(No Model.)

2 Sheets—Sheet 1.

E. B. CORNELL.

APPARATUS FOR HEATING IN FURNACES.

No. 418,451. Patented Dec. 31, 1889.

Fig. 2.

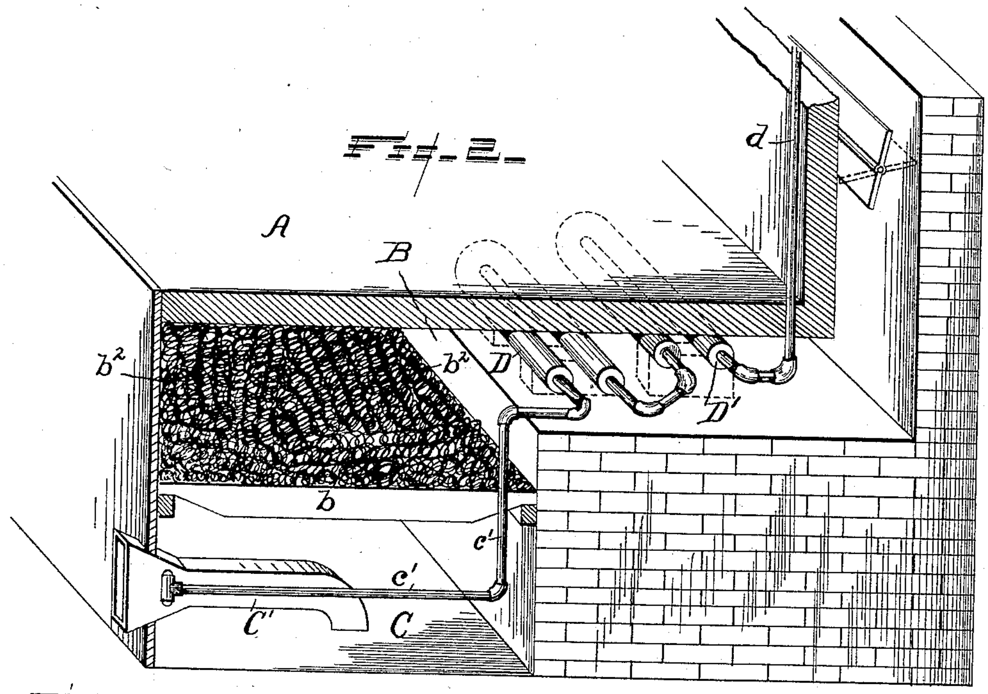


Fig. 4.

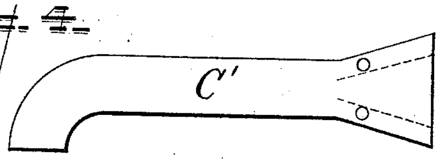


Fig. 1.

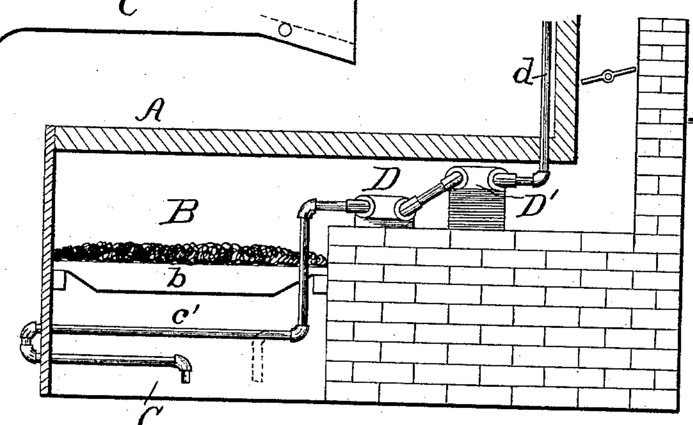
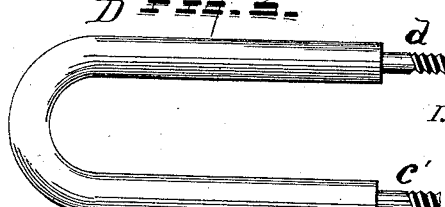


Fig. 3.



WITNESSES
H. B. Hyatt.
Geo. A. Byington

INVENTOR
Elijah B. Cornell
By S. J. Van Stavoren
Attorney

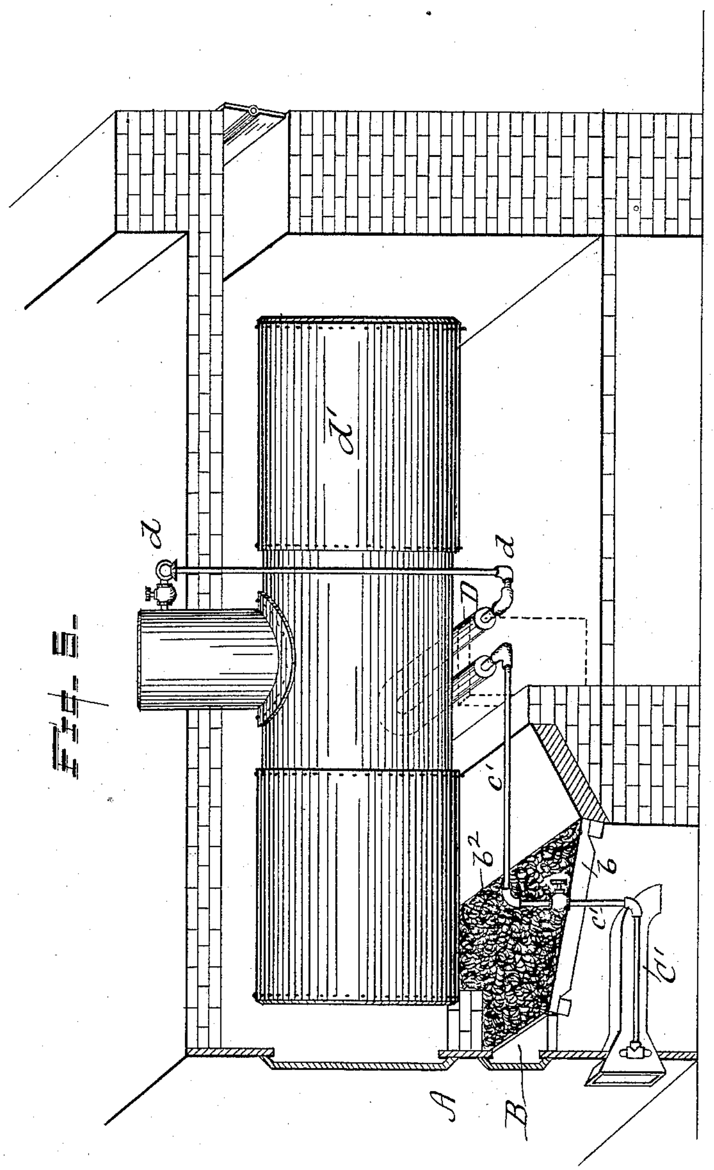
N. PETERS. Photo-Lithographer, Washington, D. C.

(No Model.) 2 Sheets—Sheet 2.

E. B. CORNELL.

APPARATUS FOR HEATING IN FURNACES.

No. 418,451. Patented Dec. 31, 1889.



WITNESSES:
H. B. Hyatt.
Geo. R. Byington

INVENTOR,
Elijah B. Cornell
By S. J. Van Stavoren
ATTORNEY

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

UNITED STATES PATENT OFFICE.

ELIJAH B. CORNELL, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE NATURAL GAS FUEL COMPANY, OF SAME PLACE.

APPARATUS FOR HEATING IN FURNACES.

SPECIFICATION forming part of Letters Patent No. 418,451, dated December 31, 1889.

Application filed November 29, 1889. Serial No. 331,897. (No model.)

To all whom it may concern:

Be it known that I, ELIJAH B. CORNELL, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Apparatus for Heating in 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.

My invention relates particularly to improvements in that branch of the art in which heat is generated through the agency of steam injected into or through the fuel; and it consists in apparatus for carrying out the methods invented by me, which methods I will hereinafter fully describe for a better understanding of the objects and uses of said apparatus, although such methods form the subject-matter of an application filed by me October 9, 1889, Serial No. 326,476.

Heretofore it has been customary to increase the heat obtainable in a furnace by increasing the consumption of fuel with relation to a given size of furnace. This increase of consumption has been effected by increasing the draft or supply of oxygen in various manners. That manner more nearly connected with my improved method has consisted in injecting steam and air upon the fuel, dry steam being preferably employed. This is a method of dissociating steam in which the action of the steam upon the fuel is to part with its oxygen to the carbon of the coal or other fuel or to the carbonic oxide formed from such fuel, setting free the hydrogen, which is burned at the expense of indrawn atmospheric air. Such a method is wasteful of the heat-units obtainable from the steam, for several reasons, among which I cite the following:

It is well known to chemists that on account of its great specific heat hydrogen has a comparatively enormous cooling effect. The increased combustion of fuel therefore caused by the separation of the oxygen and its combination with the carbon of the coal or other fuel, although giving greater amount of heat does not result in full advantage of that greater heat, as that heat is practically dissipated in heating the hydrogen evolved. The heat therefore that results is not the sum total of the heat obtainable from the combustion of the constituent gases of steam between themselves, but is a differential sum of the heats of combustion of the hydrogen in atmospheric air, and the heat evolved from the combustion of the extra fuel, less the heat lost from the latter combustion by the heating of the volume of hydrogen evolved. Thus, while in a furnace so heated it is undoubtedly possible to obtain greater heat than by a plain fire, it is only possible to obtain this greater heat by the consumption of a greater amount of fuel. While it is true that an economy may appear to be effected by the possible use of a cheaper fuel, the larger amount of the cheaper fuel consumed results in no actual economy, and this is probably the chief reason why, after lengthy trials, these methods are generally discontinued, and this method of dissociating steam consists in causing that vapor to pass over iron or similar material that will absorb the oxygen, setting free the hydrogen that can be used as fuel. I am aware that such processes are known and have been extended in the arts as "regenerative" processes, by which the oxygen absorbed has been caused to be given up from the material through the application of greater or less heat. A layer of silver has been used in this way, which, when molten, absorbed the oxygen of steam passed over it, but which, when cooled, gave up the oxygen. I mention such process particularly to show that I disclaim it as having only a *prima facie* similarity with what I shall subsequently describe as my new method. All of these processes in which dissociation occurs as the result of the affinity of a fuel or fuel material or other substance for one of the constituents of steam I consider to be wasteful, for the reasons I have given, and for the further reason that steam, when separated into its constituent gases—oxygen and hydrogen—then consists of those gases in such proportion, each relatively to the other, as will by their recombination develop the greatest amount of heat obtained from water as a primary source.

I will now explain that by the terms "dissociation of steam by heat" I mean that steam is resolved into its constituents by the loss of one of them through satisfaction by that constituent of a chemical affinity, and that generally to this loss is due a lesser heat than is obtainable by the combustion of hydrogen in oxygen; but I term that decomposition or resolution of steam into its constituent gases by heat without loss of either constituent gas, (in satisfaction of chemical affinity,) producing an oxyhydrogen gaseous mixture, "thermolysis," and the effecting of thermolysis I term "thermolysing." By thermolytic action upon steam passed through platinum and porcelain tubes Grove (also Deville) has shown that this vapor may be resolved into its constituent gases. I make use of this principle in my invention, and I have discovered that steam passed through a cast-iron tube, maintained at or above the temperature of molten silver, is decomposed into its constituent gases without oxidation of the tube. I have further discovered that this action cannot be obtained with plain wrought-iron tubes, for the reason that the wrought-iron tube is oxidized at the expense of the oxygen of the steam in so short a period of time as to render plain wrought-iron tubes practically useless. I advance the theory that the cast-iron tubes are rendered inattackable by the oxygen, for the reason that it becomes coated with a stratum of carbide of iron, or, more probably, of a carbo-silicide of iron. I also advance, as a theory explaining this fact, that hot wrought-iron is more easily oxidized than is hot cast-iron, because of its position in the electro-motive scale being more positive than that of cast iron.

According to my invention, having caused the decomposition of the steam into its constituent gases by the action of thermolysis in a heated cast-iron tubular retort, placed preferably in the hottest part of the furnace, (which furnace is employed to generate the steam to be passed through the tubular retort and therein submitted to thermolysis, or which steam may be obtained from a foreign source,) I cause the gases to pass into the closed ash-pan situated beneath the grate-bars, or their equivalent, in the furnace. If these grate-bars support a fuel—such as coal—requiring oxygen for its consumption, I supply that oxygen by causing the gases as they flow with their great initial pressure from the exit-tube of the retort to inject or induce into the ash-pan the quantity of air necessary to the consumption of the fuel without any regard to the heat to be obtained from the consumption of the oxyhydrogen gaseous mixture. I wish it to be fully understood that I consider that the heat obtained from the consumption of the oxyhydrogen gaseous mixture resulting from the thermolyzing of the steam in the cast-iron tube or retort is wholly additive to the heat obtained from the combustion of the fuel by the injected or indrawn air, which air I consider in no way a diluent of the oxyhydrogen gaseous mixture; but I further have discovered that the action of the fuel lying on the grate-bars, so far as relates to the combustion of the oxyhydrogen gaseous mixture, is a catalytic or contact action—that is, the gases will not at the pressure and velocity at which they issue from the injector ignite, and even when reduced in velocity and pressure so as to become ignitible, they then ignite only as an explosive mixture, the explosion causing discontinuance of the inflammation. It is, I believe, well known in chemical science that an explosive-gas mixture cannot be burned continuously with a continuous flame. Now I have discovered that if such gases resulting from the thermolyzing of steam be passed through the ashes of coal these ashes have such an action at a proper temperature as to cause the continued inflammation of the oxyhydrogen gaseous mixture, and as the ashes are not consumed, nor does it appear necessary that they should be, at a temperature likely to maintain inflammation by presenting a sufficiently-heated substance to cause continuously infinitesimal explosions, which as a whole might appear to be continuous inflammation, I have concluded that such action is a contact or catalytic action. More especially have I been forced to this conclusion by the reason that asbestus affords a material which will, by passing the oxyhydrogen gaseous mixture through it at a temperature below that required to initially inflame such mixture, maintain constant inflammation. I base my opinion that this operation is catalytic on other experimental facts, and I wish it understood that, whatever may be the nature of this action, I find such catalytic material necessary in practice to the continual inflammation of the gases.

I will now further describe my invention by considering the process as completed by the joint combustion of the coal under the action of atmospheric air, together with the combustion of the oxyhydrogen gaseous mixture, which combustions I consider separate but simultaneous operations until the carbon of the coal becomes exhausted, when I may and do, if I so prefer, cause the continued combustion of the oxyhydrogen gaseous mixture to maintain the heat of the furnace. Thus, by my invention practically great economy is effected, and I am enabled to support combustion at the expense of the cheaper fuel—water—with a minimum amount of the more expensive fuel—coal—which amount I consider may be reduced to that necessary to provide a layer of fresh ash, including that requisite to afford a means of reigniting the gaseous mixture when its current has been interrupted for the reduction of the temperature for any required purpose, such as the reduction of steam-pressure, should the furnace be employed in the heating of a boiler. Although I have described the injection of the gases into the ash-pan as taking place below or beneath the grate-bars supporting the fuel material, I wish it understood that I consider this material and the grate-bars merely as a septum and its support, the septum having the catalytic action necessary to the operation of continuous inflammation of the oxyhydrogen gaseous mixture. By my invention very nearly absolutely perfect combustion is attained, evidenced by the transparency of the flame burning above the layer of fuel material upon the grate-bars, this transparency being such as will render visible the fire-bridge in a furnace several feet in depth. With such nearly-complete combustion a smoke-stack may be dispensed with, and the omission of so expensive constructive work is a secondary advantage of my method.

In order that those skilled in the art may practice my improved process, I will now describe the preferred apparatus which I use.

Referring to the accompanying drawings, Figure 1 is a sectional elevation of a form of furnace equipped with a form of devices for practicing my invention, said devices comprising a catalytic septum, in itself either a fuel or not a fuel, a steam-supply pipe from a distant source of supply, a superheater or drier, a retort, and outlet-pipe from the retort, leading beneath the catalytic septum or mass. Fig. 2 is a like view, partially perspective, showing a fuel catalytic mass or septum, and, further, an air-injector connected with the retort outlet-pipe for causing the gases from the retort to inject or induce air into the ash-pan or below the catalytic mass or septum. Fig. 3 is an elevation of a preferable form of retort, drawn to an enlarged scale. Fig. 4 is a side view of preferable form of injector for use with my improvements; and Fig. 5 is a sectional elevation, partly in perspective, of a furnace and adjacent stationary boiler equipped with devices for practicing my invention.

A represents a form of furnace for any preferred purpose, composed of fire-box B, having grate-bars b, ash pit or chamber C below said grate-bars, in which is located a pipe or injector C′, having connection c' with a retort D, located within the fire-box, preferably in such position that it is subject to the heat thereof, which, while it is hot enough to cause it to convert steam into its constituent cases by thermolysis, as before described, is not sufficient to fuse or otherwise deteriorate the retort. In the form of furnaces shown in the drawings said retort is indicated as located beyond the bridge-wall. Said retort, therefore, in some furnaces, like those for stationary, locomotive, and other boilers, will be located in the hottest part of the furnace, as the heat therein is not usually sufficient to fuse the retort, whereas in smelting or other like furnaces the retort will be located without the field of the most intense part of the heat of the furnace, or, if located within said field, the retort will be suitably shielded or protected against the most intense heat, so as not to fuse.

The retort D may be of any suitable form. In practice, I use a cast-iron retort of the **U** shape, as shown, which is of a larger area in cross-section, within certain portions, than that of the inlet and outlet pipes d and c', connecting it, respectively, to the boiler d' and the injector, so as to afford sufficient heating-surface and room for expansion for the oxyhydrogen gaseous mixture needed for the full decomposition of the steam. If the retort, however, be too large in cross-sectional area, there is a probability of allowing the formation of an inner core undecomposed vapor, which will be carried forward with the gases and act detrimentally. The interior of the retort is preferably lined, or caused to be lined, in any suitable manner with carbide of iron or carbo-silicide of iron, to render it inoxidizable and avoid dissociation by affinity, as hereinbefore set forth.

Any suitable form of injector C′ may be used, a preferable form which I use in practice being that shown, described, and claimed in United States Letters Patent dated October 30, 1883, No. 287,754. The grate-bars b may be constructed, as desired, of any suitable material. On these grate-bars is placed any suitable catalytic material b^2, forming what I have termed a "septum," for acting on the constituent gases of the decomposed steam as they pass through the same. In practice, for steam-boiler furnaces I use the fuel or coal as a catalytic material or septum, as it subserves the purpose of initially generating the steam and initially inflaming the gases and maintaining constant inflammation.

If the steam-boiler d' is located adjacent to the furnace and the steam therefrom is dry, only one retort D may be used, as indicated in Fig. 5; but if at a distant location, or when, from low pressure, foaming, or priming of the boiler, the steam is wet, then two or more retorts D are used in the furnace, as indicated in Figs. 1 and 2, and the first of which is used as a superheater for the steam before it passes into that retort in which it is thermolyzed.

When fuel or coal is dispensed with as a catalytic material, the injector C′ need not then be used, in which case the outlet-pipe c' from the retort is led directly into the ash-box or equivalent chamber and may terminate in a downwardly-turned end, as desired, and as indicated by dotted and full lines, Fig. 4.

The practice of my improved method with the above-described apparatus is as follows: The catalytic material in the fire-box is first ignited or heated to initially generate steam and heat the retort D or retort and superheater or drier D′ in the fire-box, if the boiler d' is adjacent thereto, and to heat the retort D or such retort and superheater or drier D′ only if the steam-supply is brought from a distant location. The dry steam entering the retort D is by thermolysis decomposed into its constitutent gases, which pass through the injector when used, or through the continuation of pipe *e′* when the injector is not employed, and enter the ash box or chamber below the grate-bars *b*. The gases, as they pass through the catalytic material, are acted upon and burned as hereinbefore stated.

I wish it to be understood, also, that, while I have described the retort D or such retort and superheater or drier D′ as made, preferably, of cast-iron, I do not limit myself to this material, but design that the claims directed to this feature shall be of such generic nature as to include any non-oxidizable material—that is to say, any material not readily attacked by the liberated oxygen during the thermolytic action above described.

I do not herein claim the method of heating in furnaces by first thermolyzing steam into the constituent gases and then subjecting these gases to a catalytic action and combustion, nor to first drying the steam and then thermolyzing it into its constituent gases and subjecting them to a catalytic action and combustion, as the same form the subject-matter of a separate pending application filed by me October 9, 1889, Serial No. 326,476.

I claim—

1. In an apparatus for heating in furnaces, the combination of a steam generator or supply, a furnace having a fire-box and an ash-pit, a septum of a catalytic material in said fire-box, a retort having an inoxidizable inner surface in said fire-box, and pipe-connections between said steam supply or generator and one side of said retort and between the ash-pit and the other side of said retort.

2. In an apparatus for heating in furnaces, the combination of a retort having an inoxidizable inner surface, said retort being connected with a supply of steam, a septum of a catalytic material, a chamber below said septum, and a pipe-connection between the retort and said chamber below the septum, substantially as set forth.

3. In an apparatus for heating in furnaces, the combination of a retort having an inoxidizable inner surface, a superheater or drier connected to said retort, a steam-supply-pipe for said superheater or drier, a septum of a catalytic material, a chamber below such septum, and a pipe-connection between the retort and said chamber below the septum, substantially as set forth.

4. In an apparatus for heating in furnaces, the combination of a retort having an inoxidizable inner surface connected with a supply of steam, a septum of a catalytic material, a chamber below said septum, and a pipe-connection between the retort and said chamber below the septum, said retort having a larger cross-sectional area than its inlet steam-pipe and outlet-pipe connections, substantially as set forth.

5. In an apparatus for heating in furnaces, the combination of a cast-iron retort connected with a supply of steam, a septum of a catalytic material, a chamber below said septum, and a pipe-connection below the retort and said chamber below the septum, substantially as described.

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

ELIJAH B. CORNELL.

Witnesses:
EDWIN F. GLENN,
JOHN A. SEVIER.