July 3, 1928.

1,676,046

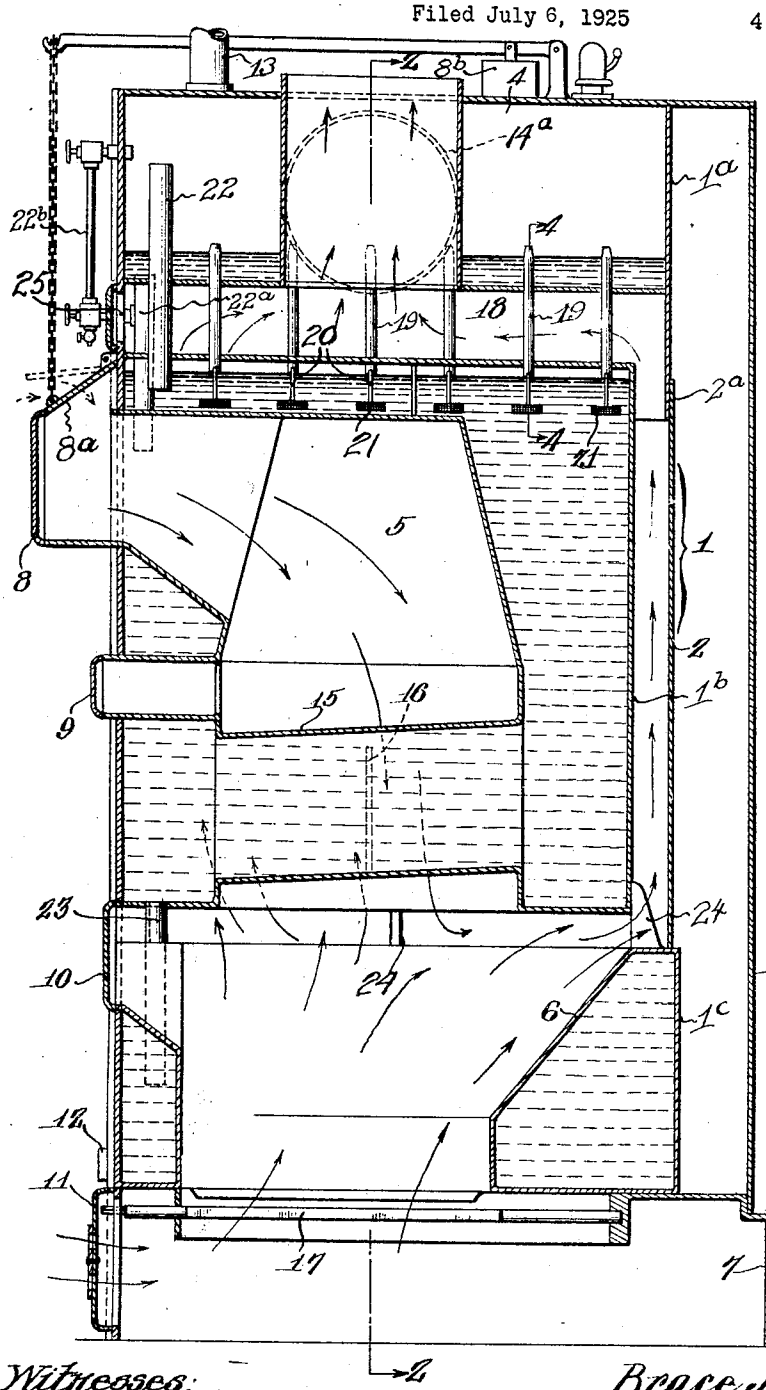
B. A. PHILLIPS

STEAM AND HOT AIR GENERATOR

Filed July 6, 1925

4 Sheets-Sheet 1

Fig. 1.




Witnesses:
Walter Thum.
George A. Gruss

Inventor:
Bruce A. Phillips.
by Joshua R. H. Potts
his Attorney.

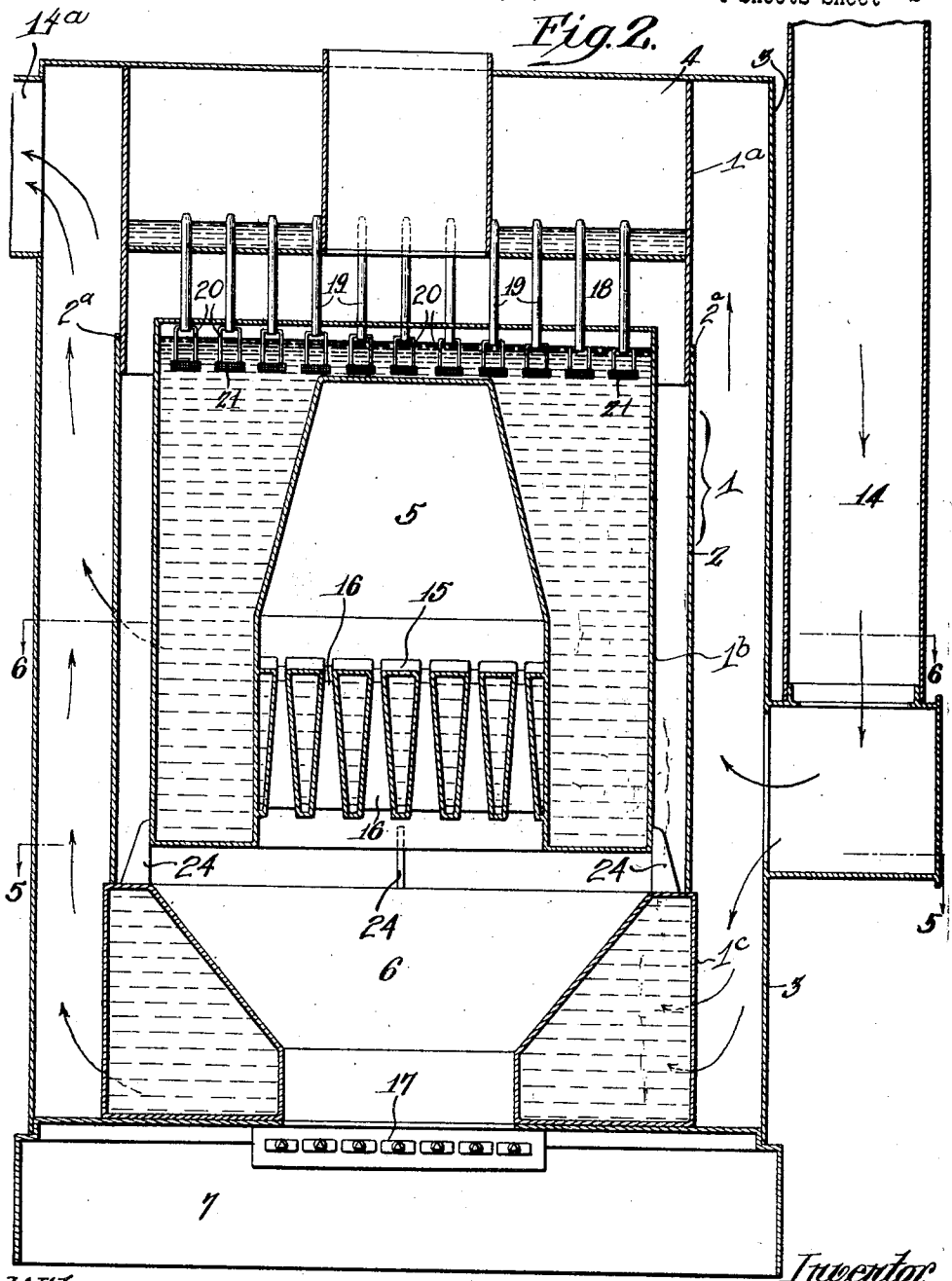
July 3, 1928. 1,676,046

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STEAM AND HOT AIR GENERATOR

Filed July 6, 1925 4 Sheets-Sheet 2

Fig. 2.




Witnesses:
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July 3, 1928.

1,676,046

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STEAM AND HOT AIR GENERATOR

Filed July 6, 1925

4 Sheets-Sheet 3

Fig. 3.

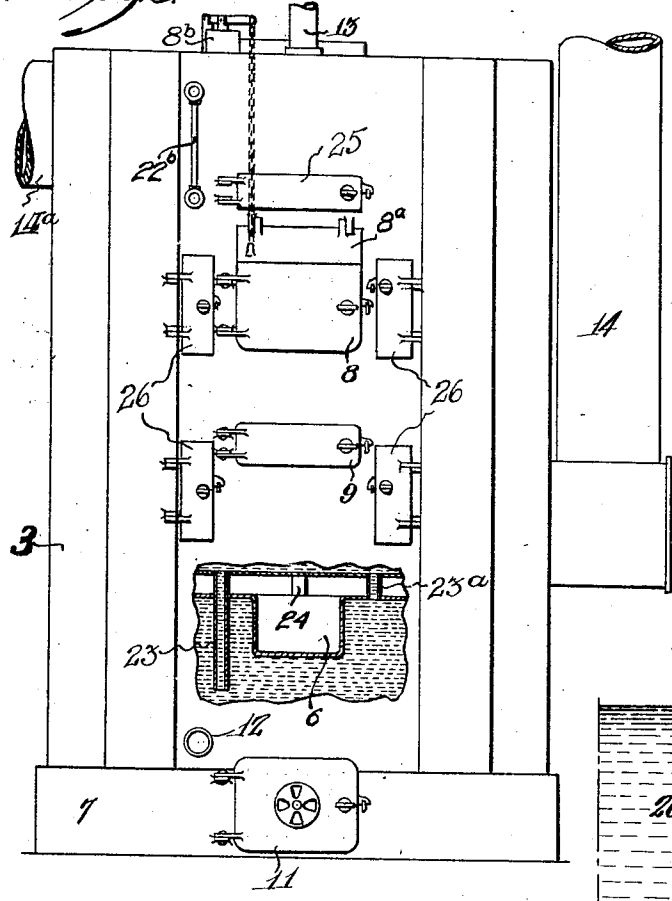
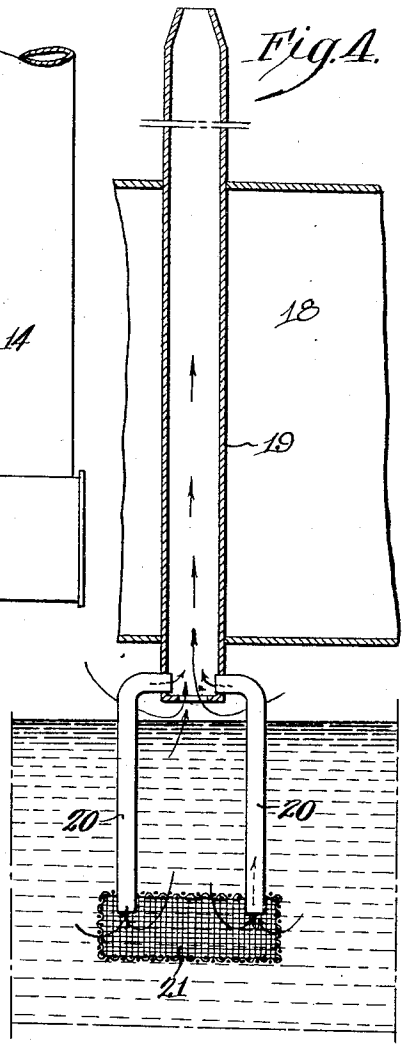



Fig. 4.




Witnesses:
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1,676,046

B. A. PHILLIPS

STEAM AND HOT AIR GENERATOR

Filed July 6, 1925

4 Sheets-Sheet 4

Fig. 6.

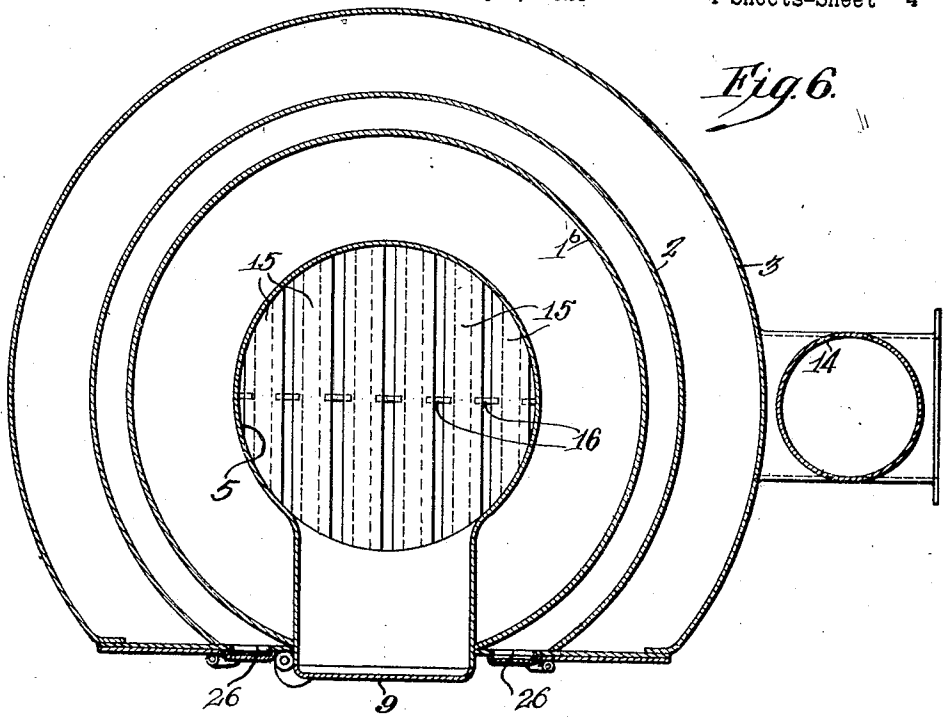
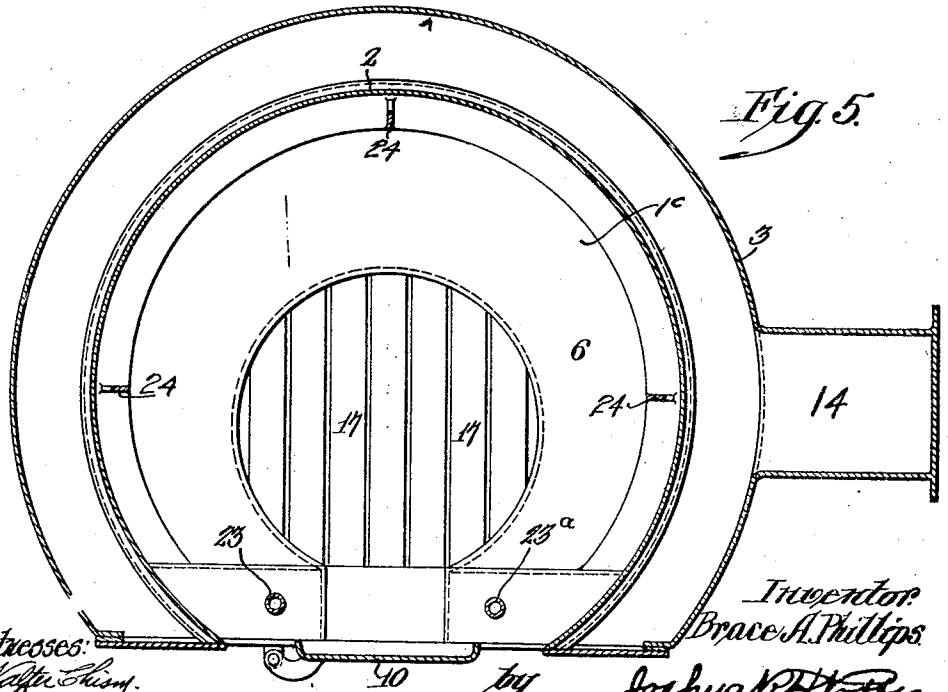



Fig. 5.




Witnesses:
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Patented July 3, 1928. 1,676,046

# UNITED STATES PATENT OFFICE.

BRACE A. PHILLIPS, OF EAST LANSDOWNE, PENNSYLVANIA.

## STEAM AND HOT-AIR GENERATOR.

Application filed July 6, 1925. Serial No. 41,716.

My invention relates to boilers and more especially to that class of boilers used for generating steam and hot air for heating and ventilating purposes. The objects of my invention are to provide a boiler in which the combustion of the fuel will be practically complete, which will absorb practically all of the heat from the products of combustion, in which the gas passages may be easily cleaned of soot, and in which the parts are free to expand and contract due to the temperature changes.

This object, and other advantageous ends which will be described hereinafter, I attain in the following manner, reference being had to the accompanying drawings in which

Figure 1 is a vertical section through a boiler embodying my invention,

Figure 2 a section on line 2—2 of Figure 1,

Figure 3 a front elevation of the boiler,

Figure 4 a section on line 4—4 of Figure 1,

Figure 5 a section on line 5—5 of Figure 2, and

Figure 6 a section on line 6—6 of Figure 2.

In the drawings, the numeral 1 indicates the boiler casing made up of three sections, an upper steam generator $1^a$, a lower steam generator $1^b$ and a feed water heater $1^c$; 2 a casing spaced from and surrounding the steam generator $1^b$, except at the front, and disposed between the upper generator $1^a$ and the water heater $1^c$ to provide a passage for the products of combustion, said casing being made of sections telescopically connected at $2^a$ to allow up and down movement of the boiler parts caused by temperature changes; 3 a casing spaced from and surrounding casing 2, upper generator $1^a$ and water heater $1^c$, except at the front, to provide an air passage; 4 a steam space in upper generator $1^a$; 5 a main combustion chamber in lower steam generator $1^b$; 6 a secondary combustion chamber disposed in water heater $1^c$ and beneath the main combustion chamber 5; 7 an ash pit beneath the secondary combustion chamber 6; 8 a door closing an opening through which fuel is fed to the main combustion chamber; 9 a door closing an opening which affords access to the main combustion chamber for working the fuel bed with firing tools. 10 a door closing an opening which affords access to the lower combustion chamber; 11 an ash pit door; 12 a feed water inlet in the feed water heater; 13 a steam outlet in the top of the superheater and communicating with steam space 4, and 14 a cold air duct which leads into the air passage between casing 2 and casing 3.

Door 8 is provided with a damper $8^a$ which may be suitably connected with a thermostat $8^b$ to control the amount of air admitted to the fuel in the main combustion chamber. The air admitted passes downwardly through the fuel bed. The ash pit door 11 is provided with a suitable damper to admit air which passes upwardly through the fuel bed in the secondary combustion chamber 6. The main combustion chamber 5 is provided with water-filled grate bars formed of a series of hollow bars 15 which communicate with the water space of the lower steam generator. The bars are arranged to slope downwardly from the rear to the front of the chamber and their side walls converge downwardly from top to bottom. Bars 15 are connected to each other by baffles 16 which cause some of the downwardly passing gases to go around the front parts of the lower steam generator and equalize the heat distribution of the gases. The lower combustion chamber is provided with a grate 17 which may be of any preferred type. The lower combustion chamber receives the unconsumed fuel which falls from the fuel bed on bars 15.

The air admitted to the main combustion chamber through damper $8^a$ passes downwardly through the fuel bed and the products of combustion pass downwardly between the water-filled grate bars 15; then under and upwardly around the lower steam generator and between the lower generator and upper generator to the stack as indicated by the arrows in Figure 1. The air admitted through the ash pit door passes upwardly through the fuel bed in the secondary combustion chamber and the products of combustion then take the same path as the products of combustion of the main fuel bed as indicated by the arrows in Figure 1. The excess air in the products of combustion coming from the secondary fuel bed supplies additional heated oxygen to insure complete combustion of the unburnt gases coming from the main fuel bed.

This arrangement for burning fuel and directing the hot gases causes the upper part

of the lower generator and the upper generator to be heated to a high temperature and unless the heat is quickly absorbed some of it will pass up the stack. I therefore provide in the passage 18, through which the products of combustion pass, a series of rows of tubes 19 which extend into the lower steam generator $1^b$ and the upper generator $1^a$. As shown in Figure 2 the lower ends of the first pair of rows of tubes at the left depend but a slight distance into the lower generator and the succeeding rows depend to gradually increasing distances. The upper ends of all the tubes extend into the upper generator to above the water level and are preferably shaped like nozzles. Opposed pipes 20 extend from the lower end of each tube into the water in the lower steam generator and carry strainers 21 at their lower ends. These tubes atomize the water, in a manner now to be described, which quickly absorbs heat to change it to steam.

As steam is formed in the lower generator, its pressure will force the water upward through tubes 19 until the water level falls below the lower ends of the tubes 19 in the rows at the left of Figure 2. The steam will then escape upward through these exposed ends of tubes 19 to the upper generator. The escaping steam passing the upper ends of the opposed pipes 20 at a high velocity, reduces the pressure around these pipe ends. The pressure above the water level in the steam generator, being greater, will force water upward through pipes 20 and out of their upper ends into the path of the inrushing steam in tubes 19. The steam striking the water will break it up into fine globules and thus atomize it. As the atomized water passes up the tubes with the steam, or after it enters the upper generator, the small globules of water will quickly absorb heat which will change them to steam. As the steam pressure in the lower generator increases, the water level in the boiler will be forced below the lower ends of the next row of tubes, and a similar atomizing action takes place in these tubes, and so on with the next succeeding rows so that the area through which the steam may escape to the upper generator automatically increases as the pressure in the lower generator increases. Should the amount of steam generated be greater than the amount that escapes, the water level will fall below the lower end of a pipe 22, extending into the steam space in the upper generator, which will allow the steam to escape to the upper generator and thus reduce the pressure and allow the water level in the lower generator to rise and close pipe 22. The water level is raised by the water in the upper generator escaping down a pipe $22^a$ which connects the water space of the upper generator with the water space of the lower generator. A gauge glass $22^b$ connected with pipe $22^a$ and steam space 4, indicates the level of the water in the upper generator and pipe $22^a$.

The water is admitted to the boiler through feed water inlet 12, into water heater $1^c$ and is heated thereby, then passes through pipes 23 and $23^a$ into the lower end of the lower steam generator. Should steam form in the water heater, it may pass upward to the lower steam generator through pipe $23^a$ which is shorter than pipe 23 and flush with the upper wall of the heater as shown in Figure 3. Pipe 23 depends into the water so that the water may pass upwardly to and downwardly from the lower steam generator to establish an equilibrium of pressures when steam forms in the water heater.

Pipes 23 and $23^a$ together with the welded lugs 24 form a support for the lower steam generator.

Access to the gas passages for cleaning soot may be readily had through clean-out openings 25 and 26. The opening 25 affords access to the gas passage between the upper generator and the lower steam generator. The clean-out openings 26 afford access to the gas passage around the lower steam generator. These openings may be closed by suitable doors, such as shown in Figure 3.

When the boiler is connected for ventilating purposes, the air passes down the cold air duct 14 into the casing 3 where it is heated by the heat radiated from the parts within the casing. After the air is heated it rises and passes out of any number of warm air ducts $14^a$ at the top of casing 3.

While I have described my invention as taking a particular form, it will be understood that the various parts may be changed without departing from the spirit thereof, and hence I do not limit myself to the precise construction set forth, but consider that I am at liberty to make such changes and alterations as fairly come within the scope of the appended claims.

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

1. In a boiler, a water heating unit; a combustion chamber therein having an upward draft through its fuel bed; a lower steam generating unit mounted on the water heating unit in spaced relation thereto to provide a gas passage between the units and connected for receiving water therefrom; a combustion chamber in the steam generating unit having a downward draft through its fuel bed; an upper steam generating unit mounted above and spaced from the lower steam generating unit to provide a gas passage; conduits passing through said last named gas passage and connecting the upper steam generating unit with the lower steam generating unit; means on the conduits for causing the steam escaping through the con-

duits to atomize the water in the lower steam generating unit and carry it toward the upper steam generating unit, and a casing between the upper steam generating unit and the water heating unit, spaced from the lower steam generating unit to provide a passage for directing the gases coming from both chambers and through the first mentioned passage to the second mentioned passage.

2. In a boiler, a water heating unit; a combustion chamber therein having an upward draft through its fuel bed; a lower steam generating unit spaced from the water heating unit to provide a gas passage between the units and connected for receiving water therefrom; a combustion chamber in the steam generating unit and having a downward draft through its fuel bed; an upper steam generating unit mounted above and spaced from the lower steam generating unit to provide a gas passage; conduits connecting the upper steam generating unit with the lower steam generating unit and passing through the gas passage between the units, and means adapted to make allowance for changes in temperature mounted between the upper steam generating unit and the water heating unit spaced from the lower steam generating unit to provide a gas passage from both combustion chambers to the gas passage between the upper and lower steam generating units.

3. In a boiler, a water heating unit; lugs thereon; a steam generating unit mounted on the lugs and spaced from the water heating unit to provide a gas passage between the units; a combustion chamber in the water heating unit having an upward draft through its fuel bed adapted to pass through the gas passage; a combustion chamber in the steam generating unit having a downward draft through its fuel bed adapted to pass through said gas passage; pipes connecting the units and passing through said gas passage, one of the pipes depending into the water space of the water heating unit, and a casing on the water heating unit spaced from the steam generating unit to provide a passage through which the products of combustion from the gas passage pass to the stack.

4. In a boiler, a lower steam generating unit; an upper steam generating unit spaced therefrom to provide a gas passage; tubes connecting the units and passing through the gas passage, and means on the tubes in the lower steam generating unit for causing the steam escaping through the tubes to atomize the water in the lower steam generating unit and carry it through the tubes toward the upper steam generating unit.

5. In a boiler, a lower steam generating unit; an upper steam generating unit spaced therefrom to provide a gas passage, tubes connecting the units and passing through the gas passage; and means on the tubes in the lower steam generating unit for causing the steam escaping through the tubes to atomize the water in the lower steam generating unit and carry it through the tubes toward the upper steam generating unit, the tubes depending into the lower steam generating unit at varying depths.

6. In a boiler, a lower steam generating unit; an upper steam generating unit disposed above and spaced from the lower steam generating unit to provide a passage for the products of combustion between the units; tubes connecting the units through the passage; means on the ends of the tubes in the lower steam generating unit for causing the steam escaping through the tubes to atomize the water in the lower steam generating unit and carry it through the tubes toward the upper steam generating unit, the tubes depending into the steam generating unit at varying depths, and a pipe depending into the lower steam generating unit below the end of the longest tube and extending into the steam space of the upper steam generating unit.

7. In a boiler, a lower steam generating unit; an upper steam generating unit disposed above and spaced from the lower steam generating unit to provide a passage for the products of combustion between the units; tubes connecting the units through the passage; means on the ends of the tubes in the lower steam generating unit for causing the steam escaping through the tubes to atomize the water in the lowest stream generating unit and carry it through the tubes toward the upper steam generating unit, the tubes depending into the lower steam generating unit, at varying depths; a pipe depending into the lower steam generating unit below the end of the longest tube and extending into the steam space of the upper steam generating unit, and a second pipe depending into the water space of the lower steam generating unit and extending into the water space of the upper steam generating unit.

8. In a boiler, a steam generating unit; a combustion chamber therein having a downward draft through its fuel bed; a passage from said chamber for the products of combustion therefrom; water-filled grate bars in said chamber communicating with the water space of the steam generating unit; baffles between the bars for directing the passage of the draft through the bars; a second combustion chamber mounted in said boiler and disposed beneath the first mentioned combustion chamber and having an upward draft through its fuel bed, means connecting with said passage providing egress to the products of combustion from the second chamber; and means forming a pas-

sage around the steam generating unit through which the products of combustion from said passage pass to the stack.

9. In a boiler, a lower steam generating unit, an upper steam generating unit spaced therefrom to provide an intermediate heat passage, tubes connecting the units and passing through the gas passage, said tubes projecting into the lower unit at varying depths, means for atomizing the water in the lower unit adjacent said projecting ends and carrying it to the upper unit, and means depending upon the pressure in the lower unit compared with that in the upper unit for allowing steam to escape from one unit to the other, and cause the shifting of the water levels in both units.

In testimony whereof I have signed my name to this specification.

BRACE A. PHILLIPS.