2 Sheets—Sheet 1.

T. R. BUTMAN.

STEAM-BOILER AND SETTING.

No. 181,237. Patented Aug. 15, 1876.

Fig. 1.

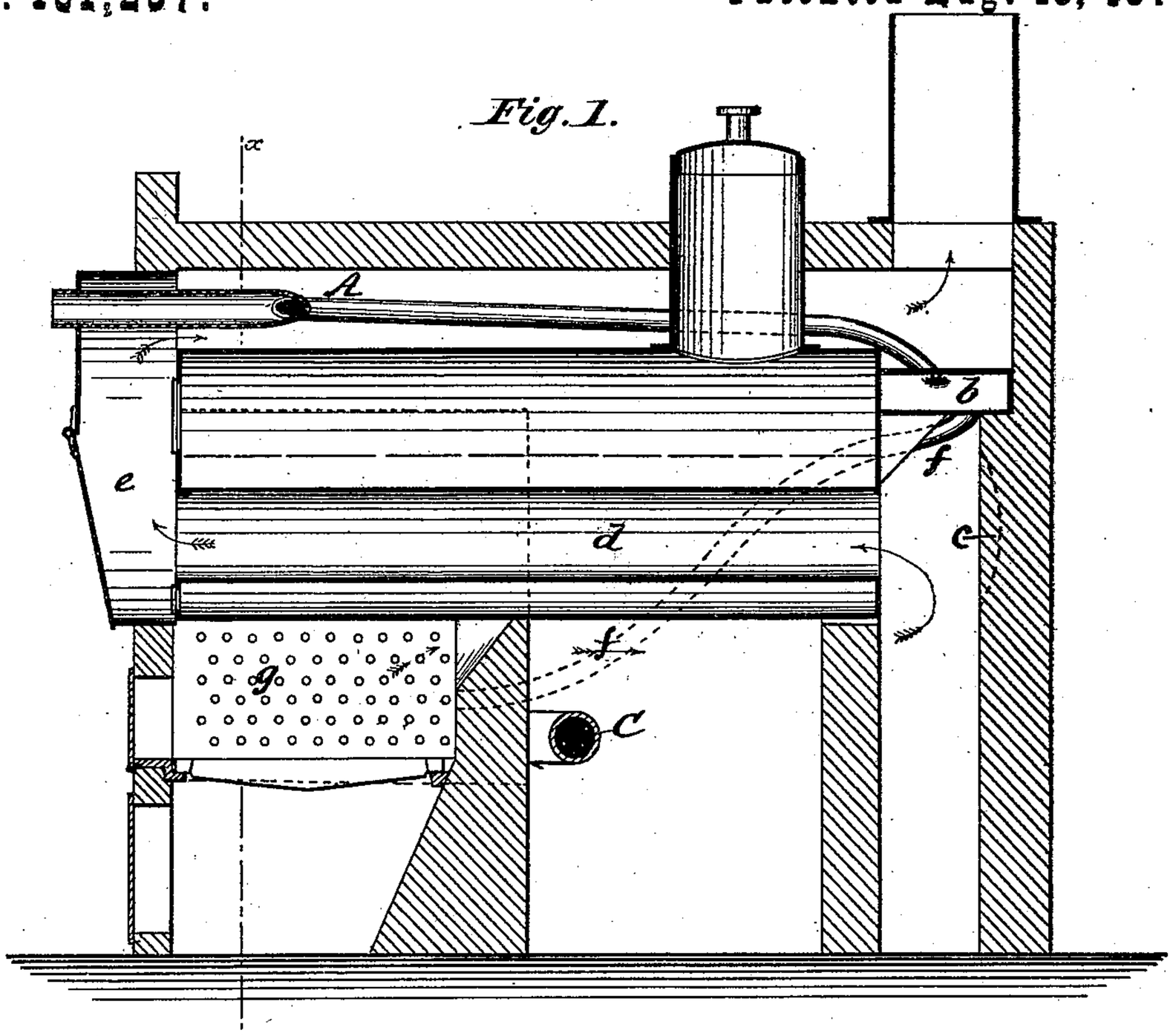
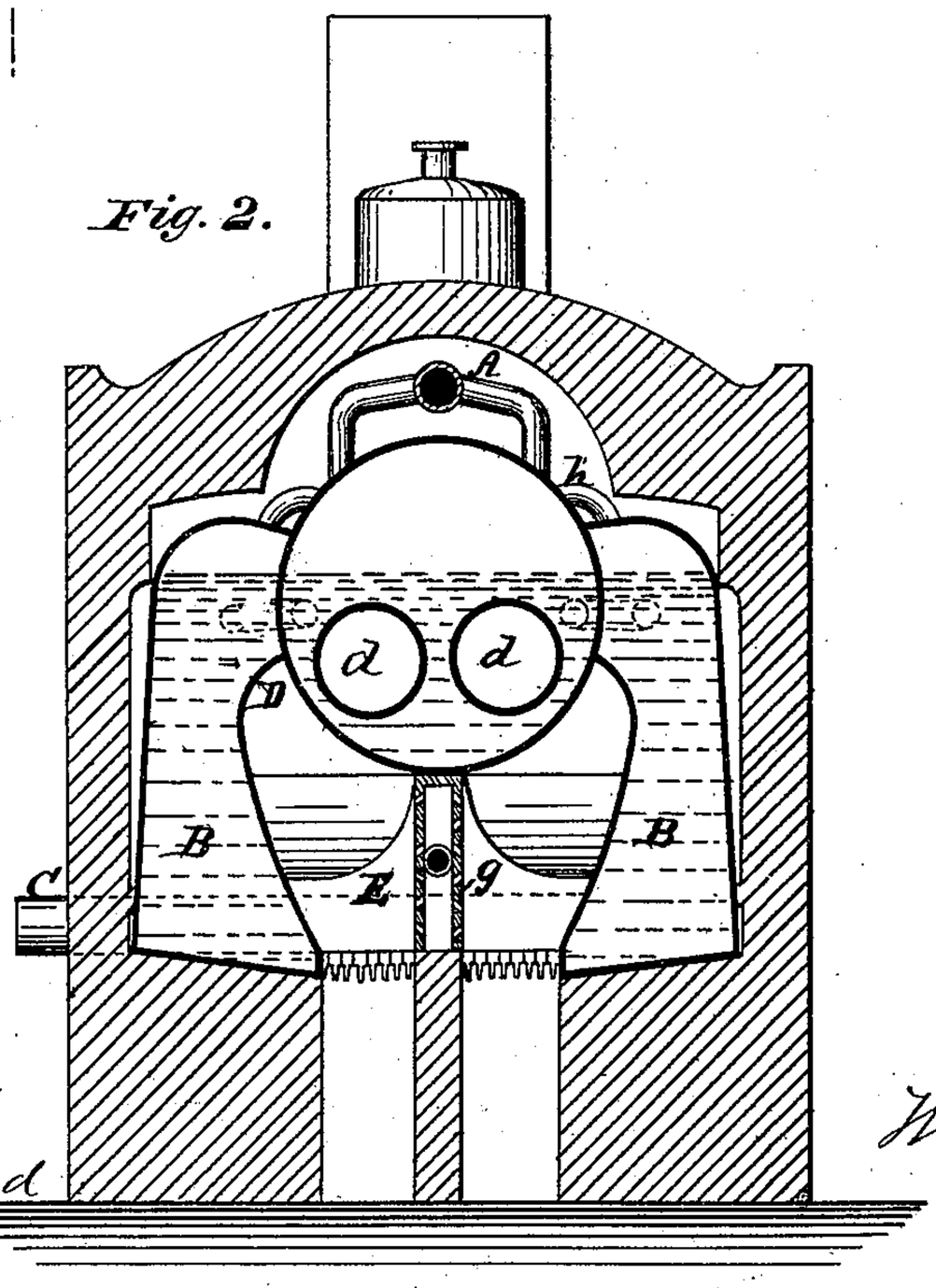


Fig. 2.



Witnesses:
Jennie B. Ames
Ludel W. Townsend

Inventor:
Thomas Reed
Butman

2 Sheets—Sheet 2.

T. R. BUTMAN.

STEAM-BOILER AND SETTING.

No. 181,237. Patented Aug. 15, 1876.

Fig. 3.

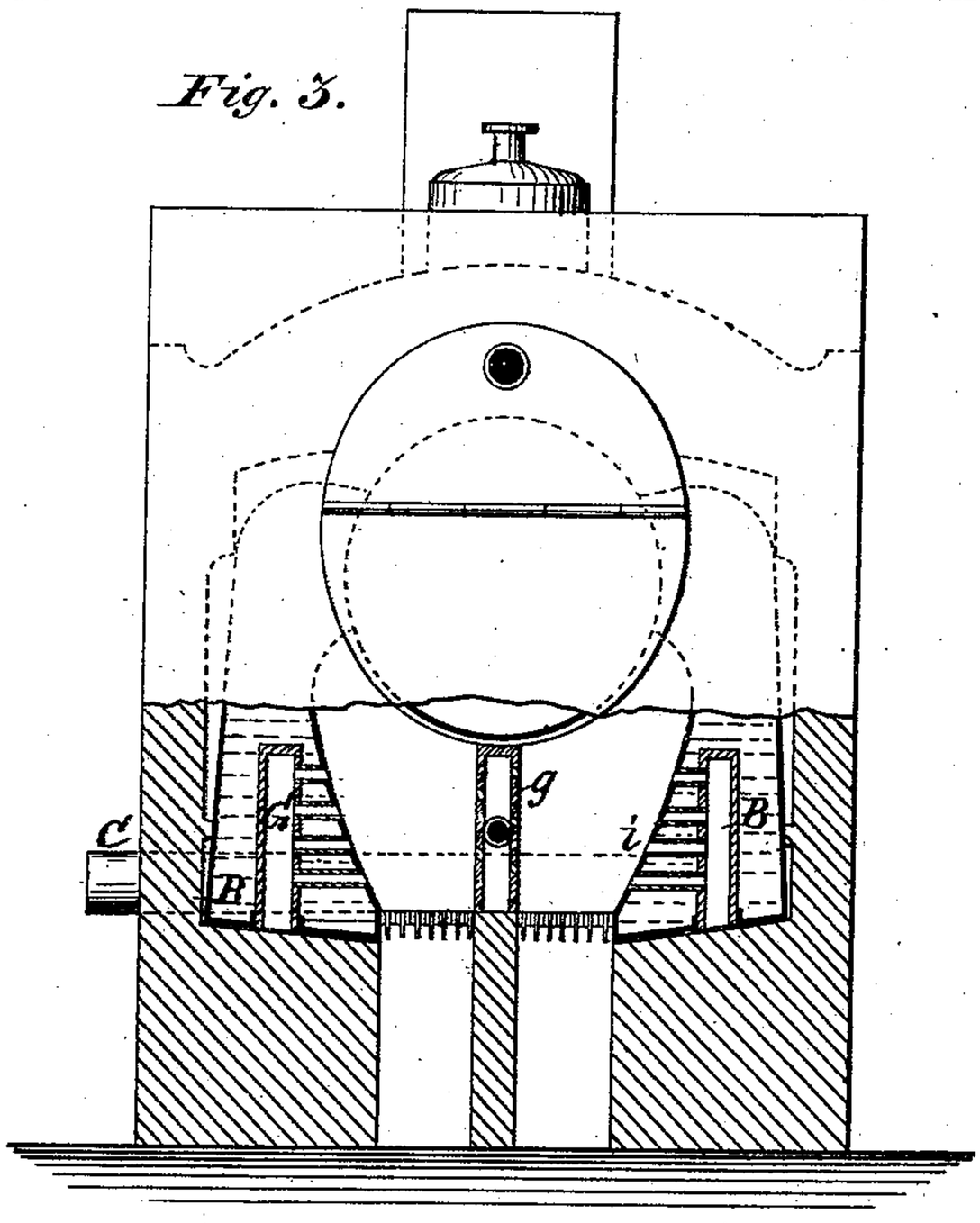
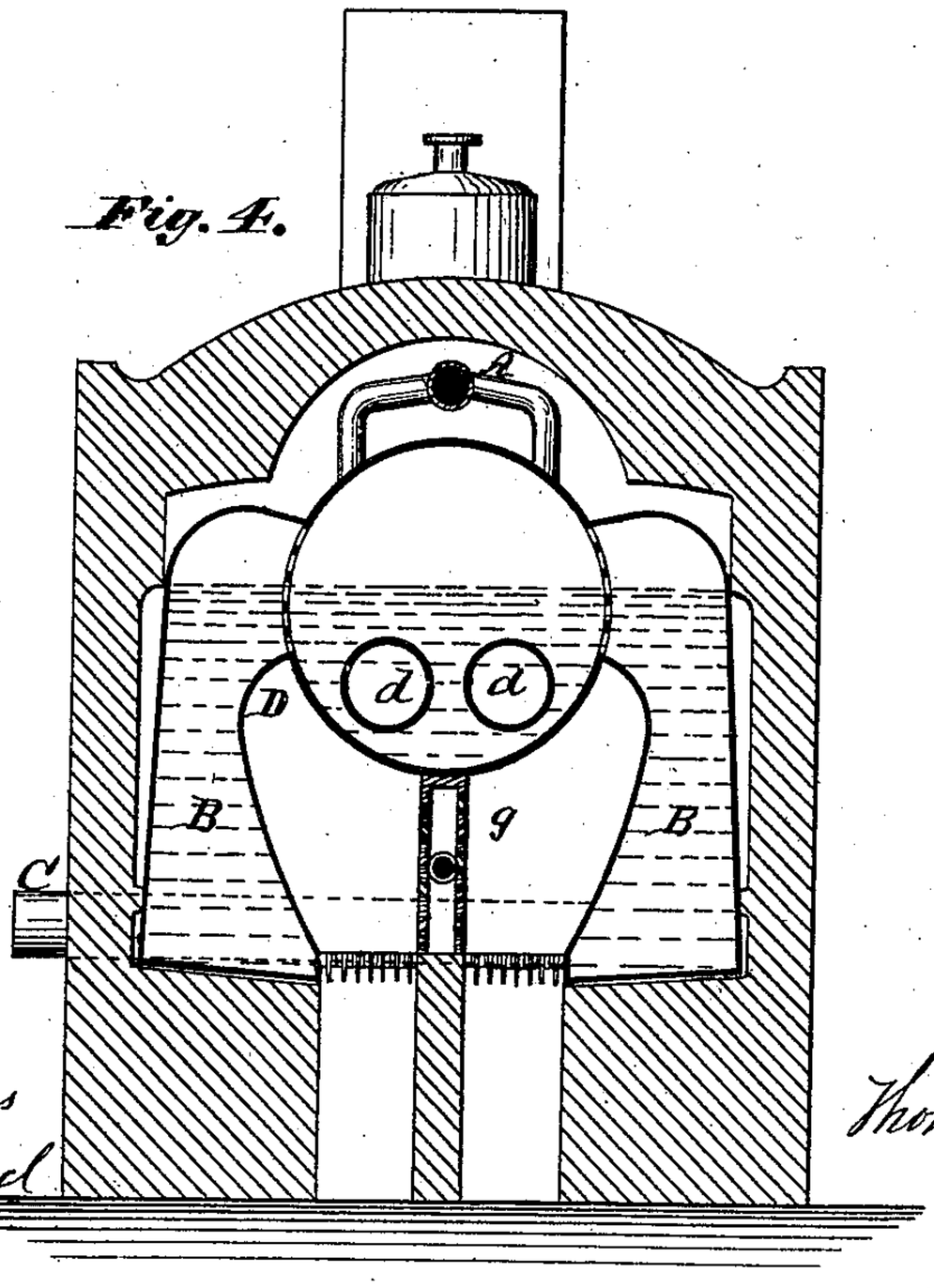


Fig. 4.



Witnesses:

Jennie B Ames

Euclid W. Townsend

Inventor:

Thomas Reed Butman

UNITED STATES PATENT OFFICE.

THOMAS R. BUTMAN, OF MILAN, OHIO.

IMPROVEMENT IN STEAM-BOILERS AND SETTING.

Specification forming part of Letters Patent No. **181,237**, dated August 15, 1876; application filed August 4, 1876.

To all whom it may concern:

Be it known that I, THOMAS REED BUTMAN, of Milan, in the county of Erie and State of Ohio, have invented certain new and useful Improvements in Steam-Boilers and Setting of the same; and I do hereby declare that the following is a full, clear, and exact description thereof, which 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:

This invention relates to an apparatus for the more perfect combustion of fuel, and therefore the greater economy of the same, and the increasing heat-transmitting power of the plate-surface of boilers and boiler-furnaces; and also by my construction the water is made to enter the boiler in a purer condition than heretofore, and also in a state of high degree of temperature, whereby the great danger of sudden contraction and expansion of the boiler-sheets is avoided, thereby preserving the boiler seams, rivets, joints, &c., from rupture, as will hereinafter more fully appear.

The erroneous idea that smoke once formed can be consumed in the same furnace in which it is generated is irreconcilable with the operations of nature. The formation of smoke arises out of the failure of some of the processes preparatory to combustion, or the absence of some one of the conditions which are essential to that consummation from which heat is obtained. To expect that smoke, which is the very result of a deficient supply of heat or air, or both, can be consumed in the furnace in which such deficient supply has occurred is a manifest absurdity, seeing that if such heat and air had been supplied this smoke would not have existed. I desire to remark, for the more clear understanding of my invention, that a distinction should be made and observed between the prevention of the formation of smoke, and the combustion of smoke after it has been made. Neither does the color of the smoke determine the combustible gases wasted and carried off. Carbonic oxide, carbureted hydrogen, and various other hydrocarbons, in the form of vapor, may escape invisibly from the chimney, and, as they are all combustible, are, strictly speaking, so much loss of fuel. Now, to overcome this great waste of combustible gases, and to consume them, is the first object of my invention, and which I accomplish by throwing jets of heated air in a peculiar manner (see drawing) into the inflammable gases and vapors which constitute so large a part of the matters which, in many ill-constructed furnaces, escape along with the finely-divided carbon, or smoke, renders them all available as sources of heat; and where this system is perfectly applied the smoke can consist of very little else than carbonic acid, steam, and nitrogen, all incombustible, and also incapable of supporting combustion.

I will now proceed to set forth and describe the second feature of my invention, viz., the water-legs, forming the sides of the fire-box. Now, it may be said that a boiler-plate possesses three essential characteristics—viz., the reception of heat by one side, its emission from the other side, and power of conduction through the body or thickness of the plate. We will therefore assume that the greater the surface exposed to the direct action of the heat the greater will be the conduction or heat transmitted to the water. It is true that the closer the proximity of this plate to the direct action of the fire the more intensely the heat is taken up, for it is well known that the farther the flame passes from the furnace where it is generated the cooler it becomes. Therefore ten feet by ten to one hundred square feet present the same amount of surface-area as one of one hundred feet long by one foot wide. As a steam-generator, however, the effect would be different, the lineal run or distance traveled over being as ten to one, and occupying ten seconds of time in the first, but one second in the other. Therefore a ten-by ten plate possesses ten times the heating-function as the plate one hundred feet long and one foot wide, and this is precisely the result obtained by my water-legs.

I am aware it is not new to locate water-legs at the sides of a boiler and connect them therewith. Neither is it new to run air-tubes through them from the outside. Such I do not claim. But these water-legs just referred to are generally constructed vertically, and

sometimes conically, so that the products of combustion pass off unconsumed for the want of space to evolve or receive the proper supply of atmospheric air, cold or heated. To all such formed furnaces I lay no claim.

It will be seen by reference to the drawing that my water-legs run the same depth of the furnace, but may run the full length of the boiler with good result. The outside walls of the legs are preferably made vertical, and the inside wall made to diverge from the grate up, turning at the top to form a curve, thus in cross-section forming the frustum of an inverted cone, the walls in both cases extending below the grate-surface, forming what might be called a "mud vessel or receptacle," and, as will be seen, is not exposed to the destructive effects of the fire, and is thus prevented from burning out.

It will also be seen, as above referred to, that the walls above the fire diverge at an incline. By this arrangement a greater plate-heating surface is exposed to the fire. This upper space, formed by said inclination and crown-curve, not only forms a greater heating-surface than has heretofore been presented, but also forms a reverberatory chamber, where the gases are evolved, and the calorific plate or box supplying streams or jets of heated air, which commingles with the gases in the fire-box, whereby an intimate mixture of the combustible gases is produced at a point where the heat is most intense, and thus enable me to extract the whole heat the combustible gases are capable of affording, and by which they are entirely consumed and the formation of smoke prevented, and thus a great economy of fuel is the result.

Having now described the furnace side of my water-legs, I will briefly set forth the action or result of the water or in side.

As before described, the furnace is flaring from the grate-surface up, and curving at the top. This construction therefore begets a tapered or wedge-shaped water-space, as shown in cross-section, the larger portion of which, or, strictly speaking, the greater body of water, being where the water is hottest—namely, near the bottom. Thus the danger of burning out is prevented, the mud-receptacle being below the grate. The upper or neck portion of this chamber is much narrower, and through which the steam and water pass into the main boiler in a very high degree of temperature, by which means sudden expansion or contraction of the boiler or its connections is avoided, which is, as is well known to practical men, a great consideration. Thus it will be seen the water is not only heated in an economical manner, but, the mud and sediment held in suspension being liberated, the water is also purified by the boiling action through which it passes in the water-legs. The mud and sediment above alluded to are precipitated to the bottom of the legs, thus relieving the boiler from the evil effects of incrustation.

The air by which the calorific box is supplied passes through a series of pipes located over the top of the boiler in a return flue, through which the products of combustion pass to the uptake, and by which the steam in the boiler is also superheated. It will be observed that by my invention all the heat generated in the furnace is utilized as far as possible. It will be further stated that the grate-surface is lessened, and that a less quantity of fuel is required for the generation of a given quantity of steam than by any other furnace known to me; and this result I produce by the reverberatory and evolving action of the flame and gases in the enlarged portion of the furnace, and increased area of plate-surface—said furnace supplied, as it is, with the heated air, heated by the waste products of combustion on their way to the uptake, and the air on its way to the furnace.

Having set forth the principle of my invention, and to enable others skilled in the art to which my invention appertains, I will now proceed to describe its construction and operation, and will refer to the drawings forming part of this specification.

Like letters in all the figures represent like parts.

Figure 1 illustrates a vertical longitudinal section of my boiler, furnace, and water-legs, in which is shown the air-heating pipe A, partly in section. This pipe is forked, to span the steam-dome. This pipe may be spirally coiled, or coiled by means of return bends, or in any other suitable manner, but, preferably, located over the boiler in a flue by which the air that supplies the furnace is heated, and the steam in the boiler is superheated. *b*, in this figure, is the air-distributing box, and which forms a horizontal partition dividing the rear flue. Under this box *b* is located a double concave deflector, *c*, by which the products of combustion are divided and deflected against the rear end of the boiler, and made, in a measure, to give up their heat. *d d* are the flues, and *e* the front smoke-box, which is provided in the usual way with a door for the purpose of cleaning out the flues and tubes, and for repairs. *f*, mostly in dotted lines, shows the pipe from the air-distributing box leading to the hollow calorific plate. This plate or box *g* is centrally and longitudinally located under the bottom of the boiler, and, preferably, the length of the furnace, resting on a partition which divides the ash-pit longitudinally, so that the air entering therefrom may be controlled and directed to either side of the calorific plate.

It will be seen that this plate is perforated or slitted, as preferred, for the purpose of throwing jets or streams of air and steam, or hydrocarbon or other gases, into the furnace, which are made thereby to mingle with the products of combustion evolving from the fuel, a large quantity of which is composed of carbureted-hydrogen gas, requiring for its combustion a

correspondingly large supply of atmospheric air. It will be further seen that the said slits or perforations are formed at an angle to each other, so that on the induction of the air or gases into the furnace they meet before impinging upon the sides of the furnace, and are made to mingle more freely with the flame or gases arising from the incandescent fuel, and in this condition are entirely consumed, thus avoiding the formation of smoke, the consumption of all the combustible gases effected, and, therefore, a more perfect combustion and economy of fuel.

The angle of the air-jets is important, for the reason if they were directed against the side of the furnace they would act in the capacity of a "blow-pipe," and in a short time burn holes in the sides of the furnace. The location of the calorific plate is also important, for by its position the intense heat is forced from the bottom of the boiler, where sediment (if there be any) accumulates and displaces the water, and the blistering or burning of the boiler-plate soon follows. Thus it will be seen the bottom of the boiler is protected. This hollow calorific plate will, in some instances, sufficiently heat the air for its own supply with good results.

Fig. 1 also represents the side of the water-legs B in dotted lines, and also the end of the water-supply pipe *c*, by which the legs are connected. This figure also shows the auxiliary combustion-chamber in the rear of the bridge-wall, and also the secondary bridge-wall at the rear flue.

Fig. 2 represents a vertical transverse section on the line *x x* of Fig. 1. This figure, as well as all the modifications, show the frustum inverted cone-shape of the water-legs B, viz., enlarging from the grate-surface to near the water-line of the boiler. The advantage of this formation with that of the curve-crown D has been before fully set forth. It will be seen in this figure that these water-legs are connected to the boiler by two series of pipes—the water-pipes, (shown in dotted lines,) and the steam-pipe *h*, (shown in full lines.) By this means the foam—generally known as priming, and from which incrustation is formed—is prevented from entering the boiler proper. Thus the boiler is kept comparatively clean, and the deleterious effect from this source avoided.

E, in Fig. 2, represents the bridge projecting upward to the center of the boiler, and then gradually sloping downward on each side to a point sufficient for the passage of the fuel. By this construction the intense heat is deflected from the extreme bottom of the boiler, where the sediment most settles, and by that means "pitting," or burning of the boiler-plate, is prevented. The water-connecting pipe C (partly in dotted lines) is shown in this and all the figures.

Fig. 3 represents a front elevation, partly in section, the section showing a modification of the construction of the water-legs, the chamber G running lengthwise through said legs, and communicating with the furnace by means of short tubes *i*. These tubes *i*, in chamber G, may be used as flue-tubes, by which additional heating-surface is produced, or they may be proportioned to be used as air-supply tubes. In either case the result is beneficial. Some kinds of fuel require a greater quantity of atmospheric air than others. In that case this construction is peculiarly applicable. The upper connection of the legs to the boiler may be made in any approved manner.

Fig. 4 represents another means of connecting the water-legs to the boiler—viz., making slits in the sides of the boiler, through which the water communicates. Circulation may be maintained between the water-legs and the boiler in any well-known manner. These water-legs are applicable to flue and tubular, sectional, and other boilers. They may also be used in reverberatory and other furnaces. This figure shows a front view of the forked heating-pipe.

It may be remarked that the waste products of combustion, passing through the flue over the boiler, superheating the steam, heating the air, &c., also impinge on the top of the water-legs, by which an additional heat is taken up.

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

1. The coiled heating-pipes A, division distributing-box *b*, pipes *f*, and calorific hollow wall *g*, substantially as described, and for the purpose set forth.

2. Water-legs B, diverging as shown, provided with the curved crown D, said legs forming the sides of a fire-box, and connected by pipe C, substantially as described and shown.

3. The combination of the diverging curve-crowned water-legs B D, connected by pipes C and the boiler, whereby an enlarged heating-surface is presented, and the water is purified and heated before entering the said boiler, substantially in the manner shown and described.

4. The water-legs B, boiler and connecting pipes, air-heating pipes, and drum, hollow calorific plate, and the bridge-walls, combined and arranged to operate in the manner and for the purpose set forth and described.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

THOMAS REED BUTMAN.

Witnesses:
JENNIE B. AMES,
CADD W. TOWNSEND.