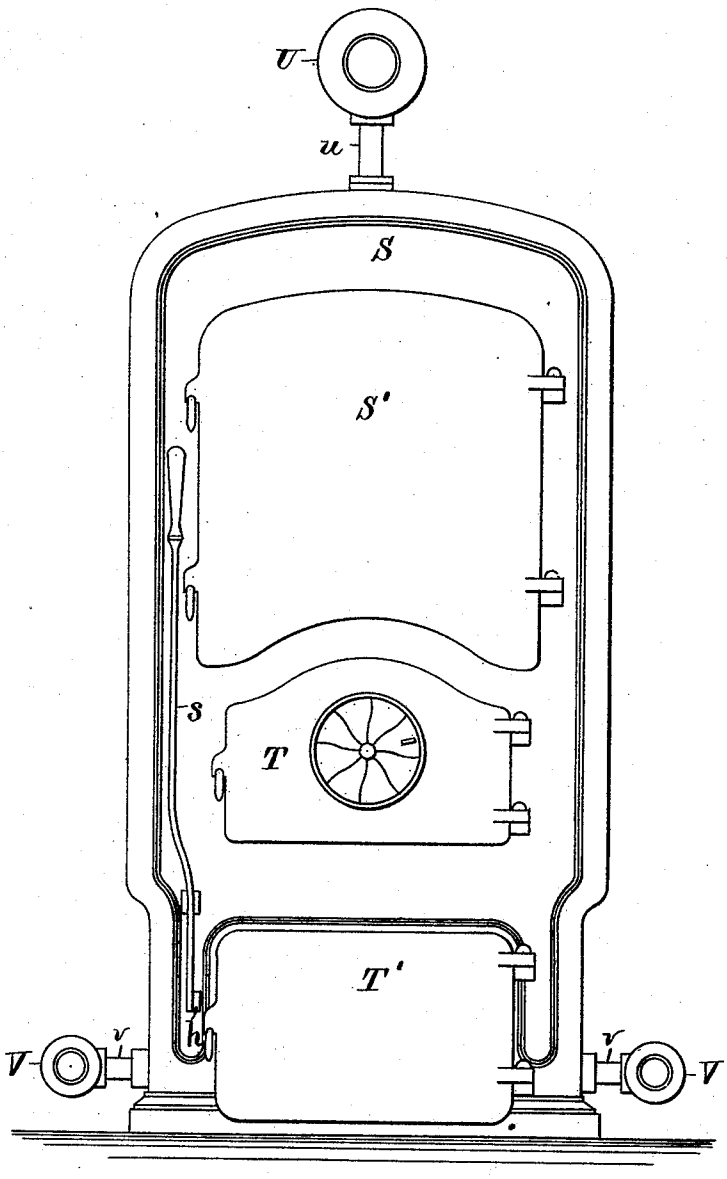
(No Model.) 5 Sheets—Sheet 1.

# J. J. BLACKMORE.

## HEATING BOILER IN VERTICAL SECTIONS.

No. 531,714. Patented Jan. 1, 1895.

*Fig. 1.*

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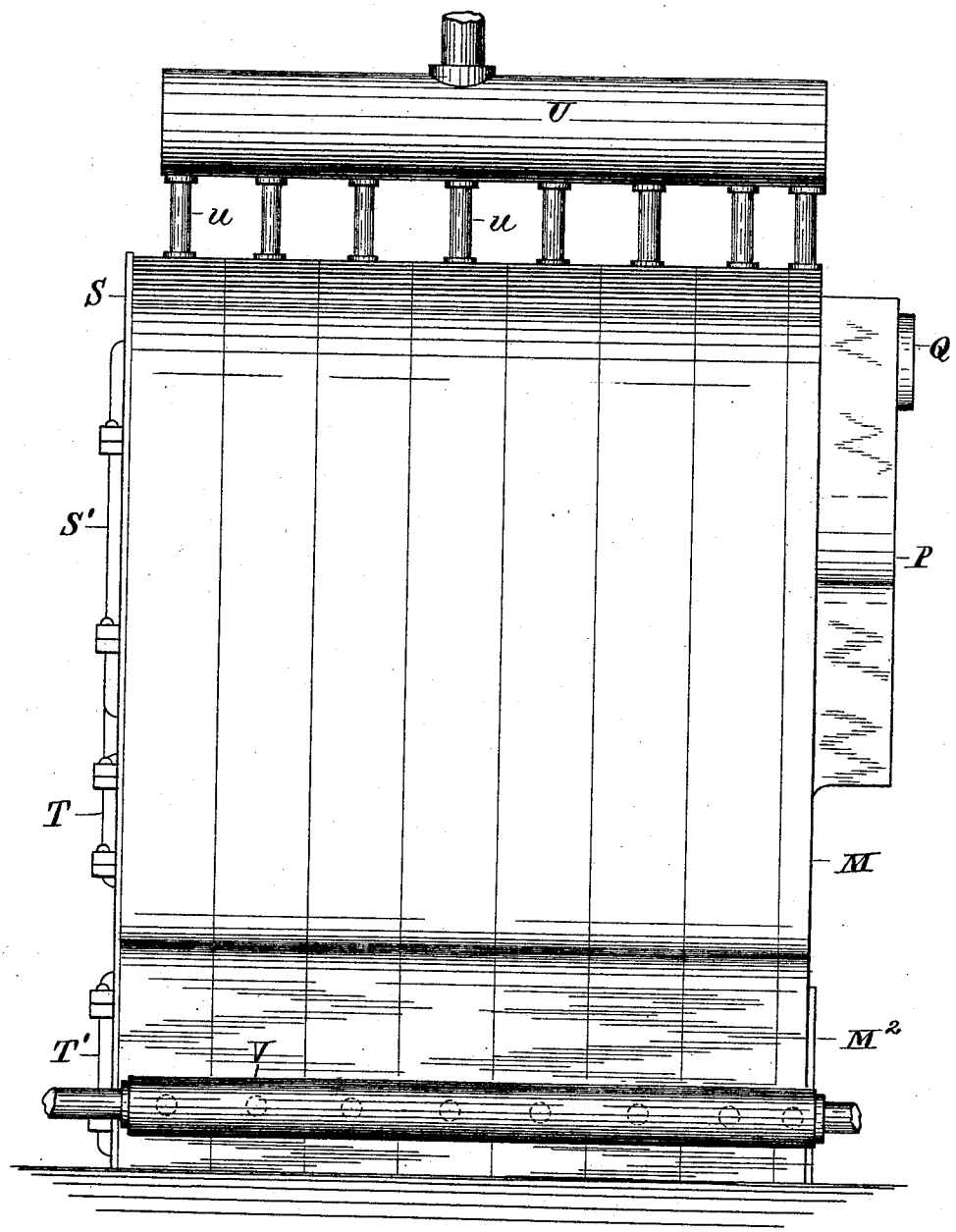
(No Model.) 5 Sheets—Sheet 2.

# J. J. BLACKMORE.

## HEATING BOILER IN VERTICAL SECTIONS.

No. 531,714. Patented Jan. 1, 1895.

*Fig. 2.*

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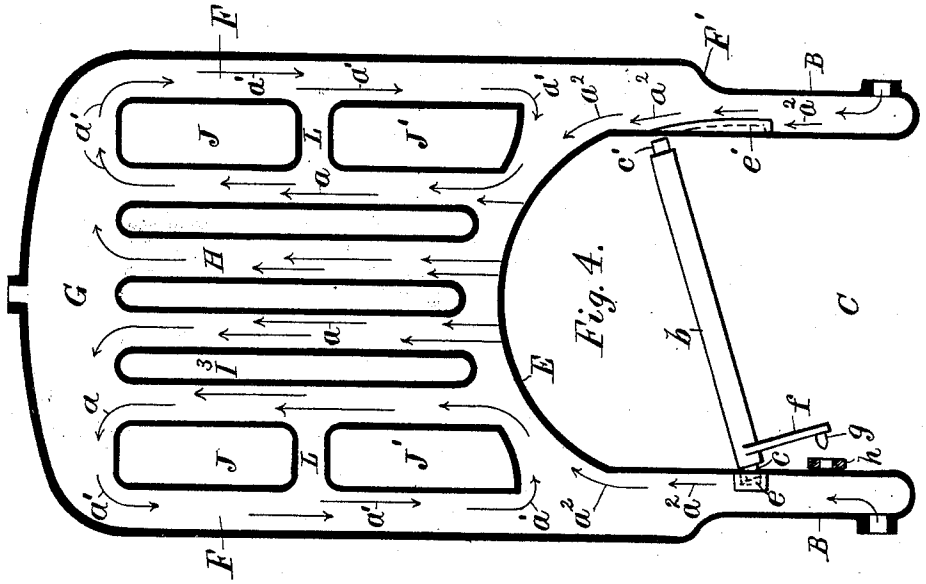
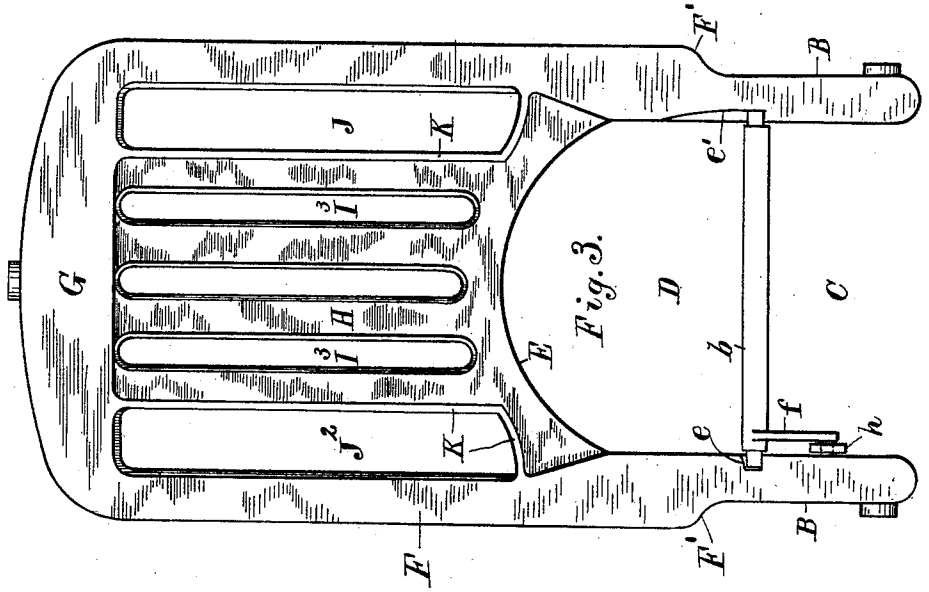
(No Model.) 5 Sheets—Sheet 3.

# J. J. BLACKMORE.

## HEATING BOILER IN VERTICAL SECTIONS.

No. 531,714. Patented Jan. 1, 1895.

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(No Model.)

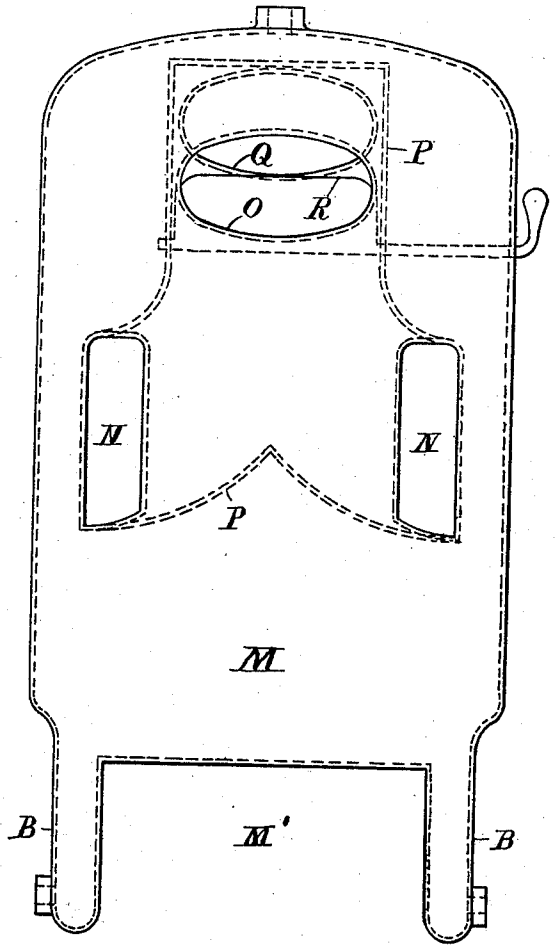
5 Sheets—Sheet 4.

# J. J. BLACKMORE.

## HEATING BOILER IN VERTICAL SECTIONS.

No. 531,714. Patented Jan. 1, 1895.

*Fig. 5.*

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(No Model.) 5 Sheets—Sheet 5.

# J. J. BLACKMORE.

## HEATING BOILER IN VERTICAL SECTIONS.

No. 531,714. Patented Jan. 1, 1895.

Fig. 7.

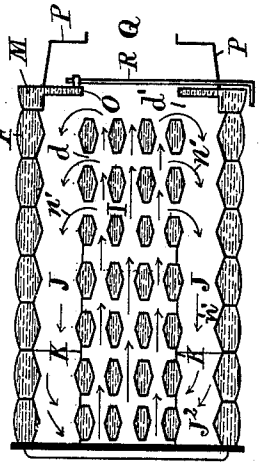


Fig. 9.

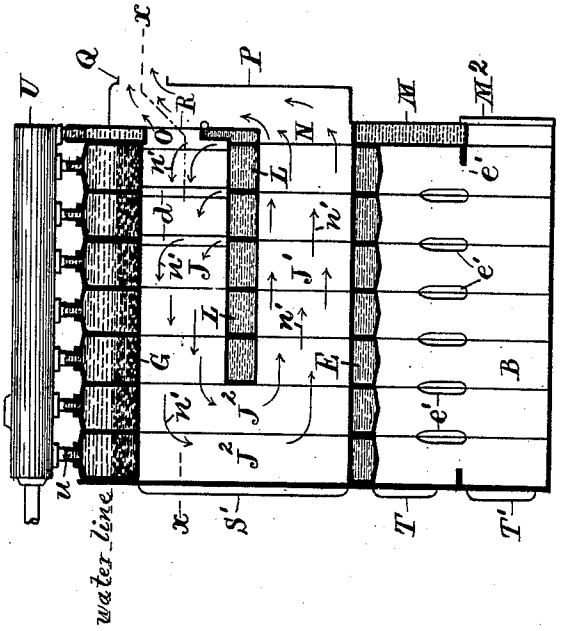


Fig. 6.

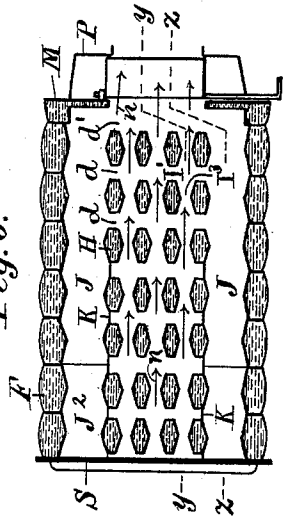
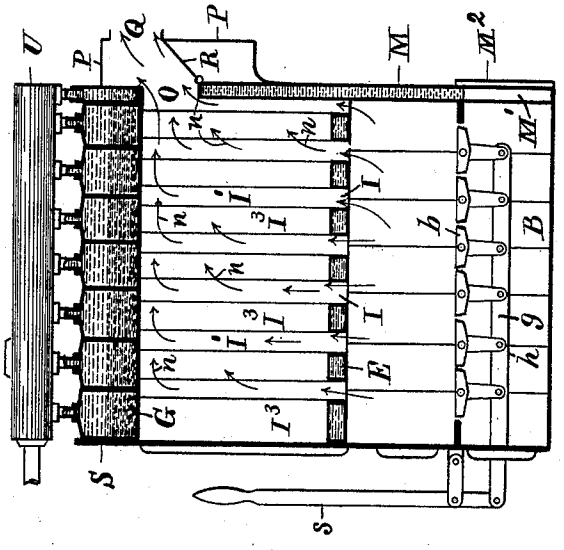


Fig. 8.



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Wm. Batson.

Inventor.
Joseph J. Blackmore
per Thomas S. Crane Atty

# UNITED STATES PATENT OFFICE.

JOSEPH J. BLACKMORE, OF NEWARK, NEW JERSEY.

## HEATING-BOILER IN VERTICAL SECTIONS.

SPECIFICATION forming part of Letters Patent No. 531,714, dated January 1, 1895.

Application filed December 28, 1893. Renewed December 3, 1894. Serial No. 530,743. (No model.)

*To all whom it may concern:*

Be it known that I, JOSEPH J. BLACKMORE, a subject of the Queen of Great Britain, residing at Newark, Essex county, New Jersey, have invented certain new and useful Improvements in Heating-Boilers in Vertical Sections, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The present invention relates to a steam or water boiler composed of vertical transverse sections, and the improvements consist partly of the construction of the several sections, adapting them to perform special functions in a certain part of the boiler, partly in means for forming direct and indirect flues through the boiler and connecting them at pleasure with a smoke outlet; and other details.

These improvements will be understood by reference to the annexed drawings, in which—

Figure 1 is a front elevation of the boiler. Fig. 2 is a side elevation of the same. Fig. 3 is an elevation of the front section with one piece of the grate. Fig. 4 is a vertical section through one of the boiler-sections having the side flues divided transversely; Fig. 5, an inside view of the rear sections; Fig. 6, a horizontal section of the boiler on line $x$, $x$, in Fig. 9, with the direct-draft damper opened. Fig. 7 is a similar section with the damper closed. Fig. 8 is a sectional elevation on line $y$, $y$, in Fig. 6; and Fig. 9 is a vertical section on line $z$, $z$, in Fig. 6.

Figs. 6 to 9 inclusive represent in diagrammatic form seven flue sections arranged together in series, with a front applied at one end and a rear plate and smoke box at the opposite end; and the constructive features of the sections are shown in Figs. 3, 4 and 5.

Each of the flue sections is of symmetrical shape, having water legs B at the bottom upon opposite sides, with space between the same for an ash pit C and fire box D, and a water arch E connecting the tops of the water legs over the fire box.

The sides of the section are formed as water tubes F extended upward, continuously with the water legs, to a steam arch G which is carried across the entire top of the section, and is connected with the fire arch by intermediate water tubes H. The water arch and tubes H are of less thickness than the remainder of the section. When a series of such sections is secured together, as shown in Figs. 2 and 8, transverse spaces I are formed between the water arches, and vertical spaces I′ also extend from the water arches upward to the under side of the steam passages in the arch G, and constitute a general combustion chamber between and around the intermediate tubes.

The under sides of the steam arches G are exposed to the direct heat of the gases, over such spaces, which gases pass freely from one of such spaces to the other through the slots $I^3$ extending through the sections between the tubes H.

The side tubes F are separated from the adjacent tubes H by a considerable space, to form return flues J, J′, $J^2$; which are divided from the combustion spaces I′, where necessary, by means of flanges K projected from the front and rear sides of the tubes H into line with the edge of the section and extended from the under side of the steam arch G along the inner and lower sides of the flues, to the inner edge of the side tube F.

It will be observed by reference to Figs. 3 and 4 that the water arch E in each section is exposed to the greatest heat of the fire, and that the water tubes H which stand directly over the arch and connect freely therewith, are adapted to convey the steam and heated water without obstruction to the steam space in the top of the boiler. The side tubes F provide in like manner for the free return of the water (after the steam is separated therefrom in the steam arch G) to the ends of the water arch, such circulation being indicated in Fig. 4 by the arrows $a'$. I have found by experience that the free return of the water to the lower part of the boiler can only be secured by the use of large passages, and I therefore make the side tubes of sufficient cross section to exceed the aggregate area of the intermediate tubes H, whatever their number.

Four intermediate tubes are shown in each boiler section in the drawings, and these intermediate tubes are shown in Fig. 6 of less aggregate area than the two side tubes F. If the number of intermediate tubes should be greater, the aggregate area of the side tubes can be readily increased by widening them upon the outer side, and I can thus maintain a larger channel for the downward movement

of the water than is provided for its upward flow. A nozzle for inlet pipe *v* is formed near the bottom of each water leg, and the return current from the radiators is admitted at such point. To provide for the free movement of such current upward to the water arch and the free passage of the fluid moving downward in the side tubes F to the same point, I offset the side tubes outwardly at their junction with the water legs below the ends of the water arch. This construction produces an enlargement F′ of the water leg adjacent to the water arch, and the lower corners of the side flues J′ or $J^2$ are projected downward into such enlarged space and serve to direct the current which rises from the water leg directly into the water arch, as indicated by the arrows $a^2$. Such current is thus prevented from rising in the side tubes F, and the descending fluid in such tube thus secures access to the water arch more freely, as indicated by the arrows *a′*.

Each boiler section is readily formed in one piece with the necessary flanges K, by casting in the usual manner. Such flanges, when the sections are abutted as shown in Fig. 6, meet together and form a partition between the combustion chamber and the flues.

The side flues are shown formed with horizontal divisions or water bridges L (at the middle of their height) in the rear five sections in Figs. 4 and 9; such divisions being of the same thickness as the section, so as to form distinct flues J and J′ above and below such division. The front two sections, as shown in Figs. 3 and 9, have the side flues $J^2$ uninterrupted, and the flanges K are shown omitted from the rear flue sections above the divisions L, to form open connecting passages *d*, between the combustion chambers I and the side flues J, at the rear end of the flues.

The boiler is closed at the rear end by a water plate M with smoke passages N extended through the same coincident with the flues J′, and a central aperture O coincident with the upper part of the combustion chambers.

An aperture M′ is in Fig. 5 shown formed in the lower end of the plate to give access to the rear end of the ash pit, and such plate is in Fig. 2 shown closed by a door $M^2$. The outer side of the water plate is provided with a smoke box P extending somewhat above the outlet O and provided near its upper end with a smoke outlet Q.

The passages N are, as shown in Fig. 9, wholly above the water arches, and the smoke box thus possesses no direct connection with the fire box. As the passages N connect with the side flues of the boiler, the smoke box is widened where it embraces such passages, but is contracted toward the top to lead the gases from both of the passages to the middle line where they are discharged to the smoke pipe Q.

A damper R is fitted within the smoke box to close the aperture O at pleasure, and when closed permits the movement of the gases from the passages N to the outlet Q. The front S is provided with a cleaning door S′ to clean the several flues, and with a fire door T and ash pit door T′; and the several sections are connected at the top with a steam drum U by outlet pipes *u*, and upon each side at the bottom with feeding drums V by inlet pipes *v*.

In Figs. 3 and 8 grate sections *b* are shown extended across between the water legs, forming an ash pit below and a fire box above the grate. Each grate section is formed at opposite ends with horizontal pivots *c c′* which are fitted at one end to a socket *e* upon the inner side of the water leg and at the opposite end to a sloping slot *e′* inside the opposite water leg.

The grate, adjacent to the socket *e*, is provided with a downwardly projecting arm *f* having a crank pin *g* projected toward the water leg; and a raking bar *h*, provided with a hole to fit loosely upon each of the crank pins, is extended along inside the water legs and projected through the front S where it is coupled to a hand-lever *s*.

The handle serves to rake all the grates simultaneously, while the sloping character of the slots *e′* renders each grate section readily detachable by lifting its pivot from the open slot, as shown in Fig. 4. When thus lifted, the angular position assumed by the arm *f* withdraws the crank pin *g* from the hole in the raking bar *h;* and in like manner the introduction of the grate pivots first into the socket *e* and then into the slot *e′* serves to introduce the crank pin into connection with the raking bar, so as to be actuated by the same.

The boiler operates as follows:—The burning gases generated in the fire box D rise through the spaces I between the water arches and ascend through the combustion chambers I′ above the same into immediate contact with the under side of the steam arches G; being prevented by the flanges K from admission to any of the side flues except at the rear part of the boiler where the connecting passages *d* permit the entrance of the gases to the upper return flue J. The diagrams in Figs. 6 to 9 inclusive show the movement of the gases of combustion when the damper R is open or closed, Figs. 6 and 8 showing the damper open and the gases thus permitted, as indicated by the arrows *n*, to pass directly from the combustion chamber formed by spaces I to the smoke outlet Q without entering the side flues. To still further use the heated gases, I use an indirect draft by closing the damper, as shown in Figs. 7 and 9, thus throwing the gases, as indicated by the arrows *n′*, first into the upper side flues J and thence through the flues $J^2$ into the lower side flues J′. From the latter flues they pass through the passages N in the rear plate M, and through the smoke box P to the smoke outlet Q. By such an indirect passage the gases are held a long time in contact with the water tubes of the boiler, and the heat is thoroughly abtracted from the gases.

The term "transverse" is applied herein to the sections, as extending across the boiler from side to side; but the term "transverse" when applied to the flues J, J′ and $J^2$ herein, is in their relation to a single section; the passages J, J′ and $J^2$ being transverse to each section and forming, when the sections are combined together, flues which extend from the front to the rear of the boiler.

From the above description it will be seen that the movement of the water through the different tubes of the boiler is strictly in accordance with natural laws, as the tubes H, which are provided for upward circulation, are over the hottest part of the fire, and are surrounded by the flames from bottom to top of the tubes. The spaces I and I′ encourage the combustion of the gases up to the under side of the steam chambers G. The combustion is not however carried on in the flues J, but the heated gases continue to give out their heat to the water therein, and as the gases cool, they move naturally downward through the flue passage $J^2$ into the lower return flue J′; which, as the gases have already discharged much of their heat, is at a lower temperature than the flues J. The water in the tubes F outside of the flues J, J′ is therefore in contact with surfaces much cooler than the tubes H, which naturally induces a downward movement of the water in the tubes F. The return fluid entering the bottoms of the water legs is also guided upward into the hottest pipes H by a natural operation of the heat, as the inner side of the water leg is heated by its proximity to the ash pit and radiation from the under side of the grates. The return fluid first strikes the inner side of the water leg, which is much hotter than the outside; and as the water rises in contact with such heated surface it flows naturally into the highly heated water arch E, instead of rising in the tubes F, in which, as well as in the outer side of the water leg, the colder fluid tends to descend. The separation of these different currents is clearly indicated in Fig. 4 by the arrows $a$ showing the rising of the hottest fluid, the arrows $a'$ showing the descent of the water in the tubes F, and the arrows $a^2$ showing the movement of the water from the water legs into the water arch. The operation of the boiler is thus in strict accordance with the laws of nature, and is adapted to secure the most active circulation, and consequently the most rapid abstraction of heat from the metallic surfaces adjacent to the fire.

The rear plate M is shown connected with the steam drum U and the feed drums V, like the flue sections of the boiler; and such construction prevents the useless radiation of heat from the rear of the boiler, as the water in the rear plate absorbs some heat from the gases.

It is obviously immaterial to the operation of the boiler whether the rear plate be provided with water spaces or not.

It is obvious that the capacity of the boiler may be varied at pleasure by uniting a suitable number of the sections together, and selecting for the front sections those with the continuous side flue $J^2$, for the intermediate sections those with the divisions L and partition plates K, and for the rear sections those having the partition plates omitted to form the open passages $d$ connecting the combustion chamber with the upper flue J.

Seven sections are shown united together in the drawings, the front two sections containing the flue $J^2$, and the flanges K being disposed to form between the rear section and the plate M two passages $d$ at each side of the boiler, in addition to a corresponding passage $d'$; but the number and arrangement of the sections may be varied in any desired proportion. The capacity of the boiler may not only be varied by the use of such sections but all the sections necessary to form the boiler, excepting the rear plate, may be formed from a single pattern, with slight modifications. This will be readily understood by reference to Figs. 3 and 4, where it will be seen that the front section shown in Fig. 3 differs only from the intermediate section (shown in Fig. 4) by the division L and flanges K; and the intermediate sections, as shown in Figs. 6 and 9, differ only from the rear sections in respect to the flanges K. These differences are readily produced when molding the castings, by the application of suitable division pieces and flange pieces to the pattern for the front section shown in Fig. 3, and a suitable modification of the core which makes the section hollow. The construction adopted thus offers many advantages both in the construction and operation of the boiler.

The arrangement of the flanges K in my construction differs from any with which I am acquainted in respect to their extension upward to the steam arch upon the inner side upon a smoke flue, which wholly excludes the outer sides of the boiler at the top, from the combustion chamber.

I am aware that it is common to make vertical boiler sections with the outer edges of greater width than the water tubes inside the same, and I do not therefore claim such a construction broadly.

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

1. In a steam boiler composed of vertical transverse sections, a front section having the water legs B with provision for the fire box D between the same, with the steam arch G at the top of the section, and water arch E connecting the water legs over the fire box, the water tubes F at the sides of the section with the transverse flues J adjacent to the same, and intermediate water tubes of less thickness than the section, and provided with the flanges K extended downward upon the inner side of the flues from the steam arch to the water arch and side tube F, and operating to exclude the outer sides of the section at the top from the combustion chamber

around the intermediate water tubes, substantially as set forth.

2. In a steam boiler composed of vertical transverse sections, the intermediate section having the water legs B with fire box D between the same, with the steam arch G at the top of the section, and water arch E connecting the water legs over the fire box, the water tubes F at the sides of the section with upper and lower transverse flues J, J′, adjacent to each of the tubes F, and the intermediate water tubes H of less thickness than the section provided with the flanges K extended downward upon the inner side of the flues from the steam arch to the water arch and side tube F, and operating to exclude the outer sides of the section at the top from the combustion chamber around the intermediate water tubes, substantially as set forth.

3. In a steam boiler composed of vertical transverse sections, the section having the water legs B with fire box D between the same, with the steam arch G at the top of the section, and the water arch E connecting the water legs over the fire box, the water tubes F and vertical intermediate tubes H connecting the steam and water arches, the flues adjacent to the tubes F with ribs K extended from the steam arch downward upon the inner side of the flues to the water arch and side tubes F, and operating to exclude the outer sides of the section at the top from the combustion chamber around the intermediate water tubes, and the lateral enlargement F′ of the water leg upon the outer side of the section below the water arch, as herein set forth.

4. In a steam boiler composed of vertical transverse sections, a section having water legs with fire box between the same, a water arch connecting the water legs over the fire box, a steam arch extended across the top of the section, side tubes and intermediate tubes forming side flues and intermediate flues through the section, and the lateral enlargement of the water leg adjacent to the water arch, with the outer corners of the side flues J′, $J^2$, extended partly over the water leg to divide the water currents, as herein set forth.

5. A sectional boiler comprising a series of vertical sections having water legs B with the fire box D between the same, and the water arch E and steam arch G connected by vertical water tubes F and H, side flues adjacent to the outer tubes F with horizontal divisions in certain of the flues forming the same into double return flues J, J′, and the front section having the side flue continuous between the water and steam arches, forming the vertical connection J at the front end of the flues, and a suitable smoke outlet being provided from the rear end of the lower return flues, substantially as herein set forth.

6. A steam boiler comprising a series of vertical transverse sections having each the opposite water legs B connected by the water arch E, and formed with a steam arch G across the top of the section, vertical side tubes F and intermediate tubes H forming direct flue and double return flues J, J′, $J^2$, the lateral enlargement F′ of the water legs at the ends of the water arch, the said sections being combined with a front having suitable doors and with a rear section having passages connecting the direct and indirect flues with a smoke outlet, and provided with a damper to close the direct flue, as herein set forth.

7. A steam boiler comprising a series of vertical transverse sections provided each with the water arch E, steam arch G, vertical side tubes F and intermediate tubes H, with flanges K forming direct flue and double return flues J, J′, $J^2$, adjacent to the side tubes, a front having suitable doors, and the rear water plate M having the external smoke box P, and provided with the direct draft passage O, the damper R for closing the same, the indirect draft passages N below the same and above the level of the water arches, and the smoke outlet Q arranged above the damper, as herein set forth.

8. A steam boiler comprising a series of vertical transverse sections, having each the opposite water legs B connected by the water arch E and formed with steam arch G across the top of the section, vertical side tubes F and intermediate tubes H forming direct flue and double return flues J, J′, $J^2$, the water legs having a space for ash pit and fire box between the same, and having the socket *e* and the sloping slots *e′* formed in halves upon the inside edges of adjacent opposite water legs, and the said sections being combined with a front having suitable doors and a rear section having passages connecting the direct and indirect flues with a smoke outlet, substantially as herein set forth.

9. A boiler comprising a series of vertical transverse sections, having each the opposite water legs B connected by the water arch E, with space for ash pit and fire box beneath such arch, certain of the water legs being provided with socket *e* and the sloping slots *e′* inside the opposite water legs, the series of transverse grate sections *b* with pivots fitted detachably to such slots and sockets, and provided each adjacent to the socket *e* with the arm *f* having pin *g* projected toward the water leg, the raking bar *h* fitted loosely and detachably to such pins and held thereon by a suitable guide, and the pin being automatically detached from the bar as the pivot *c′* is raised in the slot *e′*, as herein set forth.

10. A steam boiler comprising a series of vertical transverse sections, having each the following elements, namely, opposite water legs B with water arch E forming a fire chamber, a horizontal steam arch G at the top of the section, vertical side tubes F and intermediate tubes H with the water arch and intermediate tubes of less thickness than the remainder of the section to form combustion chambers I′ between the sections, side flues in certain of the

sections at the rear part of the boiler having horizontal divisions L forming the same into double return flues J, J′, with vertical connection $J^2$ at the forward end, and the intermediate tubes H adjacent to such flues being provided with the flanges K arranged to cut off the lower return flue J′, the connection $J^2$, and the front portion of the upper return flue J from the combustion chambers, and a suitable smoke outlet from the lower return flues, substantially as herein set forth.

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

JOSEPH J. BLACKMORE.

Witnesses:

NICHOLAS F. PETERSON,

THOMAS S. CRANE.