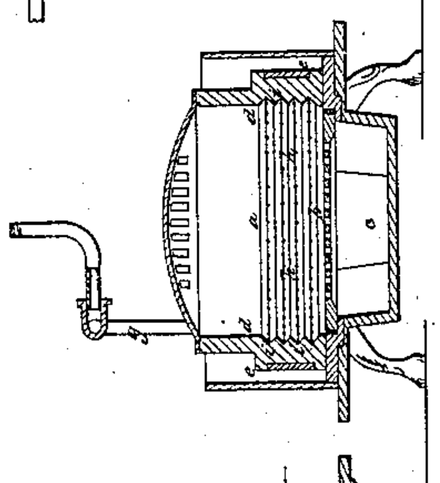


Fig. 3 B b

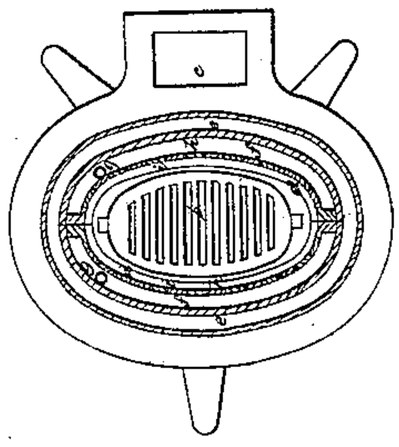
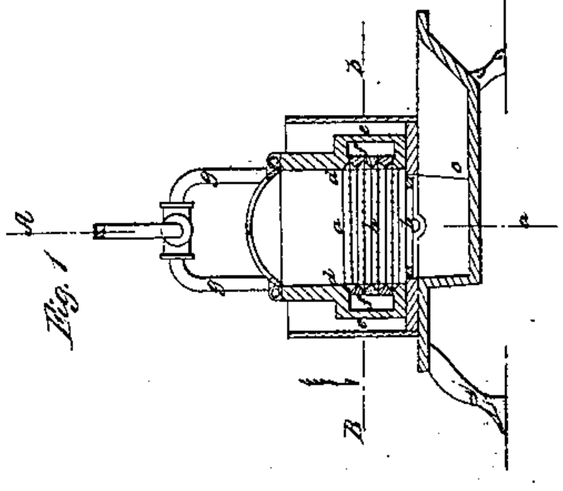


Fig. 1



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UNITED STATES PATENT OFFICE.

WILLIAM E. HAGAN, OF TROY, NEW YORK, ASSIGNOR TO JOHN B. GALE.

IMPROVEMENT IN STOVES.

Specification forming part of Letters Patent No. **41,897**, dated March 8, 1864.

To all whom it may concern:

Be it known that I, WILLIAM E. HAGAN, of Troy, Rensselaer county, and State of New York, have invented a new and improved method of burning fuel for generating heat, preventing smoke, and desulphurizing the products of combustion; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is a cross vertical section of the lower part of a heating-stove for burning fuel according to my improved method; Fig. 2, a vertical section thereof, taken at the line A *a* of Fig. 1; and Fig. 3, a horizontal section taken at the line B *b* of Fig. 1. Fig. 4 is a vertical and Fig. 5 a horizontal section of a modified form of the fire-chamber. Fig. 6 is a longitudinal vertical and Fig. 7 a cross vertical section of a cooking-stove for burning fuel according to my said improved method. Fig. 8 is a longitudinal vertical section of a heating-furnace for metallurgical purposes, with the fire-chamber adapted to my improved method of burning fuel. Fig. 9 is a horizontal section of the same, taken at the line C *c* of Fig. 8; and Fig. 10, a cross vertical section taken at the line D *d* of Fig. 9. Fig. 11 is a vertical section of a cupola-furnace for reducing ores, and Fig. 12 a like view of a blast-furnace, both adapted to my improved method of burning fuel.

In Figs. 1, 2, 3, 4, and 5 of the accompanying drawings the same letters indicate like parts, and in the said figures *a* represents a fire-chamber with a grate, *b*, at bottom, on which the fuel to be burned is placed. There is an ash-pan, *c*, below, of the usual or any suitable construction, so that atmospheric air can have access through it and between the grate-bars to the fuel, not only to ignite it, but afterward during the process of combustion. The fire-chamber is formed by an inner surrounding wall, *d*, and between the inner and the outer wall, *e*, there are two steam-chambers, *f f;* or, if preferred, a single steam-chamber may extend all around. The steam-chambers are provided each with a steam-pipe, *g*, extending to any suitable steam-generator, whether so placed as to have the steam generated by the fire in the fire-chamber *a* or by any other fire. The steam supplied to the chamber or chambers *f* is superheated by the heat radiated from the inner wall, *d*, and escapes in numerous fine jets through a series of apertures, *h*, made for that purpose through the inner wall, *d*. The inner surface of the inner wall, *d*, is grooved, as represented at *i* in Figs. 1 and 2, the bottom of the grooves being in line with the series of holes to reduce the thickness of the wall at the perforations, through which the steam is supplied to the incandescent coals to prevent the too rapid destruction of the wall by oxidation. Instead of making these grooves on the inner surface next to the fire, they may be made on the other or steam side, and they may run in any direction, although I prefer the direction represented; or, instead of grooves, the thickness of the wall may be reduced at the several perforations, in the manner represented in Figs. 4 and 5, by conical recesses or countersinks, as at *j*. The fire-chamber should be filled with the fuel, so as to be in contact with the inner wall and extend up to or above the upper range of perforations. The fuel is ignited in the usual manner by a draft of atmospheric air from the ash-pan, and after the coals are in an incandescent state steam is to be admitted to the chamber or chambers *f*, where it will be superheated and escape through the apertures *h*, and impinge in numerous small jets against the ignited coals. The supply of steam thus introduced will check the draft of air through the fuel, although a sufficient quantity will continue to pass to maintain the fuel in an incandescent state. The superheated steam thus supplied and impinging in numerous fine jets against the incandescent coals will be instantly decomposed, and the resulting gases in the nascent state will combine with the gaseous products of the coal in the nascent state, and thus generate more heat for a given quantity of fuel than by any other known method. A larger volume of flame will be produced, so that the heat evolved can be diffused to great advantage; the union of the gases in the nascent state will effectually prevent the evolution of smoke; no oxidizing gases will be evolved, so that the fire-chamber can be safely constructed of materials which would otherwise be readily destroyed by oxidation, and the heated products of the combustion, for the same reason, will be admirably adapted to metallurgical operations; and sulphur, if any be contained in the fuel, will be oxidized, or so much diluted that flame fit-

ted for metallurgical operations may be obtained from pyritous fuels.

In Figs. 6 and 7 of the accompanying drawings, which represent my said method of burning fuel as applied to cooking-stoves, *a* is an oblong fire-chamber, and *b* the grate on which the fuel is placed, and *c* and *d* the front and back fire-walls, grooved and pierced with numerous small holes for the escape of superheated steam, to impinge on the incandescent coals, as above described, from the steam-chambers *f f*, which are to be supplied with steam by two pipes, *g g*, leading from a suitable generator. Suitable boiler-holes, *h h*, are to be formed in the top plate above the fire-chamber. Ovens and other appurtenances are to be provided, as in other cooking stoves and ranges. If desired, steam-chambers and perforated wall may be made at the ends of the fire-chamber as well as in front and at the back.

In Figs. 8, 9, and 10 of the accompanying drawings, which represent my said invention as applied to a heating-furnace for metallurgical operations, *a* represents the working-bottom, where the metals to be worked are heated; *b*, the fire-bridge, and *c* the flue leading to the chimney. Each side of the fire-chamber *d* there is a steam-chamber, *e*, the inner walls, *f f*, of the chambers forming the side walls of the fire-chamber. These walls are grooved and pierced with numerous small holes, as in the other examples, for the escape of superheated steam to impinge on the incandescent fuel. The steam-chambers are provided with steam-pipes *g g*, to supply steam to the chambers *e* from some suitable generator. The steam-pipes *g g* may be coiled in any suitable manner in close proximity with the heated part of the furnace, the better to superheat the steam, as the pipes are arranged to heat the blast in furnaces working with hot-blast.

I contemplate in some instances placing a steam-generator, *h*, midway between the two side chambers, *e e*, the walls of which are to be grooved and perforated in like manner, and to be supplied with steam in the same way. I have also contemplated providing the steam-chambers with a pipe or pipes for the escape of steam, in addition to the pipe or pipes for the introduction of steam. Such an arrangement is represented in connection with the central steam-chamber, *h*, which is provided with a central wall, *i*, between the two perforated walls. The steam is admitted on one side of the central wall *i*, from a suitable generator, by the steam-pipe *j*, and on the other side of the central wall there is an escape-steam pipe provided with a valve or cock, *k*. When this valve is closed, the superheated steam will escape from the chamber through the perforations and impinge on the incandescent coals, as before described; but when the cock or valve is open, the steam will mainly escape from this pipe, and but little will escape through the perforations to impinge on the coals, and it will result from this that smoke will be evolved from the fire in greater or less quantity, depending on the size of opening of the valve.

For many purposes in metallurgical operations it is desirable at times to cause smoke to be evolved with the flames, and by the means above described this can be effected.

In Figs. 11 and 12 my said invention is represented as applied to a blast and to a cupola furnace. In both of the said figures, *a* represents the chamber or chambers for superheated steam, with the inner grooved and perforated plate, *b*, and with the steam-pipes *c c*, for supplying steam from some suitable generator. The said furnaces are to be provided below with tuyeres *d* in the usual manner for the blast of air.

From the foregoing any one skilled in the construction of stoves and furnaces for generating heat for various purposes in the arts will be enabled to apply my said invention to the various purposes which may be desired, as my invention relates entirely to the method of managing the combustion of the fuel.

My discovery relates to the effects produced by the application of superheated steam in numerous jets so as to impinge, without admixture of atmospheric air, against the incandescent coals, so that the gases resulting from the decomposition of the superheated steam shall mingle and combine with the gases evolved from the coal while these latter are also in the nascent state.

I believe the true theory or rationale of my said new method to be as follows, viz: The combustion of coal by means of a small amount of air and a considerable volume of superheated steam (HO_8) takes place with two distinct reactions, although connected. When superheated steam impinges on ignited coal or flaming fuel, it becomes decomposed into hydrogen and carbonic-acid gases. The intense ignition of the coal is somewhat reduced by the heat absorbed in the act of decomposition, and the highly-heated gases convey it away to the point where they burn. When the fuel is such as would produce smoke, through its volatile constituents burning imperfectly in air, the highly-heated steam seizes upon these and suffers decomposition. The mixtures of hydrogen and carbonic acid are present momentarily, as in the case of the steam impinging on ignited coal, the more combustible parts of the coal or fuel having been first taken up to form these gases. The second reaction is the combustion of the hydrogen by the carbonic acid (CaO_2) present at an elevated temperature, developing a great additional heat with the formation of carbonic oxide, (CaO,) which consumes afterward in presence of air.

As steam has heretofore been applied, we have had steam thrown on coal under conditions favoring the production of hydrogen, carbureted hydrogen, and carbonic oxide, which were burned farther on by contact with air and

produced heat; but the robbing of the fuel of its heat of combustion to form carbonic oxide left little gain in economical results, and only in case of special application were such modes important. By my discovery, however, the heated vapor of water forming at once carbonic acid maintains the heat of combustion nearly as well as air does, while at a more distant part of their flow the intense heat following the combustion of hydrogen by carbonic acid is obtained, the carbonic oxide resulting burning as it comes in contact with air. The essential difference between this and the well-known plans rests on the modifications of combustion brought about by the limited amount of air supplied to the burning fuel, and the substitution of heated vapor (HO_3) for air in part. Economically the result obtained has a high value, as it prevents the accumulation of heat in masses of fuel, and destruction thereby of furnace-walls. It carries the heat in a voluminous flame to the place of application. This combustion oxidizes sulphur and dilutes the products so much that a flame fitted for metallurgical operations may be obtained from pyritous fuel.

Although I believe this to be the true explanation of the chemical changes which take place in working my said method, I do not wish to be understood as resting my claim on the soundness of the theory as herein stated, my claim resting on the discovery of the better results due to the application of superheated steam, so as to impinge directly against the incandescent coals without admixture of atmospheric air, but in connection with atmospheric air applied by draft or blast in the usual way.

I am aware that prior to my said discovery steam was applied to aid in the combustion of fuel; but in such cases it was either applied with atmospheric air below the grate or applied separately above the fuel, and with the blast or draft of atmospheric air from below; but neither of these methods will produce results like my discovery or invention.

What I claim as my discovery or invention in the management of combustion in fire-chambers is—

1. The application, substantially as herein described, of superheated steam in jets so as to impinge, without admixture with atmospheric air, directly against the incandescent coals, in addition to or in combination with the supply separately of atmospheric air, either by draft or blast in the usual manner, as set forth, and for the purpose specified.

2. In the construction of fire-chambers for the combustion of fuel, and provided with apertures at or near the bottom for the admission of atmospheric air, combining therewith a steam chamber or chambers for superheated steam, the inner wall of the steam chamber or chambers having numerous small apertures next to the fuel for the escape of the superheated steam to impinge, without admixture of atmospheric air, against the incandescent coals, substantially as and for the purpose specified.

3. In the construction of fire-chambers combined, substantially as herein described, with a chamber or chambers for superheated steam, and with numerous apertures for the escape of jets of superheated steam to impinge against the incandescent coals, making the perforated wall of the fire-chamber grooved or the equivalent thereof, to reduce the thickness of the wall at the perforations, substantially as and for the purpose specified.

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