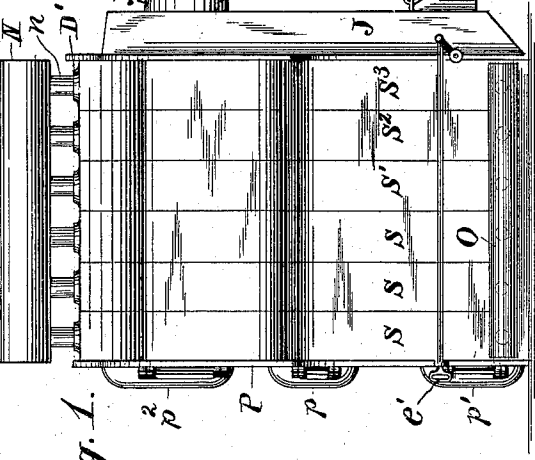
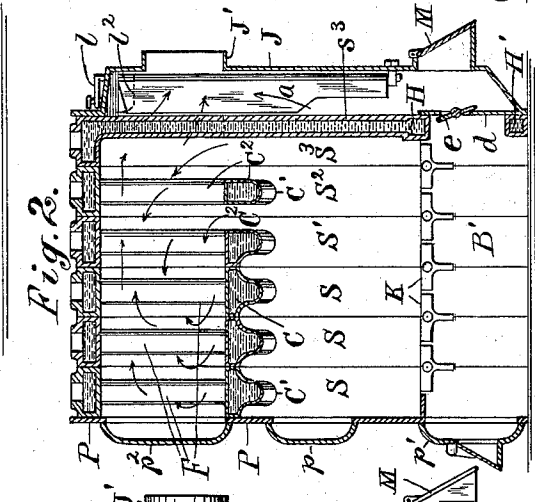
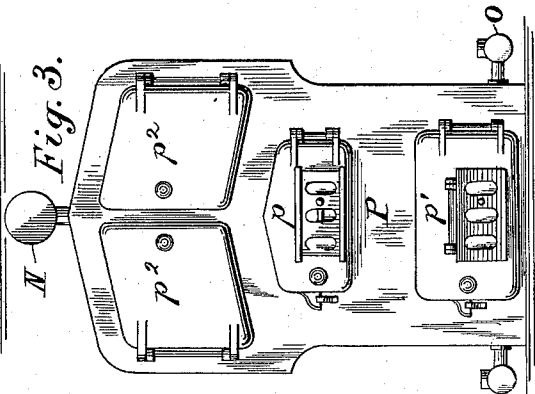
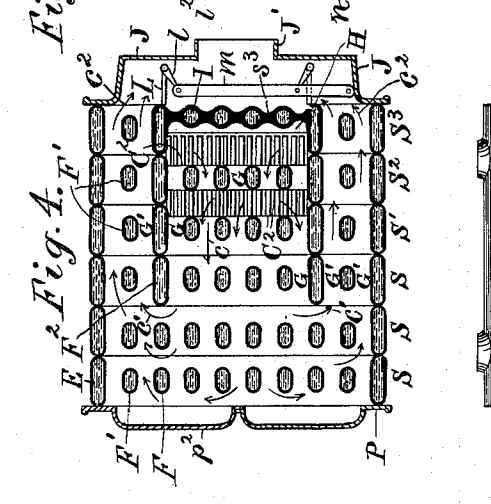
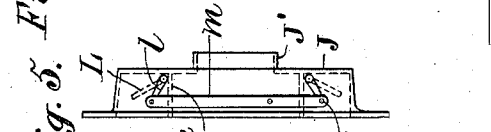
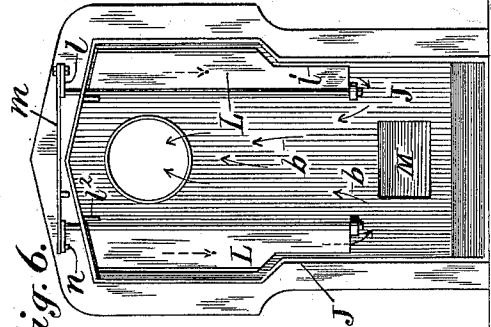
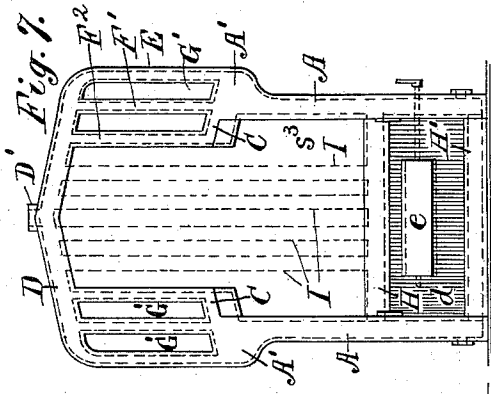


W. M. MACKAY.

BOILER FOR STEAM OR HOT WATER HEATING.

No. 591,236.

Patented Oct. 5, 1897



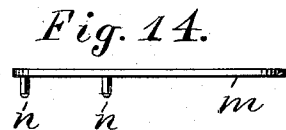
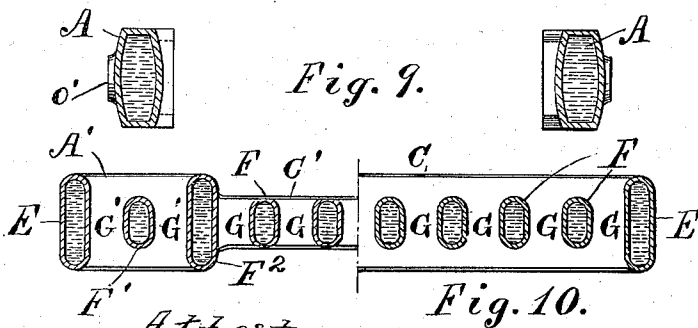
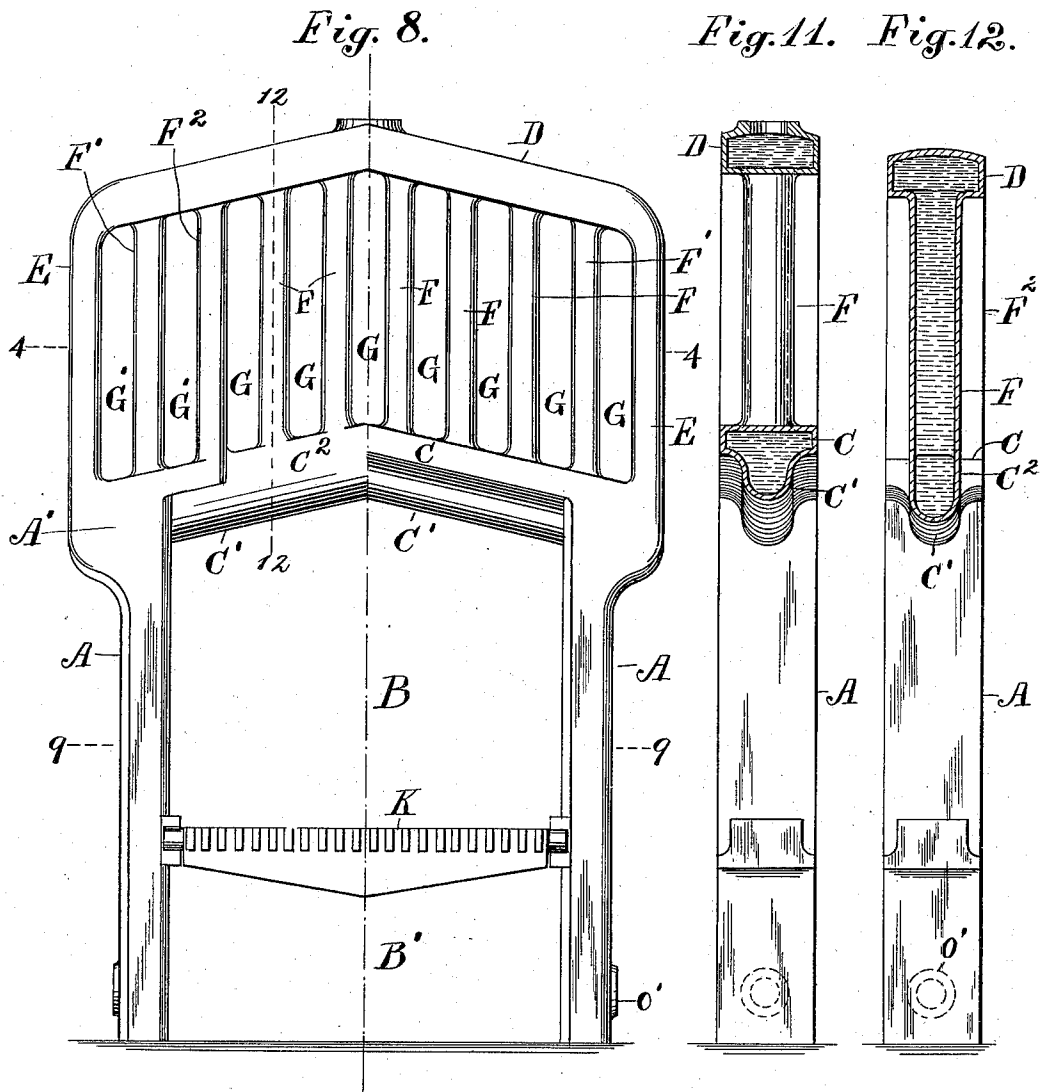
Attest:  
 L. Lee.  
 Edw. F. Mansory per Thomas S. Crane, Atty.

Inventor.  
 William M. Mackay.

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Attest:  
*Lo. Lee*  
*Edw. F. Conroy*

Fig. 10.

Inventor.

*William M. Mackay,*  
*per Thomas S. Crane, Atty.*

# UNITED STATES PATENT OFFICE.

WILLIAM M. MACKAY, OF NEWARK, NEW JERSEY, ASSIGNOR TO THE HART & CROUSE COMPANY, OF UTICA, NEW YORK.

## BOILER FOR STEAM OR HOT-WATER HEATING.

SPECIFICATION forming part of Letters Patent No. 591,236, dated October 5, 1897.

Application filed March 8, 1897. Serial No. 626,398. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM M. MACKAY, a citizen of the United States, residing at Newark, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Boilers for Steam or Hot-Water Heating, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to that class of steam or hot-water boilers which is composed of a series of flat vertical sections having a fire-box formed by the water-legs of the sections and a hollow fire-arch for water-circulation extended between the legs at the top of the fire-box.

In the present construction the boiler is formed of suitable capacity by using the required number of vertical sections, but the sections are not of uniform pattern, as the intermediate sections are slightly different from the front section to control the movement of the gases and the rear section is formed of a water-plate from the level of the grate upward to close the rear end of the fire-box.

In the present construction the water-legs are extended downward to form the sides of the ash-box, which is closed at the front end by a boiler-front having fuel-door, ash-door, and cleaning-out door and at the rear by a smoke-box containing dampers to vary the draft through the flues.

The operation of the construction is described in a boiler for heating water, but the same construction may also be used for generating steam, in which case the upper portions of the sections would be filled with steam instead of water.

Each section is provided with a water-arch at the top, which is connected with the fire-arch by vertical water-tubes, and the fire-arches are made the full thickness of the sections over the front part of the fire-box to prevent the ascent of the gases, while the fire-arch in the sections at the rear of the boiler is notched in the middle upon one or both sides to permit the gases to rise among the water-tubes. Certain of the water-tubes at opposite sides of the center line are made the full thickness of the section to form partitions extending nearly to the front of the

boiler, to make return-flues at the sides of the boiler, which are connected at their rear ends with the smoke-box. The gases which rise between the rear sections are thus compelled to move forwardly among the water-tubes before they can enter the return-flues which lead them to the smoke-box.

The invention is especially adapted for boilers of rather small capacity, in which a large grate-surface is not desired, but in which considerable area is required between the water-tubes to form the flues for the forward and backward passage of the gases. To secure such area, I have constructed the water-arch at the top of the section considerably longer than the fire-arch which unites the tops of the water-legs, so as to secure the requisite space for flues between the water-tubes, and have proportioned the passages which extend from the tops of the water-legs to the top of the section of smaller sectional area than the water-legs, so as to divert into the fire-arch a portion of the water which rises from the water-legs. I form the top of water-leg at the ends of the fire-arch with outwardly-projecting water-chamber, which thus stands at the junction of the water-legs, the vertical tubes above the same, and the fire-arch on one side of the chamber. The enlarged space in such chambers prevents conflict between the upward and downward currents entering such chambers, which sometimes occurs in the generation of steam. The fire-arch confines the gases to the furnace, excepting at the rear part of the boiler, where the fire-arches are notched over the middle of the furnace to permit the gases to rise upwardly, and certain of the water-tubes at opposite ends of such notches are made the full thickness of the section to divert the gases into the front sections of the boiler, from whence they return to a fire-box at the rear of the boiler through lateral flues over the water-chambers just mentioned.

The invention consists partly in the constructive features of the different sections, partly in their combination, as shown in the drawings, and partly in the means for adjusting the dampers within the smoke-box.

These improvements will be understood by reference to the annexed drawings, in which—  
Figure 1 is a side elevation of a boiler em-

bodying my improvements. Fig. 2 is a vertical section of the boiler upon the center line transverse to the sections. Fig. 3 is a front elevation of the boiler; Fig. 4, a horizontal section on line 4 4 in Fig. 8, with the dampers closed and the cranks and their link connection retained upon the tops of the dampers. Fig. 5 is a plan of the smoke-box, with the dampers shown opened in dotted lines and the link adjusted to the cranks to hold them in such position. Fig. 6 is an inside view of the smoke-box, with the damper, cranks, and their link connection. Fig. 7 is an inside view of the rear section of the boiler. Fig. 8 is an elevation showing at the right-hand side of the center line one of the front sections of the boiler and at the left side of the center line one of the intermediate sections. Fig. 9 is a cross-section on line 9 9 in Fig. 8, and Fig. 10 is a cross-section on line 4 4 in Fig. 8. Fig. 11 is a vertical section across the center of one of the front sections of the boiler, and Fig. 12 is a similar section of one of the intermediate sections. Fig. 13 is a plan, and Fig. 14 an edge view, of the link for adjusting the damper-cranks.

A designates the water-legs at opposite sides of the fire-box B. Water-chambers A' are projected outwardly at the tops of the water-legs and connected upon their inner sides with a fire-arch having its upper portion or body C the full thickness of the section (except where notched at the middle portion, as hereinafter described) and its lower side formed with a central water-channel C'. A water-arch D extends across the top of the section and is connected at its ends with the water-chambers A' by vertical tubes or passages E, and vertical water-tubes F F' F<sup>2</sup>, with interspaces G G', connect the water-arch with the fire-arch.

The group of sections constituting the boiler is connected at the top with a header N and pipe connection n, attached to the outlet D' upon the top of each section, and by manifolds O, connected by suitable pipes with inlets o', near the bottom of each water-leg. A boiler-front P, having fuel-door p, ash-door p', and cleaning-out door p<sup>2</sup>, is secured upon the front of the boiler and a smoke-box J upon the rear of the boiler.

From the outer sides of the chambers A' upon each section passages E are extended upward to the ends of the water-arch D. The water-arch is made of sufficient capacity to permit the movement of the water through the different water-tubes to the outlet D' upon the middle of the water-arch, and the fire-arch is, including the water-channel C' upon its under side, of still greater cross-section to permit a free distribution of the water to the water-tubes in which the water-current is most rapid; but the passages E are made of much less capacity than the water-arch or fire-arch, so that the water which rises from the water-leg into the chamber A' may be di-

rected into the tubes over the fire, where it will be most effectively heated.

The water-chamber is made of much greater cross-section than the fire-arch to prevent conflict between upward and downward currents entering such chamber, which sometimes occurs in the generation of steam, as hereinafter set forth, and especially to permit a free circulation of water within the boiler when the external circulation is cut off without checking the fire, and a downward movement in the passages E is produced by the upward movement in the tubes over the fire.

The variations in the sections are noticeable in Figs. 2 and 4, Fig. 2 showing the three front sections S with the fire-arch the full thickness of the section, while the intermediate sections S' and S<sup>2</sup> and the rear section S<sup>3</sup> are notched upon the side of the fire-arch to permit the gases to pass upwardly into the spaces between the tubes F. Fig. 4 shows the tubes F' next to the passages E of less thickness than the section, like the tubes F, while the adjoining tubes F<sup>2</sup> in all the sections except the two at the front are made the full thickness of the section to form partitions between the spaces G and G', which adjoin the tubes F and F', respectively.

The rear section shown in Figs. 2 and 7 is formed of a water-plate s<sup>3</sup>, having upon its edges the water-legs A, passages E, and water-arch D, with passages H and H' connecting the water-legs at the upper and lower parts of the ash-box B', which is shown in Fig. 2. Vertical water-passages I are extended within the plate through passage H to the water-arch D, and the water-chambers A' are provided between the passages E and the water-legs, and portions of the fire-arch C are extended inwardly from such chamber, with tubes F' and F<sup>2</sup> extended upwardly therefrom to the water-arch D. The spaces G', adjacent to the tubes F', form flue-passages for the escape of the smoke to the fire-box J, which is secured upon the rear of the boiler and is provided with smoke-outlet J'. Dampers L are hinged vertically inside the smoke-box between the outlet J' and the passages G' upon the plate s<sup>3</sup> to circulate the smoke and gases downwardly within the smoke-box during the regular operation of the boiler before they are permitted to escape. The dampers are shown closed in Fig. 4, as indicated by dotted lines in their open position in Fig. 5, which permits the gases to pass directly from the flue-passages in the rear section to the outlet J'. The damper-spindles are provided with cranks l at their upper end, and a link m is shown bolted to one of the cranks and provided with two pins n, adapted to engage an eye upon the other crank when the dampers are respectively opened and closed. The pins are fitted loosely to the eye to be engaged with it or removed readily.

By bolting the link to one of the cranks it is secured permanently, while the provision

of the two pins  $n$  adapts it to lock the dampers in an open or closed position without any additional mechanism. The engagement of the pins with the cranks in the two positions is shown in Figs. 4 and 5, respectively.

By forming the return-flues over the water-chambers  $A'$  the upper half of each section is materially wider than the lower half, and the smoke-box is made of corresponding shape, with parallel sides, and to secure the requisite movement of the dampers within such smoke-box when opened, as shown in Fig. 6, the dampers are notched or formed each with a narrowed portion  $l'$  near the lower end. By this construction the dampers may be extended downward into the narrow part of the smoke-box and the gases thus forced to a lower point within the smoke-box before they escape to the outlet  $J'$ . When the dampers are closed, as shown in Fig. 2, the narrow portions  $l'$  at the lower end permit a portion of the gases to pass upwardly, as indicated by the arrows  $a$ , but the remainder are driven into the course shown by the arrows  $b$  in Fig. 6, which carries them over the entire rear surface of the water-plate  $s^3$  upon the rear section and thus conveys the heat from the gases to such water-plate. The arrows  $b$  represent the movement of gases when the dampers are closed. The water-plate is thus exposed to the heat upon both sides, and the water in the passages  $I$  and tubes  $F'$  and  $F^2$  is thus effectively heated. A damper-plate  $d$  closes the space between the passages  $H$  and  $H'$  upon the rear section and is provided with a dust-damper  $e$ , operated by rod having handle  $e'$ , as shown in Fig. 1. A check-draft damper  $M$  is shown upon the smoke-box near the bottom, and grates  $K$  are shown pivoted between the sections in the usual manner, the water-legs being extended downward below the grate-bearings  $k$  to inclose the sides of the ash-box and absorb the heat therein.

At the right hand of the central line in Fig. 8 one of the sections  $S$  is represented with the body  $C$  of the fire-arch the full thickness of the section, and at the left side of the same line one of the intermediate sections  $S'$  or  $S^2$  is shown with the body  $C$  formed with notches  $C^2$ , extended to the side of the water-channel  $C'$ .

The passages formed by the notches  $C^2$  are lettered  $C^2$  in Fig. 4, and the gases rising through the same are guided by the tubes  $F$  to the forward end of the boiler through the sections  $G$  adjacent to the tubes  $F$ , as indicated by the arrows  $c$ . They then turn around the front end of the partition formed by the tubes  $F^2$  and move backwardly between such tubes and the tubes or passages  $E$ , as indicated by the arrows  $c'$ , escaping through the passages  $G'$  in the rear section  $S^3$  to the smoke-box  $J$ , as indicated by arrows  $c^2$ . With this construction the gases are compelled to traverse all the spaces between the tubes and are retained in contact with the tubes as long as

is desirable to impart their heat to the water. It will be observed by reference to Fig. 10 that the water-tubes  $F^2$  are of about the same sectional area as the passages  $E$ , and the water-tubes  $F'$  directly over the chambers  $A'$  are of very much less area, while the united area of the tubes  $E$  and  $F'$  is less than that of the water-leg  $A$ . Where the boiler is used for heating water, this relation of the parts prevents the water from flowing upwardly through the outer sides of the section to the outlet at the top of the water-arch and drives a part of the water naturally into the fire-arch, where it is heated and passes upwardly through the middle tubes  $F$ . It will also be observed that the chambers  $A'$  are much greater in sectional area than the water-legs, which extend downward, the fire-arch which, extends laterally, or the tubes  $E$  and  $F'$ , which extend upwardly therefrom. This construction affords a great advantage whether the boiler be used for the heating of water or the generation of steam. In the latter case the steam rises most rapidly in the tubes  $F$  directly over the fire, producing an upward current in such boiler-tubes, and when the water is separated from the steam in the water-arch  $D$  it necessarily flows downward through the cooler tubes  $F$  and  $F'$  at the sides of the section. As the current entering the water-inlet  $o'$  at the bottom of the water-legs is very trifling in a steam-boiler, the circulation is almost entirely through the tubes mentioned and the fire-arch, and the enlargement of the chamber  $A'$  permits the free movement of the water downward from the tubes  $E$  and  $F'$  and its free passage into the fire-arch.

When the boiler is used for heating water and the section is entirely filled with such fluid, a considerable current of the fluid passes upward in the water-legs from the inlets  $o'$  when the external circulation is in operation, and such upward movement interferes seriously with the natural downward movement of the current in the side passages  $E$ , except the chambers  $A'$  be provided at the junction of the water-leg and such passages to permit the union of such upward and downward currents and their free passage into the heated water-arch from which the upward current is drawn.

Where the external circulation of the boiler is cut off and the upward current ceases in the water-legs, the water-chambers  $A'$  perform then the same function as when generating steam and permit the downward current from the side passages of the section to descend freely to enter the fire-arch and move upward through the hotter tubes of the boiler. Such free internal circulation prevents the surface of the section from becoming overheated when the external circulation is cut off. The formation of the fire-arch  $C$  with the water-channel  $C'$  of the same width as the tubes  $F$  preserves a great part of the internal area of the fire-arch when notched

upon the sides, and thus maintains a free circulation within the intermediate sections which require to be thus notched.

Having thus set forth the nature of the invention, what is claimed herein is—

1. In a steam or hot-water boiler having fire-arches with spaces between the same in some of the rear sections for the upward movement of the gases and a forward flue over the middle of the fire-arch with backward flues over the sides of the same, a flat vertical section with water-legs at the bottom to inclose a fire-box, a fire-arch to form the top of the fire-box, a water-arch at the top of the section, vertical passages connecting the ends of the water-arch and fire-arch, vertical water-tubes connecting the water-arch and fire-arch between such passages, the fire-arch having its upper part the full thickness of the section, and upon its lower side a central projecting water-channel of less thickness, and said arch being notched at the middle upon opposite sides to permit the upward passage of the gases between such sections, substantially as herein set forth.

2. In a steam or hot-water boiler having fire-arches with spaces between the same in some of the rear sections for the upward movement of the gases and a forward flue over the middle of the fire-arch with backward flues over the sides of the same, a flat vertical section having water-legs A connected at the top upon their inner sides by the fire-arch C, and provided upon their outer sides at the ends of such fire-arch with the outwardly-projecting chambers A', passages E extended upwardly from the chambers A' at the outer sides, a water-arch D connecting the tops of such passages, and vertical water-tubes F connecting the water-chamber and the fire-arch intermediate to the passage E, as and for the purpose set forth.

3. In a steam or hot-water boiler having fire-arches with spaces between the same in some of the rear sections for the upward movement of the gases and a forward flue over the middle of the fire-arch with backward flues over the sides of the same, a flat vertical section having water-legs A connected at the top upon their inner sides by the fire-arch C, and provided upon their outer sides at the ends of such fire-arch with the outwardly-projecting chambers A', passages E extended upwardly from the chambers A' at the outer sides, a water-arch D connecting the tops of such passages, vertical water-tubes F and F<sup>2</sup> connecting the water-arch and the fire-arch intermediate to such passages, and the tubes F<sup>2</sup> at opposite sides of the center having the full thickness of the section, and the remaining tubes having a less thickness, as and for the purpose set forth.

4. In a steam or hot-water boiler having fire-arches with spaces between the same in some of the rear sections for the upward movement of the gases and a forward flue over the middle of the fire-arch with backward flues

over the sides of the same, a flat vertical section having water-legs A connected at the top upon their inner sides by the fire-arch C, and provided upon their outer sides at the ends of such fire-arch with the outwardly-projecting chambers A', passages E extended upwardly from the chambers A' at the outer sides, a water-arch D connecting the tops of such passages, vertical water-tubes F and F<sup>2</sup> connecting the water-arch and the fire-arch intermediate to such passages, the tubes F<sup>2</sup> at opposite sides of the center having the full thickness of the section, and the remaining tubes having a less thickness, and the fire-arch being notched laterally between the tubes F<sup>2</sup> to admit the gases upwardly among the tubes F, substantially as herein set forth.

5. In a steam or hot-water boiler, composed of flat vertical sections as described, the intermediate section having water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C, having central water-channel C' upon its under side, passages E extended upwardly from the chambers A' at the outer side, a water-arch D connecting the tops of such passages, the water-tubes F and F<sup>2</sup> connecting the water-arch and the fire-arch, the water-tubes F<sup>2</sup> having the thickness of the section, and the water-tubes F having the thickness of the water-channel, and one side of the fire-arch notched between the water-tubes F<sup>2</sup> to permit the upward passage of the gases at one side of the fire-arch, substantially as herein set forth.

6. In a steam or hot-water boiler, a flat vertical section having water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C, passages E extended upwardly from the chambers A' at the outer side, a water-arch D connecting the tops of the passages, vertical water-tubes connecting the water-chamber and the fire-arch, and the fire-arch having its upper part the full thickness of the section, and upon its lower side a central projecting water-channel of the same thickness as the central water-tubes, and the fire-arch being notched laterally at the middle portion to the thickness of the water tubes and channel, substantially as herein set forth.

7. In a steam or hot-water boiler, a rear section consisting of the plate s<sup>3</sup> having the water-legs A upon one side with the chambers A' extended outwardly therefrom, and portions of a fire-arch C<sup>2</sup> projected inwardly from such chambers, and the water-arch D at the top of the water-plate connected with the chambers A' and fire-arch portions C<sup>2</sup> by passages E, tubes F' and F<sup>2</sup>, with the smoke-spaces G' between the same, substantially as herein set forth.

8. In a steam or hot-water boiler, a rear section consisting of the plate s<sup>3</sup> having the water-legs A upon one side with the chambers A' extended outwardly therefrom, and portions of a fire-arch C<sup>2</sup> projected inwardly

- from such chambers, and the water-arch D at the top of the water-plate connected with the chambers A' and fire-arch portions C<sup>2</sup> by passages E, tubes F' and F<sup>2</sup>, with the smoke-spaces G' between the same, the passages H connecting water-legs A, and the vertical passages I within the plate s<sup>3</sup> connecting the passage H and arch D, substantially as herein set forth.
9. In a steam or hot-water boiler, a rear section consisting of the plate s<sup>3</sup> having the water-legs A upon one side with the chambers A' extended outwardly therefrom, and portions of a fire-arch C<sup>2</sup> projected inwardly from such chambers, and the water-arch D at the top of the water-plate connected with the chambers A' and fire-arch portions C<sup>2</sup> by passages E, tubes F' and F<sup>2</sup>, with the smoke-spaces G' between the same, the passage H connecting water-legs A at the grate-level with opening below the same between the water-legs, and the vertical passages I within the plate connecting the passage H with the water-arch D, substantially as herein set forth.
10. In a steam or hot-water boiler, the flat vertical section having water-legs A connected at the top upon their inner sides by the fire-arch C, and provided upon their outer sides at the ends of such fire-arch with the outwardly-projecting chambers A', passages E of less sectional area than the water-legs extended upwardly from the chambers A' at the outer sides of the same, a water-arch D of greater sectional area than the passages E connecting the tops of such passages, and vertical water-tubes connecting the water-chamber and the fire-arch, substantially as herein set forth.
11. In a steam or hot-water boiler, the flat vertical section having water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C, having central water-channel C' upon its under side, passages E of less sectional area than the water-legs extended upwardly from the chambers A' at the outer side, a water-arch D, of greater sectional area than the passages E connecting the tops of such passages, and vertical water-tubes of the same thickness as the water-channel C' connecting the water-chamber and the fire-arch, as and for the purpose set forth.
12. In a steam or hot-water boiler, the flat vertical section having water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C, having central water-channel C' upon its under side, the passages E of less sectional area than the water-legs extended upwardly from the chambers A' at the outer side, a water-arch D, of greater sectional area than the passages E connecting the tops of such passages, and vertical water-tubes of the same thickness as the water-channel C' connecting the water-chamber and the fire-arch, and the fire-arch being notched at the middle to the sides of the water-channel C' to permit the upward passage of the gases between a series of such sections, substantially as herein set forth.
13. In a steam or hot-water boiler, the flat vertical section having water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C, having central water-channel C' upon its under side, passages E of less sectional area than the water-legs extended upwardly from the chambers A' at the outer side, a water-arch D, of greater sectional area than the passages E connecting the tops of such passages, the water-tubes F and F<sup>2</sup> connecting the water-chamber and fire-arch, the water-tubes F<sup>2</sup> having the thickness of the section, and the water-tubes F having the thickness of the water-channel C', and the side of the fire-arch being notched between the water-tubes F<sup>2</sup> to permit the upward passage of the gases, substantially as herein set forth.
14. A vertical sectional boiler comprising a series of flat sections having the vertical water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C and having the passages E of the same thickness as the section extended upwardly from the chambers A' at the outer side, with water-arch D connecting the tops of such passages, and vertical water-tubes connecting the water-arch and the fire-arch, substantially as herein set forth.
15. A vertical sectional boiler comprising a series of flat sections having the vertical water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C and having the passages E of the same thickness as the section and of less sectional area than the water-legs extended upwardly from the chambers A' at the outer side, with water-arch D of greater sectional area than the passages E connecting the tops of such passages, and vertical water-tubes connecting the water-arch and the fire-arch, substantially as herein set forth.
16. A vertical sectional boiler comprising a series of flat sections having the vertical water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C and having the passages E of the same thickness as the section and of less sectional area than the water-legs extended upwardly from the chambers A' at the outer side, with water-arch D of greater sectional area than the passages E connecting the tops of such passages, the vertical water-tubes F<sup>2</sup> of the same thickness as the section and the same sectional area as the passages E, and the water-tubes F having less thickness than the section, substantially as herein set forth.
17. A vertical sectional boiler comprising a series of flat sections having the vertical water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by the fire-arch C having water-channel

C', and having the passages E of the same thickness as the section and of less area than the water-legs, extended upward from the chambers A' at the outer side, with water-arch D of greater sectional area than the passages E connecting the tops of such passages, the vertical water-tubes F<sup>2</sup> of the same thickness as the section, the water-tubes F and F' of the same thickness as the water-channel C', and the water-arch between the tubes F<sup>2</sup> being notched upon the side, as and for the purpose set forth.

18. In a boiler comprising a series of flat vertical sections having each the water-legs A, water-chambers A', fire-arch C, passages E, water-arch D, and water-tubes connecting the fire-arch and water-arch, the combination, with the sections S having the fire-arch the full thickness of the section, of the intermediate and rear sections S', S<sup>2</sup> and S<sup>3</sup> having the fire-arch notched to permit the upward movement of the gases, and the rear section formed with the plate s<sup>3</sup>, and provided upon its upper part with the openings G', the whole arranged and operated substantially as herein set forth.

19. In a boiler comprising a series of flat vertical sections having each the water-legs A, water-chambers A', fire-arch C, passages E, water-arch D, and water-tubes connecting the fire-arch and water-arch, the combination, with the sections S having the fire-arch the full thickness of the section, of the intermediate and rear sections S', S<sup>2</sup> and S<sup>3</sup> having the fire-arch notched to permit the upward movement of the gases, and the rear section formed with the plate s<sup>3</sup>, having upon its upper part the openings G' and upon its lower part the transverse water-passages H and H' with openings for dust-flue between such passages, the whole arranged and operated substantially as herein set forth.

20. In a boiler comprising a series of flat vertical sections having each the water-legs A, water-columns A', fire-arch C, passages E, water-arch D, and water-tubes connecting the fire-arch and water-arch, the combination, with the sections S having the fire-arch the full thickness of the section, of the intermediate and rear sections S', S<sup>2</sup> and S<sup>3</sup> having the fire-arch notched to permit the upward movement of the gases, and the rear section formed with the plate s<sup>3</sup>, having upon its upper part the openings G' and upon its lower part the transverse water-passages H and H' with the plate d secured thereon and the dust-damper e fitted to an opening in such plate, and a smoke-box fitted to the section S<sup>3</sup> and inclosing the passages G' and dust-damper, substantially as herein set forth.

21. A vertical sectional boiler comprising a series of flat sections having the vertical water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C and having the passages E of the same thickness as the section extended upwardly from the chambers A' at the

outer side, the water-arch D of the same thickness as the section connecting the tops of such passages, vertical water-tubes connecting the water-arch to the fire-arch, the notches C<sup>2</sup> in the fire-arches of the rear sections, and certain of the water-tubes made the full thickness of the section, and the remainder of less thickness, to form a forward flue over the fire-box and backward flues at the sides of the section over the chambers A', substantially as herein set forth.

22. In a boiler comprising a series of flat vertical sections of greater width upon the upper than upon the lower part, with a rear section having the plate s<sup>3</sup> with flue-openings G' in the upper part, the combination, with such sections, of the smoke-box J of greater width in the upper than in the lower part, as set forth, fitted to the rear section to inclose the said flue-openings, and provided with smoke-outlet in the middle at the upper part, and having the dampers L pivoted in the smoke-box between such outlet and flue-openings, and provided with the narrowed portions l' at the lower end extended downward into the narrow part of the smoke-box, substantially as herein shown and described.

23. In a boiler comprising a series of flat vertical sections with a rear section having the plate s<sup>3</sup> with flue-openings G' in the upper part, the combination, with such sections, of the smoke-box J fitted to the rear section to inclose the said flue-openings, and provided with smoke-outlet upon the center line, and having the dampers L pivoted in the smoke-box between such outlet and flue-openings, with the cranks l attached to the spindles, and the link m bolted to one of said cranks and provided with two pins n fitted interchangeably and detachably to an eye upon the other crank to adjust the dampers open and shut respectively, substantially as herein set forth.

24. A vertical sectional boiler comprising a series of flat sections having the vertical water-legs A with outwardly-projecting chambers A' at the top connected at their inner sides by fire-arch C, and having passages E of less sectional area than the water-legs extended upwardly from the chambers A' at the outer side, with water-arch D of greater sectional area than the passages E connecting the tops of such passages, and vertical water-tubes connecting the water-arch with the tops of the chambers A' and the fire-arch, the united area of the tubes over the top of each water-chamber being less than the area of the water-legs, to drive the current of water from the water-legs partially into the fire-arch, substantially as herein set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

WILLIAM M. MACKAY.

Witnesses:

I. LEE,

THOMAS S. CRANE.