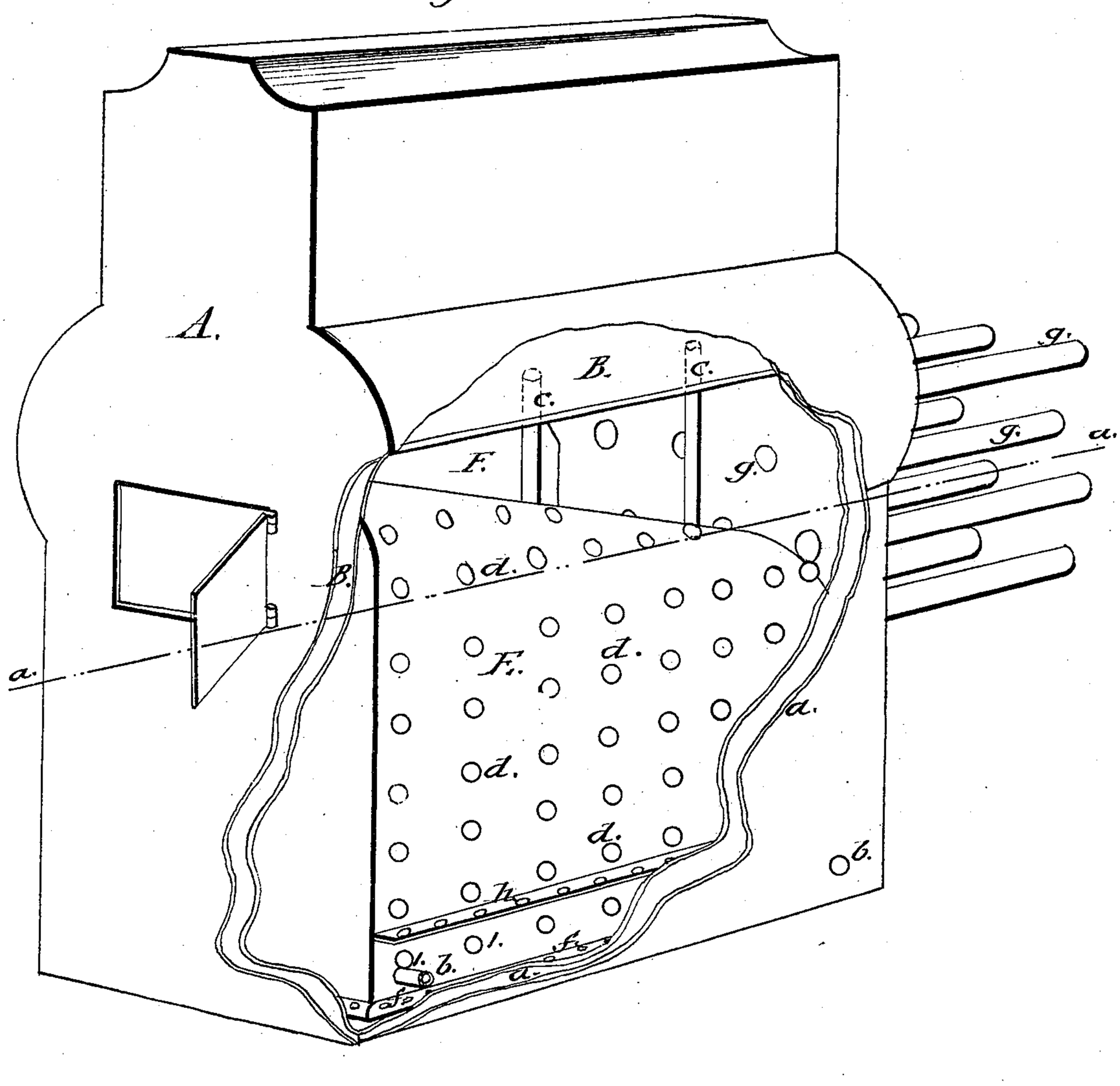
Sheet 1. 2 Sheets.

S. C. Salisbury,

Furnace.

No. 93,232. Patented Aug. 3. 1869.

Fig. 1.



Witnesses:

J. D. Lane.

Fred. B. Dearborn

Inventor:

Silas C. Salisbury.

Sheet 2. 2 Sheets.

S. C. Salisbury,

Furnace.

No. 93,232. Patented Aug. 3. 1869.

Fig. 2.

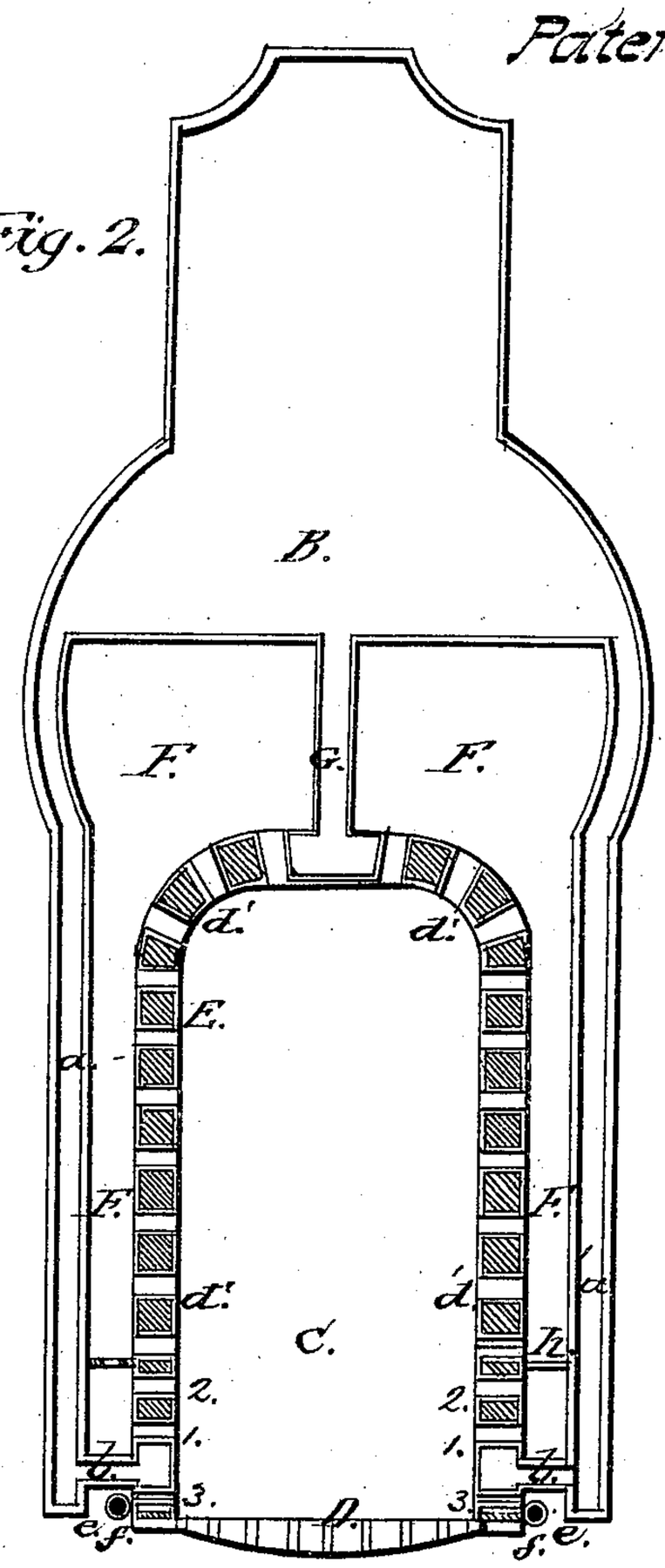
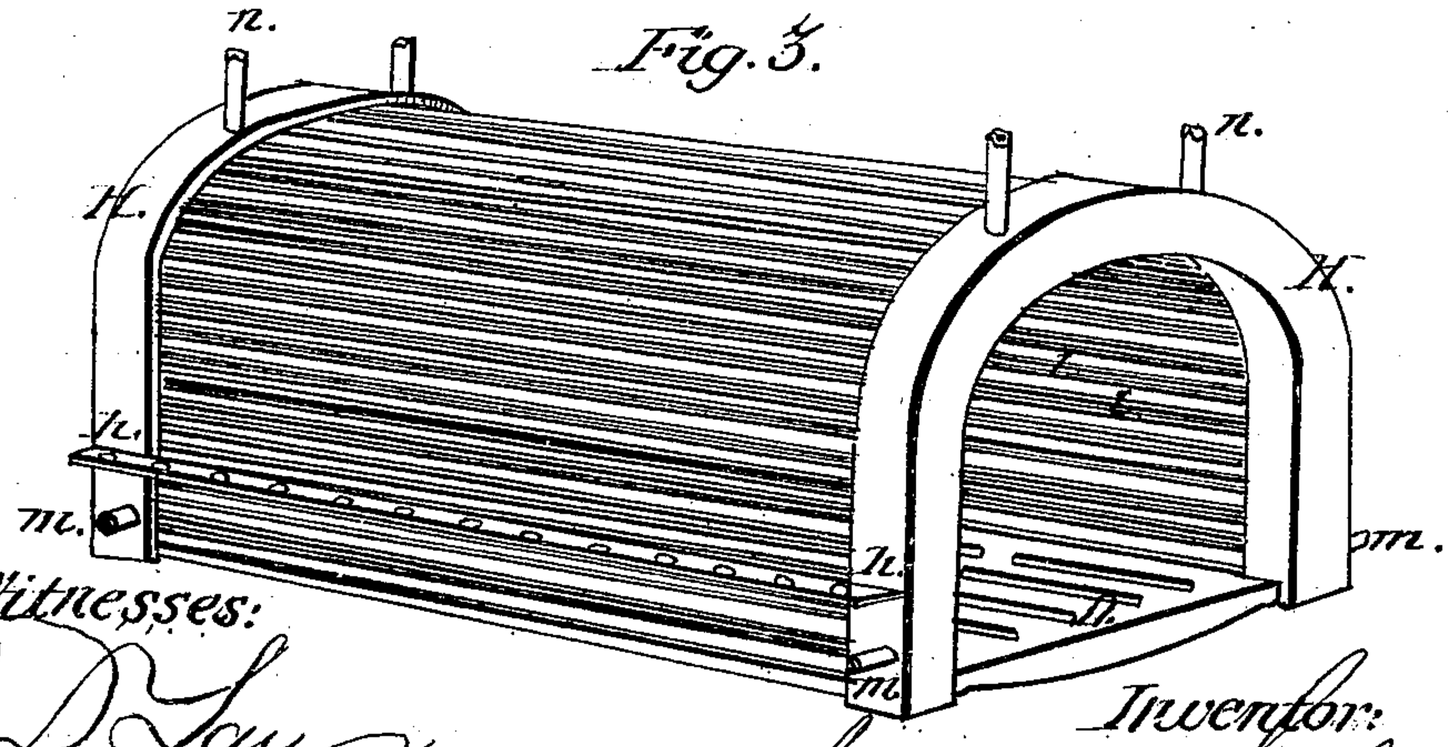


Fig. 3.



Witnesses:

L. D. Law.

Fred't B. Dearborn.

Inventor:

Silas C. Salisbury.

United States Patent Office.

SILAS C. SALISBURY, OF NEW YORK, N. Y.

Letters Patent No. 93,232, *dated August* 3, 1869.

IMPROVEMENT IN STEAM-GENERATORS.

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that I, SILAS C. SALISBURY, of the city of New York, in the county of New York, and State of New York, have invented a new and improved Steam-Generating Furnace; and I do hereby declare that the following is a full, clear, and exact description thereof, and of its mode or manner of operation, reference being had to the accompanying drawings, and to the letters of reference marked thereon, and making a part of this specification.

The objects of this invention are, to economize the use of fuel for generating steam, and render the same as effective as possible by utilizing the gases, and securing their more perfect or complete combustion, and by the construction and arrangement of a part of the water-chamber, to greatly increase the fire-surface of the boiler and its steam-generating capacity, and with the combustion of a comparatively small quantity of fuel.

Figure 1 is a perspective view of a horizontal locomotive-boiler, with a portion broken away, to show more clearly the application of my invention in connection therewith.

Figure 2 is a vertical section of fig. 1, through the line *a a*.

Figure 3 shows a modification, or different construction of the inner portion of the boiler forming the fire-chamber.

The external construction of the boiler A, and of the outer water-chamber B, is substantially the same as in boilers heretofore constructed, the water-chamber extending around the fire-chamber, and having, when required, water-legs *b b* on the sides of the fire-chamber.

The entire furnace C is placed inside the boiler, or between its water-legs or their equivalent, as in ordinary cases; and the grate or grate-bars D are substantially like those generally used, except that the openings or air-passages therein should be as numerous and large as possible, and be often separated or divided from each other, so as not only to supply large quantities of air to the bottom of the fire, but also divide the air, as it is admitted to the fire, into numerous currents.

The fire-chamber C, which may properly be called the preparing-chamber of the furnace, instead of being directly in contact with, or its walls forming the inner walls of the main water-chamber B, is placed within an outer or combustion-chamber, and separated some little distance from the main or outer portion of the boiler, as shown more plainly in fig. 2.

Such chamber is formed by, or is within a shell or hollow chamber, E, which is made of boiler-iron, firmly riveted together and braced, and of the shape required or desired for a fire-box, the plates forming such shell being generally about two inches apart. The space or chamber between such plates is a water-space or chamber, within which the water of the boiler is heated, and through which it circulates, such shell or inner water-chamber connecting with the main or outer water-chamber, as follows:

At either side of such shell or chamber E, and near the bottom, two or more tubes or pipes, *c c*, extend from such shell, and connect with and open into the main or outer water-chamber, or its water-legs *b b*, and similar tubes or pipes, *d d*, extend from the top of such shell, and open into the main water-chamber A, above the furnace. The shell or inner water-chamber E will thus be kept continually full of water from the main or outer chamber; and as the water in such shell becomes heated, it rises, and passes out through the tubes *d d* into the outer water-chamber, while at the same time the water from such chamber rushes into the inner chamber or fire-shell E, through the pipes *c c*. A constant and active circulation of the whole body of the water in the boiler is thus secured, and such circulation is constantly toward and in contact with that part of the boiler where the heat is the greatest and the evaporation is most rapid.

The tubes *d d*, extending from or near the top of the shell E, into the water-chamber above it, should be sufficiently numerous and large enough to allow the water to be freely and rapidly discharged through them; but they should not be so numerous but that the water will pass from the inner to the outer water-chamber with a considerable force or pressure, so as to insure a more rapid circulation of the whole body.

The walls of such shell or water-chamber E are also perforated with numerous holes, scattered over their entire surfaces to within about a foot of the bottom, as shown in fig. 1, and which are fitted with tubes *e e*, fig. 2, of about an inch, or thereabout, in diameter, properly swaged or tightly fixed in such openings.

These tubes form the means of connection between the fire or preparing-chamber C and the outer or combustion-chamber F. The direct action of the burning fuel is thus rendered effective, not only upon the wall of the fire-chamber or the inner plate of the water-chamber E, but also upon the surfaces of the tubes *e e*, by the passing of the heated products of combustion through them, and the fire-surface of the boiler directly acted on by the burning fuel, is thus increased by the extent of the surface of all such tubes.

For about a foot from the bottom of the fire-chamber or furnace C, the sides or walls of such chamber E are pierced, and fitted with about three-eighths inch tubing, *f f f*, and which are placed about two inches apart or distant from each other. These are

air-tubes, for the admission of air into the fire or preparing-chamber C, such air being supplied or admitted through suitable and sufficient openings, *g g*, in the bottom. Surrounding such lower part of the chamber E, and covering the mouths of the tubes *f f f*, I place wire gauze or loosely-woven asbestos-cloth, to divide or fractionize the air as it passes through such tubes into and upon the burning fuel, and also to heat it as it passes to the fuel. By means of such tubes, air is continually furnished to the fire or preparing-chamber, and enters such chamber in small or divided jets on every side of the burning fuel, and at or near the top thereof, and at different points below, and is thus presented to and distributed through every part of the burning fuel.

To such fire or preparing-chamber C, there is also admitted, through or by means of a pipe, *h*, extending underneath the openings *g g*, and opening into them by means of small perforations or jets, steam or superheated steam, (taken from the boiler, or any convenient or suitable source,) which becomes decomposed in passing into or on entering such chamber, furnishing additional oxygen, and also hydrogen, and thereby assisting to perfect a more complete combustion of the fuel.

By thus supplying the fire or preparing-chamber on every side thereof, and on the top of, and at different points of the burning fuel, with divided jets of air and decomposed or decomposing steam, the decarbonization of the fuel commences, and is carried on from the top and from the outside of the furnace, instead of principally from the bottom; but at the same time the intense heat penetrates the centre, and completely effects the same results there. A very intensified heat is thus produced, and with a comparatively slow combustion of fuel; and as such combustion is carried on most actively from the top and sides of the fire, the under-surfaces of the grate-bars, notwithstanding the great intensity of the heat, remain quite cool, comparatively, and consequently will last much longer than they could, under ordinary circumstances, with a fire of a much less intensity.

The combustion-chamber F is outside of, and surrounds the fire or preparing-chamber C, communication between these two being solely through or by means of the small tubes or pipes *e e*, which pass through the inner water-chamber E. The carbonic oxides and products of combustion, formed in the fire or preparing-chamber, by passing through the tubes *e e*, are divided into numerous small currents, and enter such combustion-chamber at many different angles, and are thus caused to come in more complete and intimate contact with, and thereby be more effectually mixed with the jets of air and steam which enter such chamber, as well as the fire or preparing-chamber.

Air and steam are supplied to the combustion-chamber F through the same openings *g g*, and by means of the same steam-pipes *h*, which supply the air and steam to the fire-chamber.

A perforated plate or diaphragm, *i*, placed just above the series of air-tubes *f f f*, allows the air and steam entering below to pass upward, part of it into the combustion-chamber, at the same time dividing the air and steam so entering the combustion-chamber into numerous currents, so as to insure their more general distribution among and mixture with the products of combustion and gases entering such chamber from the fire or preparing-chamber. Such diaphragm also serves to arrest or obstruct the passage upward of the air and steam, and deflects the larger portion backward and downward, and causes them to enter the fire or preparing-chamber, through the tubes *f f f*, for the purposes specified.

The air becomes heated while passing to the combustion-chamber, and is rendered lighter than the carbonic oxides continually being poured into such chamber from the fire-chamber, and an immediate chemical union and utilization of such gases of coal, air, and steam, takes place, and their complete combustion is produced.

The pressure and velocity of the steam escaping upward from the pipes *h*, also produces or causes an increased draught, and consequently an increased amount of oxygen is carried in and supplied to both the fire and combustion-chambers. Actual experiment has proved that such use of steam, in such chambers, adds greatly to the economy produced by the general combination.

The quantity of air and steam supplied to the fire and combustion-chambers is governed and regulated by a sliding-plate, so arranged as to graduate or vary the size of the openings *g g*.

The heat and products of combustion, after leaving the combustion-chamber, pass off, through the tubes *b b*, into the smoke-stack or chimney.

By thus making a part of the boiler form the fire-chamber, or chamber in which the fuel is burned, and placing such part of the boiler between the two chambers of the furnace, communication between which is by means of fire-tubes passing through that part of the boiler making the fire-chamber, an intense heat is made effective upon both sides of a comparatively small body of water, and also in many directions through such body of water, thereby causing large and rapid evaporation; and by means of the connection between the inner and outer water-chambers of the boiler, a continuous and rapid circulation of the whole body of water in both chambers is going on, and every portion of the water brought in contact with the most intensely heated surfaces. A largely increased evaporation or production of steam is thus obtained, and by the consumption of a comparatively small quantity of fuel.

Fig. 3 shows another construction of the inner water-chamber, or shell of the fire-chamber, the action and operation of which are the same as when the inner water-chamber is made as before described. Such fire-chamber, shell, or inner water-chamber, as represented in fig. 3, consists of a series of horizontal tubes, *l l*, generally about two inches in diameter, and placed about an inch from each other, which connect at either end with, and open into hollow arched chambers H H, such chambers connecting with the main or outer water-chambers at the bottom, by means of tubes *m m*, and at the top, by other tubes, *n n*. Circulation from the outer to the inner water-chamber, and through the latter, and from that into the former, is substantially the same, though perhaps not quite so rapid, as when the inner water-chamber is constructed as shown in figs. 1 and 2. A covering of heavy wire cloth upon the outside of the tubes *l l* serves to more effectually divide into separate currents the carbonic oxides and products of combustion, as they pass from the fire to the combustion-chamber, and thus prepare them to be more easily and completely mixed and combined with the air and steam entering that chamber.

By the use of a furnace and boiler thus constructed, the escape of sparks is prevented, the small particles of fuel escaping from the fire-chamber are consumed in the combustion-chamber, and consequently the flues are but little, if any, injured by them; the fire-box or chamber is far less likely or liable to be burned out than when ordinary furnaces are used, and thus a great saving in repairs is effected; there is far less liability to injury and breakages, from or by reason of the great strain produced by extreme contraction and expansion, when one plate is kept so very hot and the other is comparatively cool, as in ordinary boilers; and as the water is rapidly conveyed to the hottest

part of the boiler from the colder parts, it absorbs or takes up the extreme heat, thus heating the water as fast as it comes in contact with such hotter part, and as this is discharged above the water in the main boiler, it at once becomes steam.

The steam-generating capacity of a boiler, when so constructed, is increased very largely, nearly or quite one-third.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The arrangement, in combination with the main water-chamber of a boiler, of an inner water-chamber, forming the shell of the fire-chamber, such inner and outer water-chambers being connected together, substantially as described.

2. The arrangement, in combination with such an inner water-chamber, forming the fire-chamber, of the fire-tubes *e e*, passing through such water-chamber, substantially as described.

3. The combination of the portion of the water-chamber of a boiler within the furnace-chamber, or between that part of the furnace where the coal is burned and that part where the gases and products of combustion are consumed, substantially as described.

4. The combination, with a boiler consisting of two water-chambers, an inner and an outer, connected together, of a furnace, having two, or a preparing and combustion-chamber, when the inner water-chamber is between the preparing and combustion-chambers of the furnace, and the combustion-chamber of the furnace is between the inner and outer water-chambers, substantially as herein set forth.

SILAS C. SALISBURY.

Witnesses:
S. D. LAW,
FRED. B. SEARS.