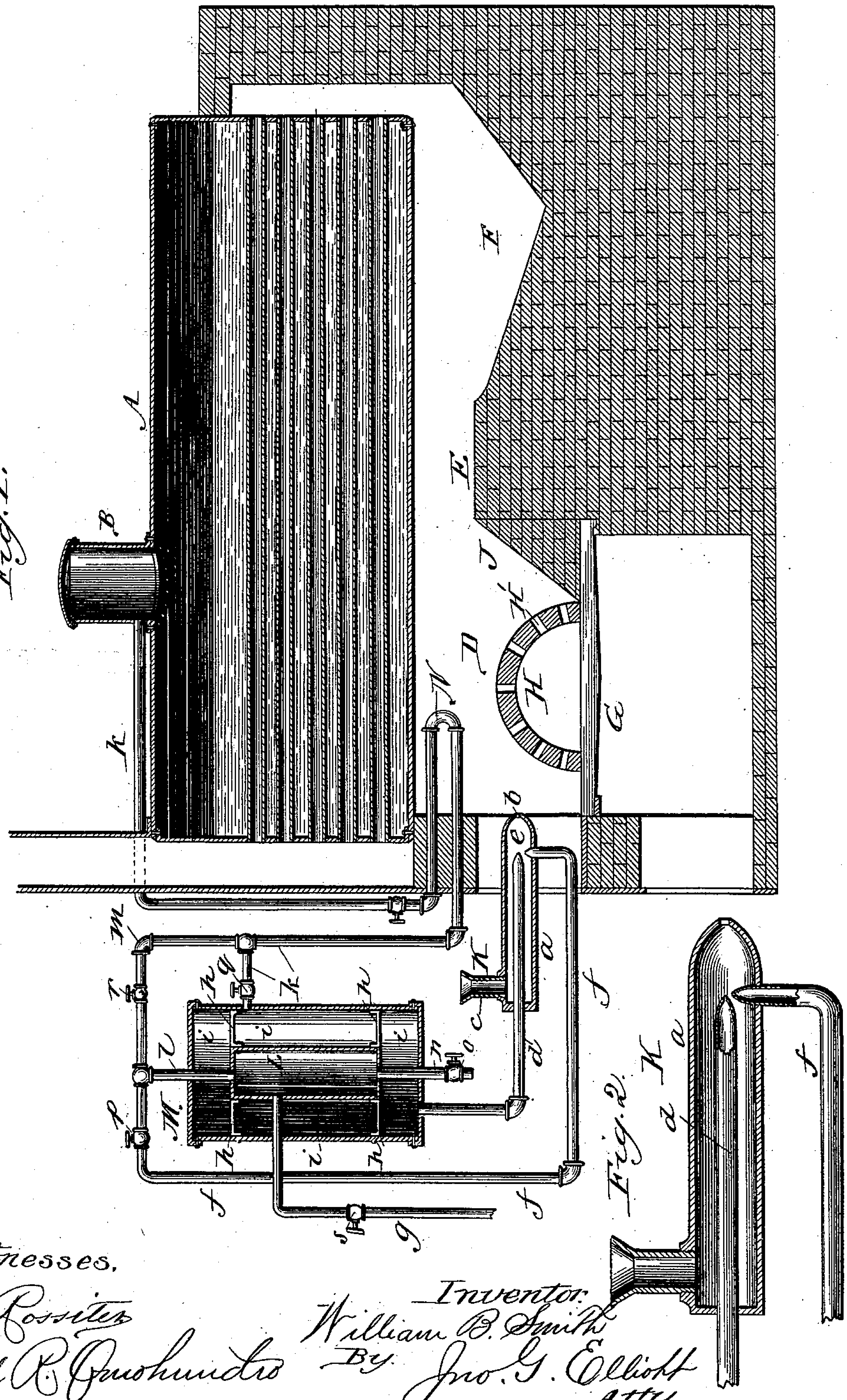
(No Model.)

W. B. SMITH.

HYDROCARBON FURNACE.

No. 378,852. Patented Feb. 28, 1888.



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HYDROCARBON-FURNACE.

SPECIFICATION forming part of Letters Patent No. 378,852, dated February 28, 1888.

Application filed February 2, 1886. Serial No. 190,575. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM B. SMITH, a citizen of the United States, residing in Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Hydrocarbon-Furnaces, of which the following is a specification.

This invention relates to improvements in hydrocarbon-furnaces in which a combined jet of hydrocarbon, steam, and air is injected into the fire-chamber of a furnace and in contact with fire-brick or other heat absorbing and radiating materials to the exclusion of coal or other fuel in the furnace.

In all furnaces in which hydrocarbons are sought to be used for generating heat to the exclusion of other fuel practice has demonstrated the absolute necessity of combining with the hydrocarbons, before their discharge into the furnace, both steam and air, and that a perfect combustion and successful utilization of hydrocarbons for furnace purposes is dependent upon the relative volumes of each of these three elements, the thoroughness with which they are combined, and the temperature they must have before their escape into and ignition in the fire-chamber. In some instances efforts have been made to unite the three elements at the same moment and just prior to their escape into the fire-chamber; but in practice this has been a failure, because the hydrocarbons are unavoidably carried in a liquid state into the fire-chamber, in which condition only the lighter portions are ignited, while the heavier portions drip through the grate-bars and are wasted, or at best are not fully utilized, by reason of an insufficient volume of oxygen and the hydrogen of steam. In other structures the air has first been superheated before coming in contact with the steam and hydrocarbons, and as a result the air is so expanded that it is utterly impossible to supply the requisite volume of oxygen for successfully producing a combustion of the hydrocarbons. In this connection it is proper to state that hydrocarbons cannot be successfully used in a furnace unless vaporized before their admission to the fire-chamber, and that, owing to the high degree of heat required to vaporize hydrocarbons, it is impracticable to combine with them prior to their discharge into the injector from which it escapes into the furnace sufficient air to promote a successful combustion of the hydrocarbons, because of the expansion of the air reducing the volume of oxygen to such an extent that it is insufficient for the volume of hydrocarbon vapors with which the air is so combined.

Practice and experiment have demonstrated that steam in a superheated condition may successfully be combined with and at the same time utilized for vaporizing the hydrocarbons, and that a sufficient volume of oxygen can only be obtained by admitting air at the normal temperature to the injector and not superheated until it shall have passed or met the steam-jet and hydrocarbons immediately before their escape from the injector into the furnace, and it is to the attainment of these ends my invention is directed.

Further objects of this invention are to have the hydrocarbon-reservoir entirely surrounded by a steam-jacket in which there is a free and continuous circulation of superheated steam, whereby the hydrocarbons are vaporized, and in a vaporous condition are combined and thoroughly mixed with superheated steam prior to its introduction into the injector. These objects are obtained by the devices and arrangement of devices shown in the accompanying drawings, in which—

Figure 1 illustrates a longitudinal sectional view of a furnace, hydrocarbon-reservoir, and injector embodying my invention; Fig. 2, an enlarged detail longitudinal section of the injector.

Similar letters of reference indicate the same parts in both figures of the drawings.

The boiler A and its dome B are of the ordinary construction of tubular steam-boilers and set in the setting or furnace C in the usual manner. The fire-chamber D, the bridge-wall E, and combustion-chamber F may be of any ordinary construction; but in practice I prefer to mount on the grate-bars G, or other suitable bottom of the fire-chamber, a semicircular or arched structure, H, composed of fire-brick or other suitable material, provided with a series of perforations, H′, through which air in a divided condition and supplied through the

ash-pit I may be distributed in the fire-chamber, which said arch preferably rises in a plane above the injector, hereinafter described, but may be in a plane below the same, and in either case is wholly or partially covered with broken pieces of fire-brick (not shown) or other heat absorbing and radiating material.

The face of the bridge-wall is preferably inclined, as shown at J, as is also the combustion-chamber F, formed to a V shape in cross-section; but while the details of construction so far described are preferred, they are not absolutely necessary for the purposes of my invention, for I may use any ordinary form of construction of furnaces so far as my invention relates to the special construction, operation, and combination of the steam, air, and oil supply pipes and passages hereinafter described.

Projecting into the front of the furnace, and preferably in a horizontal plane, is an injector, K, the shell *a* of which has its rear end provided with a slit or opening, *b*, through which the steam, air, and oil combined escape into the fire-chamber of the furnace, and preferably in a horizontal plane below the top of the bridge-wall. The forward end of this shell is closed, and in its upper side is tapped a flaring-mouthed and short tube, *c*, through which air may pass to the shell, which tube or air-inlet and so much of the shell forward of the open ends of the steam and oil supply pipes, hereinafter described, constitute an air-supply passage for the injector.

Projecting through the forward and closed end of the injector-shell is a steam-pipe, *d*, which opens in the shell a short distance from the inner and rear end of the shell, or at such a point from the escape-orifice thereof that there is an unoccupied chamber, *e*, between the opening of the steam-pipe and the escape-orifice of the injector, in which steam, air, and oil may be combined before being discharged into the furnace.

Opening into the shell of the injector at a right angle to the steam pipe or nozzle *d*, and slightly in the rear thereof, is a pipe, *f*, which, as hereinafter described, supplies to the injector steam and oil or other hydrocarbon combined, the opening of the steam-pipe and steam and oil pipe being so arranged relative to each other that the escaping steam from the pipe *d* will pass across the opening of the pipe *f* in escaping to the furnace, and thereby not only raise the temperature of the combined hydrocarbon and steam jet, but have an exhaust effect thereon, promoting its discharge into the mixing-chamber *e*, and thence into the fire-chamber of the furnace.

The supply of oil or other hydrocarbon for the injector may be contained in some suitable tank, (not shown,) and conducted thence by pipe *g* to a reservoir, L, preferably cylindrical in form and entirely inclosed on all sides by and suspended in a shell or cylinder, M, by brackets *h*, so that an enlarged chamber formed by the walls of the reservoir and the shell M entirely surrounds the reservoir and constitutes, as will presently be described, a surrounding steam-jacket, *i*, for the reservoir, whereby the contents of the reservoir may be raised to a high degree of temperature before their escape therefrom.

Opening into the steam-jacket, and at a point just below the upper end of the reservoir, is a pipe, *k*, connected with the dome B of the boiler, and having in it a superheater, N, projecting through the front walls of the furnace into the fire-chamber. The steam supplied by the pipe *k* to the steam-jacket first circulates around and heats the reservoir, and then escapes from the steam-jacket through the bottom thereof, through the steam-pipe *d*, to the injector.

The oil cannot escape without rising in the reservoir and through a pipe, *l*, projected through the shell M and steam-jacket and tapped into the reservoir, which pipe *l* is coupled with a steam-pipe, *m*, branching from the steam-pipe *k*, before described, and containing superheated steam, and both the oil-escape pipe or passage and steam-pipe *m* are in turn coupled with and discharge their contents into the pipe *f*, which, as before stated, discharges the combined hydrocarbon and steam in the mixing-chamber *e* of the injector and across the path of the steam escaping from the pipe *d*. In this connection it is proper to observe that the circulation of steam around the reservoir not only serves to elevate the temperature of and vaporize the contents of the reservoir, but by discharging the superheated steam as it enters the jacket against the upper end of the reservoir the effect of the steam on the hydrocarbons is best utilized for the steam at its highest degree of temperature therein and at a much higher degree of heat than they are toward the bottom of the reservoir. As a result of heating the contents of the reservoir in this manner, the best effects of the superheated steam in the pipe *m* are utilized for further elevating the temperature of the hydrocarbons and of promoting the thorough mixing of steam with the hydrocarbons while both are at a high degree of temperature and of discharging these elements in this condition to and combining them with steam and air in the mixing-chamber of the injector.

In operation the steam and hydrocarbons discharge into the mixing-chamber of the injector, and during their discharge have mixed with them an additional supply of steam from the pipe *d*, which increases the volume of hydrogen and insures the desired degree of heat of the hydrogen and hydrocarbons before their escape into the fire-chamber, and at the same time causes a supply of air to rush in through the air-passage C, so that a combination of air and an additional volume of steam is effected at the same moment with the hydrocarbons. Before its combination with the steam and hydrocarbons the air in passing through its passage to the mixing-chamber is heated sufficiently by the steam-pipe *d* to prevent the air

from reducing the temperature of steam and hydrocarbons below the degree at which they best combine and ignite, while at the same time the air is not so expanded that it lacks the necessary volume or density of oxygen to promote the best results and supply the hydrocarbons and hydrogen of steam with all the oxygen necessary to promote perfect combustion. In this connection it should be stated that by uniting the three elements in a chamber just before their discharge therefrom into the fire-chamber a more perfect combination is effected than is possible by any other known means, and the more perfect the combination of these three elements, is perfect combustion correspondingly promoted.

For the purpose of cleansing the oil-reservoir L and removing the sediment therefrom a pipe, *n*, is provided, opening into the bottom of said reservoir and projecting through the lower end of the shell or cylinder M, and having a valve or petcock, *o*, secured to the end thereof, through which pipe the sediment from the said reservoir will be forcibly ejected when the valves *p* and *q* are closed and the valves *o* and *r* are opened, thus directing the entire force of the superheated steam from the boiler-dome directly through the reservoir, during which operation the valve *s* in the oil-supply pipe *g* should remain closed.

I am aware that prior to my invention various combinations of hydrocarbon, steam, and air have been employed in the effort to produce perfect combustion in hydrocarbon-furnaces—such, for instance, as superheated air, steam, and hydrocarbon simultaneously discharged into an injector, or a combined stream of steam and hydrocarbon fed into the injector simultaneously with air, superheated or not, or else a single stream of combined steam, hydrocarbon, and atmospheric air fed into the mixing-chamber of an injector prior to its discharge into the furnace; but I am not aware that prior to my invention these elements have been combined after the manner, in the proportions, and at the times herein shown and described—namely, in three several and separate bodies, as follows: a combined stream of vaporized hydrocarbon and steam, pure live steam, and atmospheric air, all of which are discharged into the injector in separate and distinct jets just prior to their delivery to and ignition in the furnace.

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

1. The combination, with a furnace and with an oil-reservoir connected with the boiler and with the injector, and provided at its upper end only with a discharge-opening for the hydrocarbon into the steam-passage connecting the boiler with the injector, a steam-jacket entirely surrounding said reservoir, and a passage or passages connecting said jacket with the boiler and with the injector, of an injector consisting of a shell provided with an air-inlet in the upper side thereof and an opening into the furnace, a steam-pipe projecting in said shell, a combined oil and steam pipe opening into the shell in the path of the steam of the steam-pipe, and a mixing-chamber in said shell at a point between the discharge-openings of said pipes and the discharge-opening of the shell, substantially as described.

2. The combination, with a furnace, of an injector opening into the fire-chamber, an oil-reservoir connected with the boiler and with the injector and provided at its upper end only with a discharge-opening for the hydrocarbons into the steam-passage connecting the boiler with the injector, a steam-jacket entirely surrounding said reservoir, and a passage or passages connecting said jacket with the boiler and with the injector, substantially as described.

3. A furnace and an injector therefor, in combination with a reservoir provided with a discharge-opening at its upper end, a steam-passage opening into said discharge-opening and connecting the boiler and injector therewith, a steam-jacket entirely surrounding said reservoir, a steam-passage connecting said jacket with the boiler and opening into said jacket at a point opposing the upper portion of the reservoir, and a steam-passage connecting the lower end of the reservoir with the injector, substantially as and for the purpose specified.

4. The herein-described method of utilizing hydrocarbon as a fuel in furnaces, the same consisting in first fully vaporizing the hydrocarbon in a chamber isolated from steam and air, then combining said vapors with live steam to the exclusion of air, and afterward discharging the same into a mixing-chamber into which are simultaneously introduced separate bodies of live steam and air not superheated, which steam and air are mixed with the hydrocarbon vapors and steam immediately before being discharged into the fire-chamber, substantially as and for the purpose described.

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