(No Model.) 4 Sheets—Sheet 1.

E. F. EDGAR.

BOILER.

No. 577,240. Patented Feb. 16, 1897.

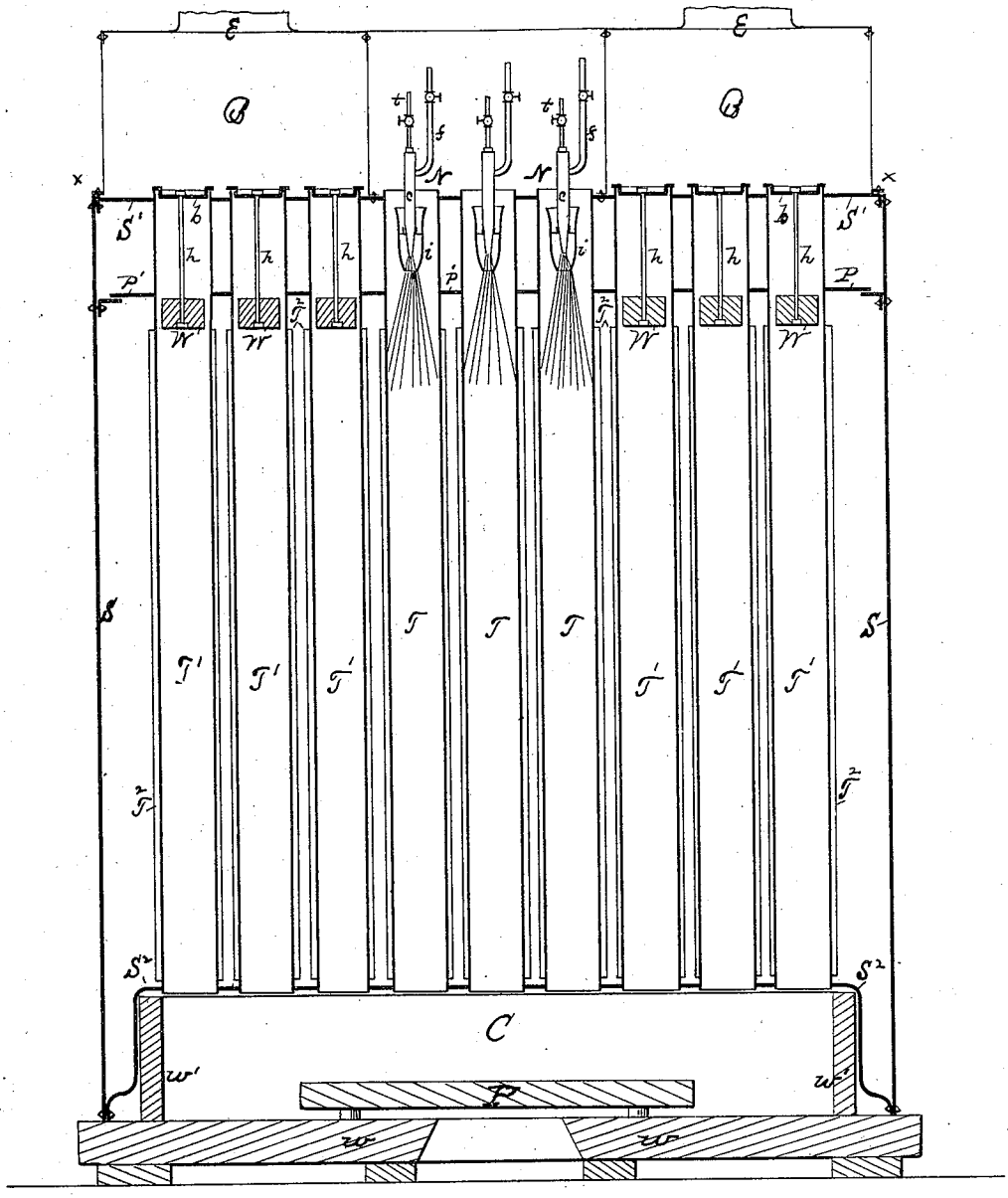

Fig. 1.

WITNESSES:

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INVENTOR

Ellis F. Edgar

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his ATTORNEY

(No Model.) 4 Sheets—Sheet 2.

E. F. EDGAR.

BOILER.

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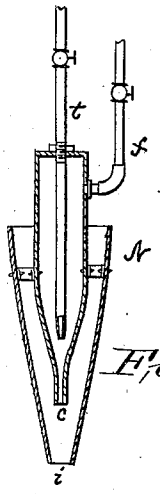

Fig. 3.

Fig. 5.

Fig. 6.

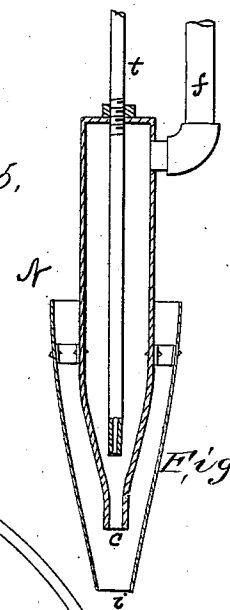

Fig. 4.

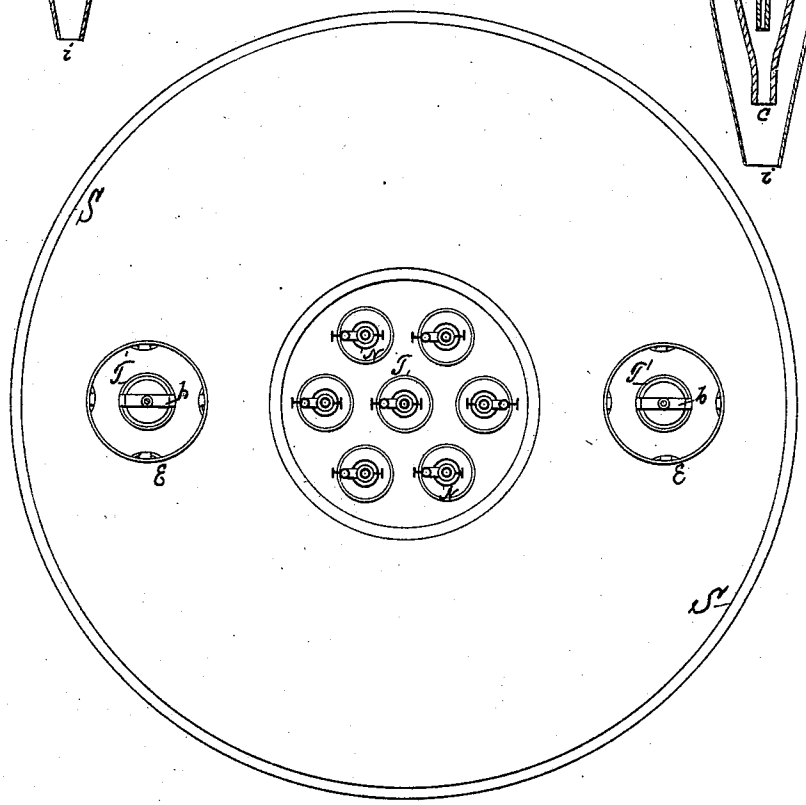

Fig. 2.

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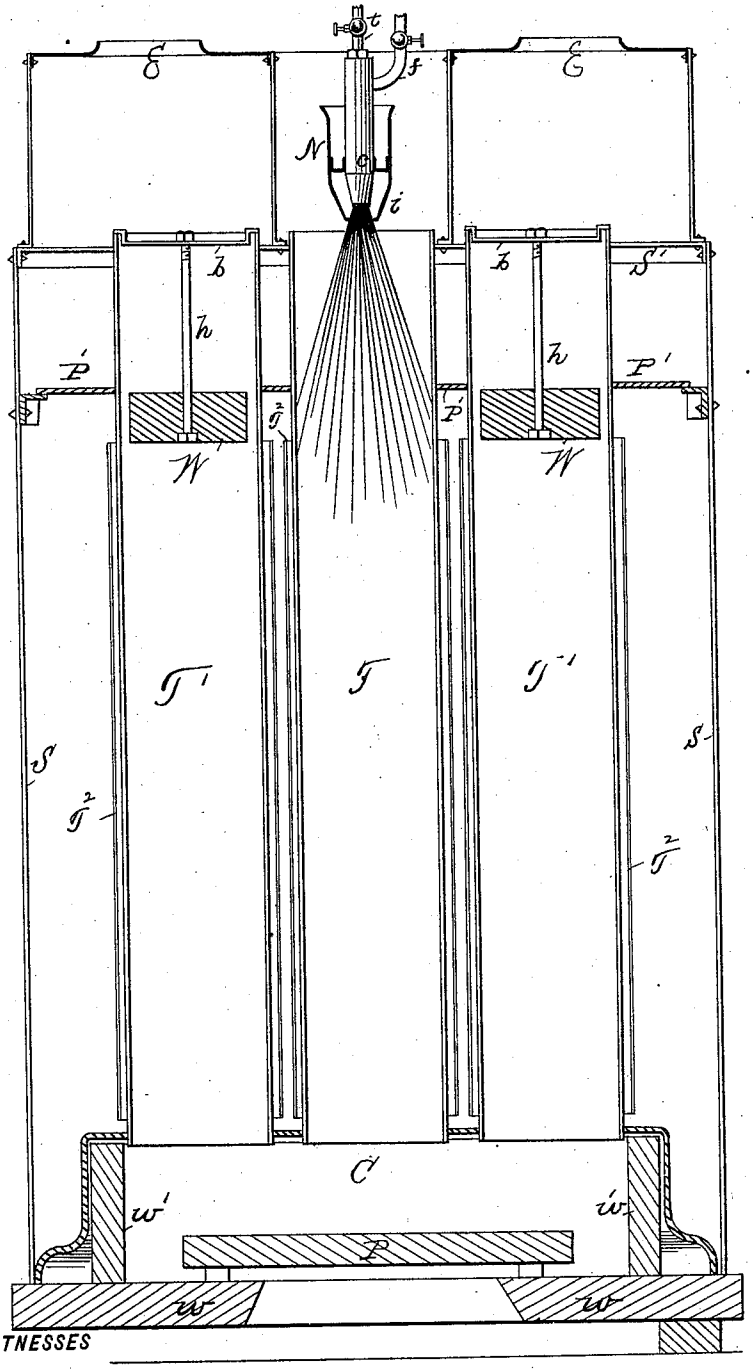
(No Model.) 4 Sheets—Sheet 3.

E. F. EDGAR.

BOILER.

No. 577,240. Patented Feb. 16, 1897.



WITNESSES

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Fig. 4.

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(No Model.) 4 Sheets—Sheet 4.

E. F. EDGAR.

BOILER.

No. 577,240. Patented Feb. 16, 1897.

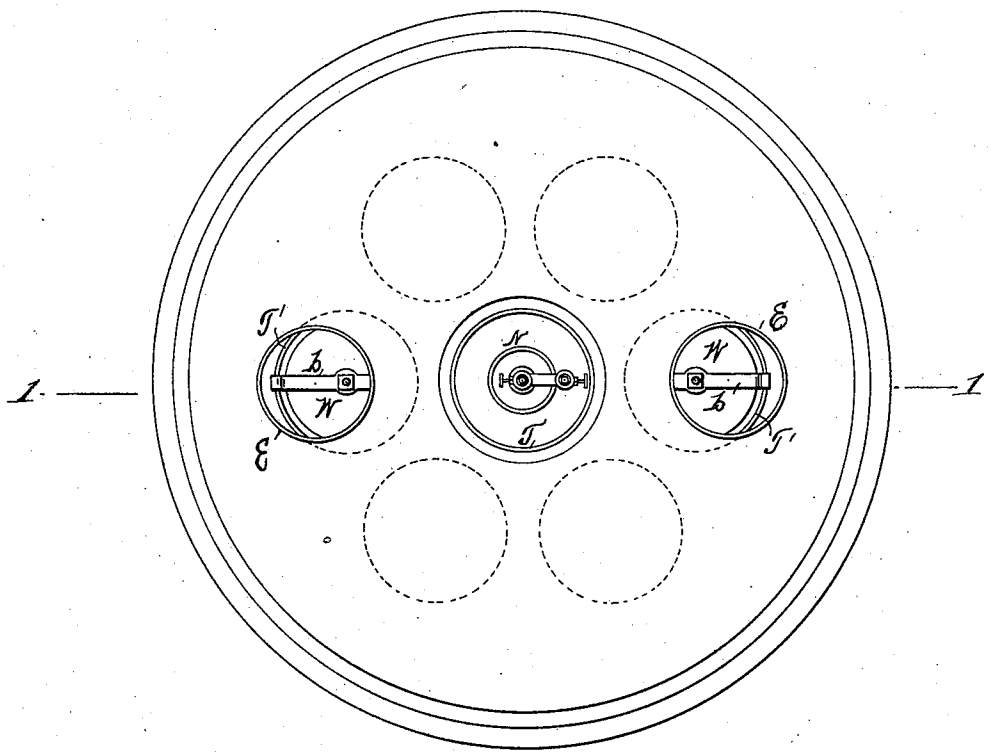

Fig. 8.

WITNESSES

C. W. Benjamin

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INVENTOR

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UNITED STATES PATENT OFFICE.

ELLIS F. EDGAR, OF WOODBRIDGE, NEW JERSEY.

BOILER.

SPECIFICATION forming part of Letters Patent No. 577,240, dated February 16, 1897.

Application filed August 1, 1895. Serial No. 557,924. (No model.)

To all whom it may concern:

Be it known that I, ELLIS F. EDGAR, a citizen of the United States of America, and a resident of Woodbridge, in the county of Middlesex and State of New Jersey, have invented certain new and useful Improvements in Boilers, of which the following is a specification, reference being had to the accompanying drawings, forming part of the same, in which—

Figure 1 is a central vertical sectional view of a boiler embodying my invention, some parts of the burner being in full view. Fig. 2 is a cross-sectional view on line *x x* of Fig. 1. Fig. 3 is a sectional view of one form of burner I use when oil is the fuel. Fig. 4 is a similar view of a form of burner I use when the fuel is coal-dust. Figs. 5 and 6 are detail views of the ends of the tubes I prefer to employ. Fig. 7 is a central vertical sectional view of a boiler embodying my invention, but having only one fire-tube in which the draft is downward; and Fig. 8 is an upper face view of the boiler of Fig. 7.

For some uses, especially in marine work, a boiler needs to be so constructed that its center of gravity is low, and it can be placed in a boat so as to have her center of gravity low, or to even lower it below the point where it was before the boiler was shipped. The boiler I have invented and now describe is especially satisfactory in this regard, for it can be so arranged as to have no furnace (in the usual sense of the term) at the bottom and will permit the weight to be brought well down. This result is partially attained by putting the burners preferably at the top of the boiler and directing them downward, as shown, though some of the benefit might be secured in a different style of construction. Then instead of one long and direct tube I use short tubes with return-tubes or their equivalents—for instance, a long tube bent into U shape, which of course gives a shorter boiler and one with the center of gravity lower. I use comparatively large tubes and thereby avoid killing the flame from the burners and at the same time insure that a greater proportion of heat to the heating-surface shall enter the return-tubes than would be the case were they quite small in diameter, as cross area increases faster than circumference. Then to avoid losing all the heat thus forced into the return-tubes I contract them at or about the water-line, thereby causing the heat to be utilized in heating the water and not merely pushed through to be lost in the stack or the outer air, and I insure the use of the heat by placing circulator-tubes about the fire-tubes.

Provision for deflecting the flame in some forms is made by the use of a spatter-plate, and the plate is kept from excessive heating and the combustion assisted by means of air led through passages into a combustion-chamber and about the spatter-plate. The steam is kept dry by the use of a separating-plate, to be described.

The combination results in a very effective boiler; but I do not limit my claims to a boiler which possesses all of the advantages specified, as some of the invention may be used and be of great service even though some other features were omitted; and I consider that my invention consists in devising a return-tube boiler which can be used vertically and in various devices and combinations of devices which are useful in such a boiler, (some may be in others,) and my claims will be more particularly specified hereinafter.

The form here shown is that of a circular outer shell S, provided with an upper tube-sheet S′ and a lower sheet S^2, in which a series of fire-tubes T and T′ are set vertically, tubes T being those or that part in which the draft is intended to be downward to the lower combustion-chamber C (each tube is also in fact a combustion-chamber) and tubes T′ being the other part or the return-tubes leading from combustion-chamber C to the smoke-box B.

The proportion of one to the other may be varied; but I have found in a boiler, such as that shown in Figs. 7 and 8, three feet high and twenty-two inches in diameter, with tubes five inches in diameter, one down to six up, was satisfactory, and in higher boilers—say six feet high and six feet in diameter—with five or six inch tubes, one down to two or four up, though these proportions need not be rigidly maintained.

If U-shaped tubes were used, there would of course be one down for each one up.

The return-tubes I contract at or about the water-line to prevent the escape of the heat

units, and I prefer to do this by suspending in each tube by a hanger *h* from a bar *b* a fire-clay wall or block W of such size that the united cross areas of the space between said walls W and the tubes T′ shall approximate the cross areas of the exit or exits of the smoke-box—that is, the stack—though I do not limit myself to contracting the draft-space in that manner.

It might be thought that such construction would so retard the draft as to impair combustion, but I find it otherwise. Using large tubes, flame and highly-heated air and gases enter them very rapidly, and they are much hotter than a small tube would be, but heat is also rapidly absorbed by the tubes and the water upon their outer sides, and as volume depends very largely upon heat I do not need as great a space for the exit from the tubes as I do for the entrance, and if I left it of the same size I would be permitting large quantities of heat to pass beyond the point where I can make it most useful.

The burners N are located at the entrance or upper end of tubes T, preferably several, and one for each tube; but I might substitute one large tube and burner for the several I prefer.

The burners shown are quite simple in construction, having an inner tube *t* for the introduction of compressed air or steam, a so-called "combining chamber and nozzle" *c*, surrounding said tube, having a fuel-pipe *f* for oil or coal-dust leading into it, and an air-inlet nozzle *i* surrounding the combining-chamber. Any other of the hundreds of such burners may be used in place of those shown. These burners are directed downward, and in this form, where the flames would impinge upon the base-plate or bottom wall *w* of chamber C, I place a spatter-plate P, made usually of fire-clay, (other substances might be used,) to assist in spreading the flames and deflecting them so that they will enter the return-tubes with the currents to the uptake. This plate P is set on blocks and located over a hole cut through the bottom wall *w*, and a space or passage is left or made between said plate and wall from the hole in the wall to the chamber C, through which additional air enters to aid the combustion within. This air passing along in contact with said plate will itself become heated (an advantage) and by taking heat units from the plate will increase its life.

As no ash-pit, grate-bars, or large fuel-space is required at the bottom of the boiler the combustion-chamber C, if one is used, being much shallower than an ordinary furnace, it is evident my boiler may be set much lower and be much shorter (up and down) than those of ordinary construction. I preferably guard the mud-legs by side walls *w′*, of fire-brick or fire-clay. The natural course of heat is of course upward, and as the draft herein is first downward and then upward the natural force is at first acting against the force with which the burning fuel is thrown into the tubes, which combination of circumstances causes what I may term "compression" within the tubes, and this enhances the heat therein, likewise aided in the return-tubes by the contraction therein. So great is the heat when thus enhanced that the boiler would in all probability foam and prime were it not for the circulating-tubes T^2, which are a little larger in diameter than the fire-tubes, but placed about them and set on feet or blocks or otherwise raised a little from the lower tube-sheet, so that water may freely enter them at the bottom and pass up between their interior faces and the outer faces of the fire-tubes, insuring rapid continuous circulation. These circulating-tubes may be held in place concentric with the fire-tubes by fins, usually four at each end, arranged within them, the four at the bottom projecting a short distance beyond the circulating-tube to hold the same up from the tube-sheet and thus allow for the entrance of water, and the height of the circulating-tubes is such that they terminate usually just above the water-level.

A "smoke-box" B (so called) is arranged above the ends of the return-tubes (here in annular form to accommodate the form of the boiler) and provided with one or more draft-exits E, (here two.) A separating-plate P′ is interposed between the upper ends of the circulating-tubes and the steam-exit, that any water driven up by the very rapid circulation may not pass off into the steam-pipe, but will fall back into and remain with the water of the boiler.

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

1. The combination in a vertical boiler, of a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit and a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, all substantially as set forth.

2. The combination in a vertical boiler, of a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit and a burner located within that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, all substantially as set forth.

3. The combination in a vertical boiler, of a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit, circulator-tubes surrounding said fire-tubes, and a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, all substantially as set forth.

4. The combination in a vertical boiler, of

a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit, the draft-space of which is contracted at or near the water-level of the boiler, and a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, all substantially as set forth.

5. The combination in a vertical boiler, of a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit, and provided with an incombustible block located within the tube and at or near the water-level and a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, all substantially as set forth.

6. The combination in a vertical boiler, of a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit, circulator-tubes surrounding said fire-tubes, a separator interposed between the upper end of the circulator-tubes and the steam-exit, and a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, all substantially as set forth.

7. The combination in a vertical boiler of a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit, a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber and a spatter-plate located in the combustion-chamber and opposite the nozzle of the burner, all substantially as set forth.

8. The combination in a vertical boiler, of a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit, a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, a spatter-plate located in the combustion-chamber and opposite the nozzle of the burner, one or more openings through the walls of the combustion-chamber and a passage between it and the spatter-plate, all substantially as set forth.

9. The combination in a vertical boiler, of a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit, a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, and a substantially annular smoke-box inclosing the upper end of the fire-tube leading from the combustion-chamber, all substantially as set forth.

10. The combination in a vertical boiler, of a combustion-chamber provided with side and bottom walls, an opening through the bottom wall of the combustion-chamber, a passage between said wall and the spatter-plate, a fire-tube leading to and opening into said combustion-chamber, a fire-tube leading from said combustion-chamber to the draft-exit, a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, and a substantially annular smoke-box inclosing the upper end of the fire-tube leading from the combustion-chamber and provided with a draft-exit, all substantially as set forth.

11. The combination in a vertical boiler, of a combustion-chamber, a fire-tube leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit, circulator-tubes surrounding said fire-tubes, and a nozzle-burner located within that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, all substantially as set forth.

12. The combination in a vertical boiler, of a combustion-chamber, a fire-tube leading vertically downward to and opening into said chamber, a fire-tube leading vertically upward from said chamber to the draft-exit, circulator-tubes surrounding said fire-tubes, and a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, all substantially as set forth.

13. The combination in a vertical boiler, of a combustion-chamber, a fire-tube above said combustion-chamber and leading to and opening into said chamber, a fire-tube leading from said chamber to the draft-exit and a burner located at that end of the first fire-tube opposite the combustion-chamber and directed substantially parallel to said fire-tube and toward said combustion-chamber, all substantially as set forth.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 22d day of July, 1895.

E. F. EDGAR.

Witnesses:
IDELLA B. EDGAR,
A. G. N. VERMILYA.