(No Model.) 4 Sheets—Sheet 1.

L. R. BLACKMORE.

HEATING BOILER.

No. 540,228. Patented June 4, 1895.

Fig. 3.

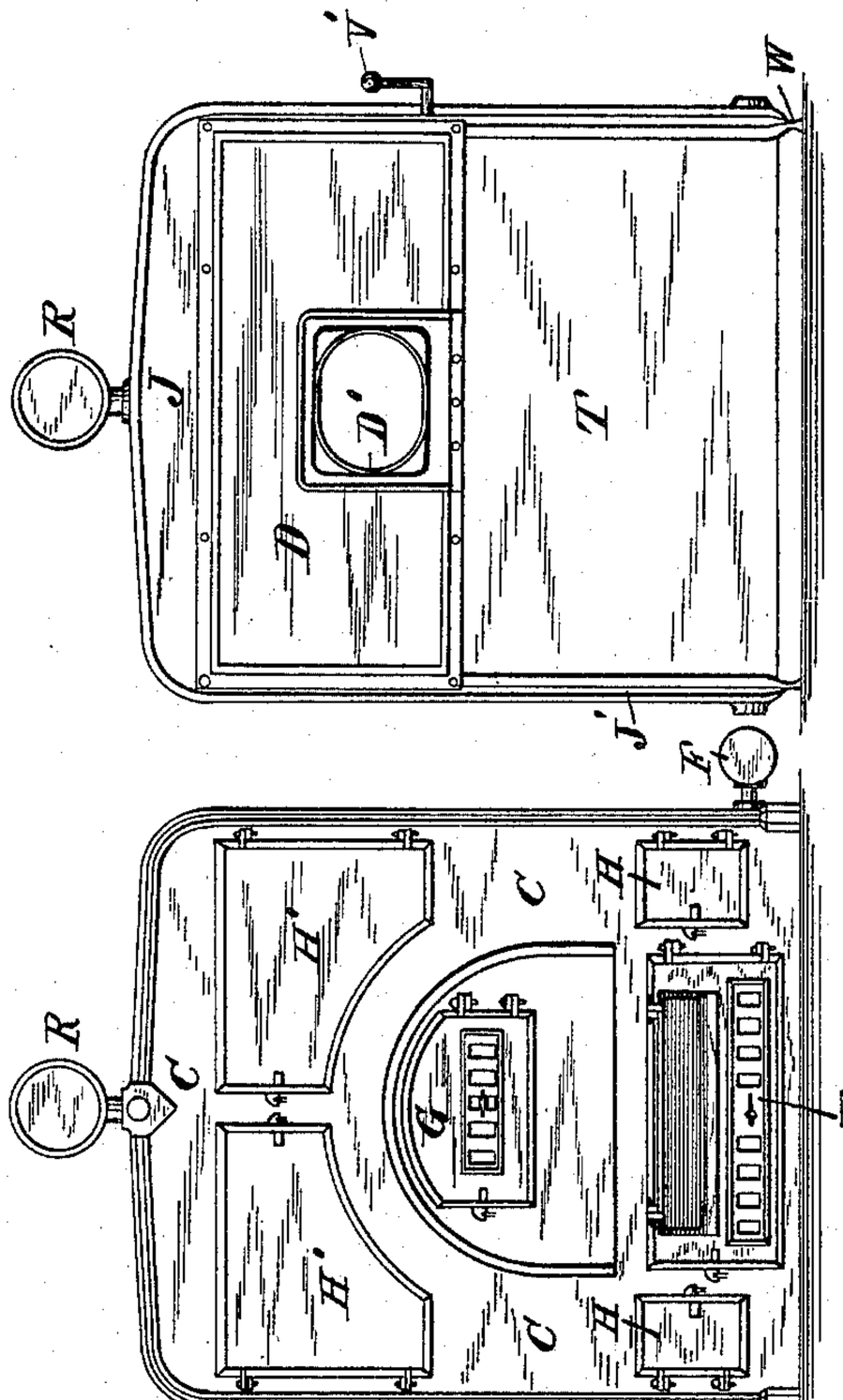

Fig. 2.

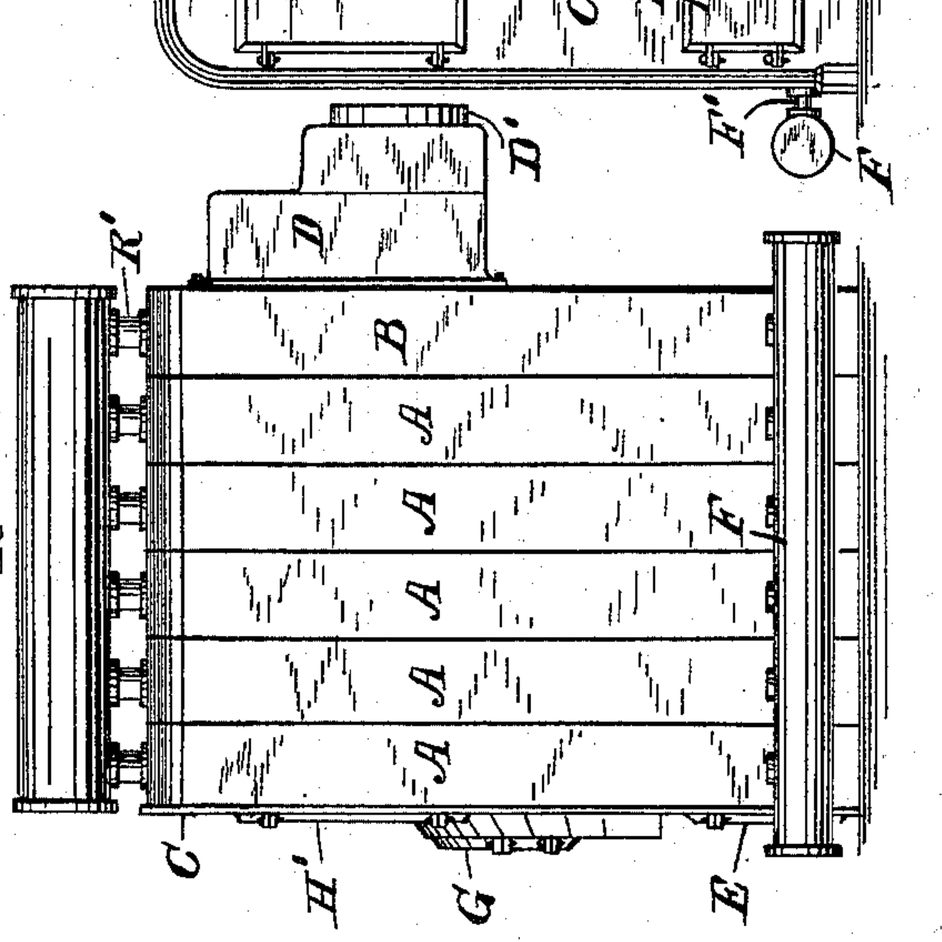

Fig. 1.

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per Thomas S. Crane, Atty.

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HEATING BOILER.

No. 540,228. Patented June 4, 1895.

Fig. 4.

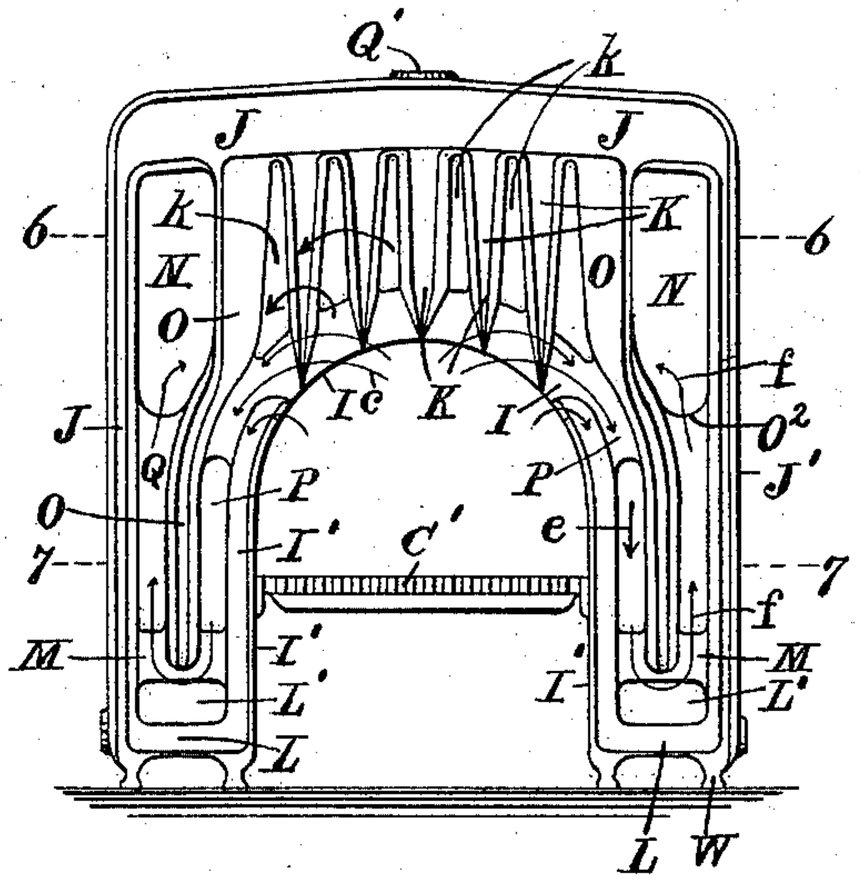


Fig. 5.

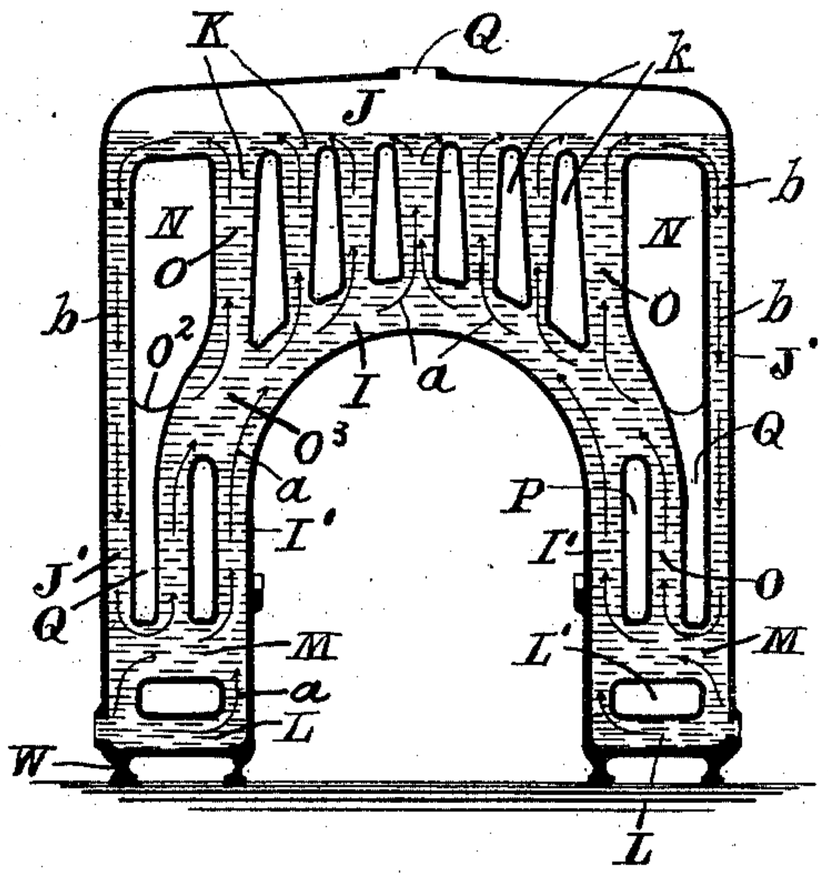


Fig. 6.

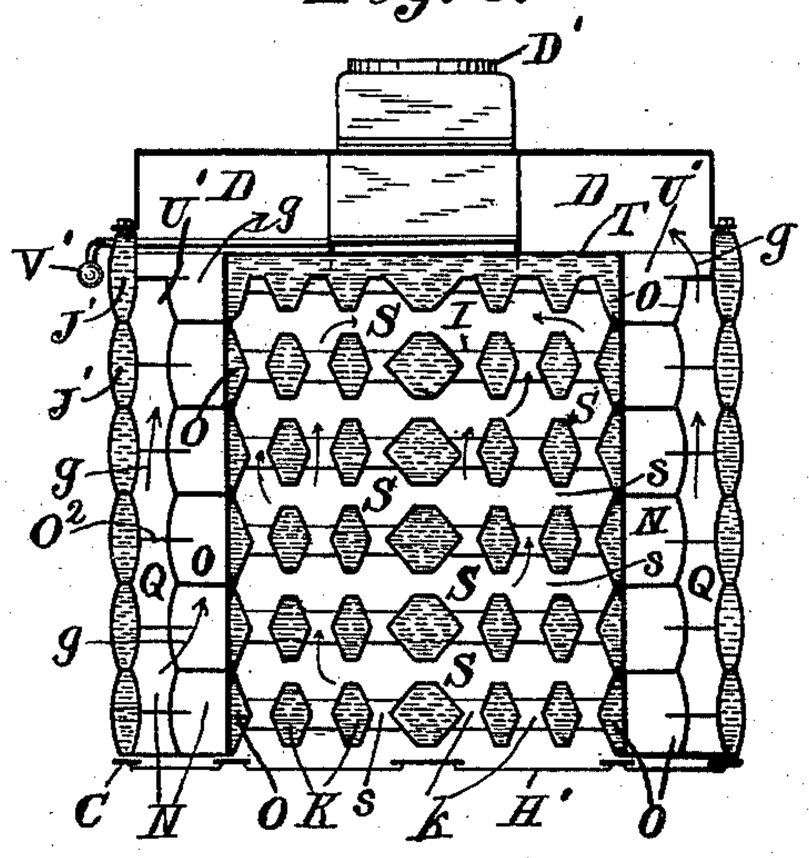
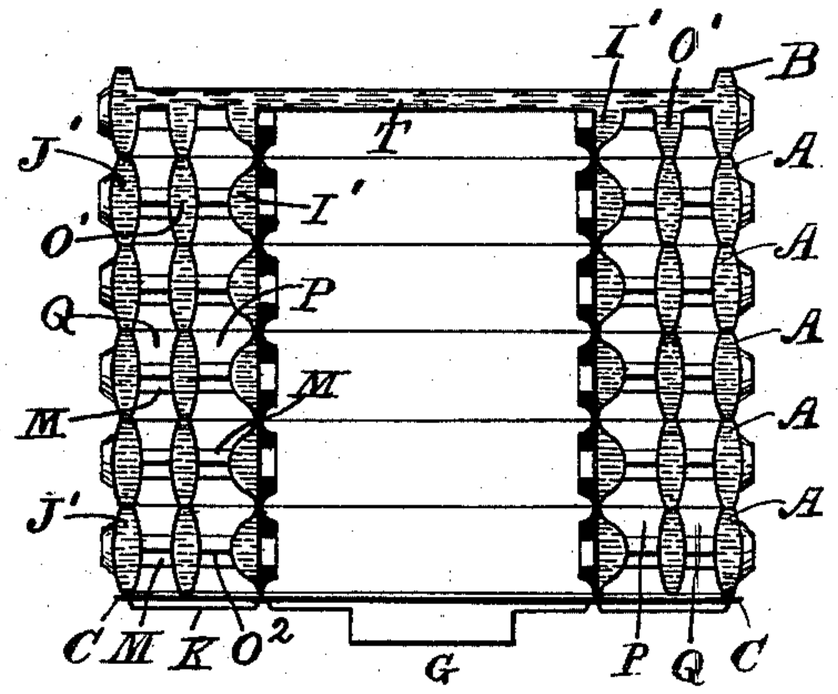


Fig. 7.



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(No Model.) 4 Sheets—Sheet 3.

L. R. BLACKMORE.

HEATING BOILER.

No. 540,228. Patented June 4, 1895.

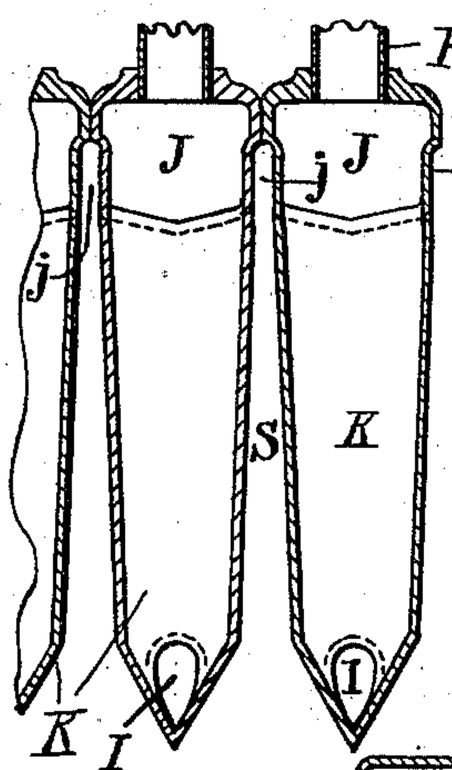
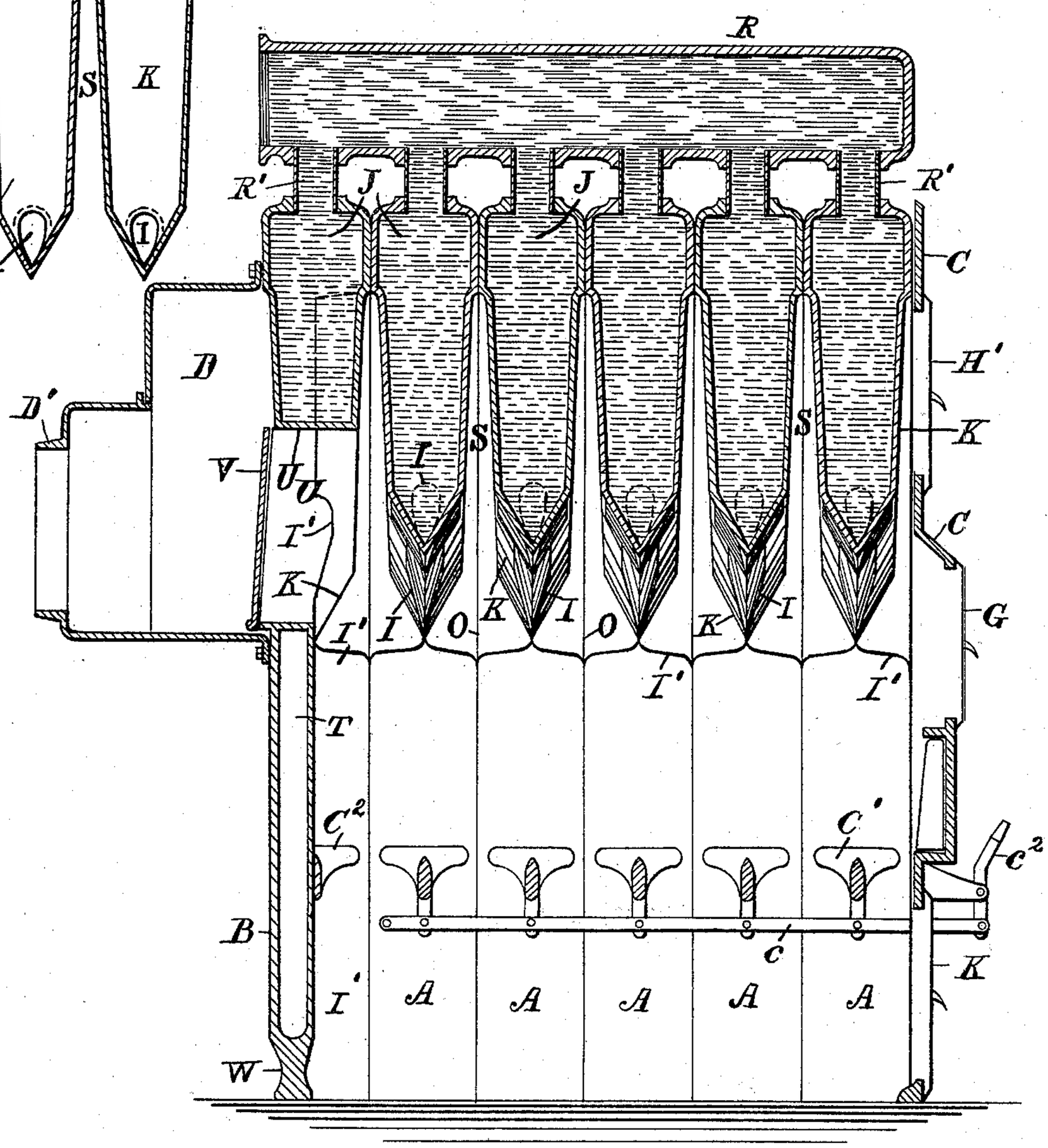


Fig. 8a.

Fig. 8.



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(No Model.) 4 Sheets—Sheet 4.

L. R. BLACKMORE.

HEATING BOILER.

No. 540,228. Patented June 4, 1895.

Fig. 9.

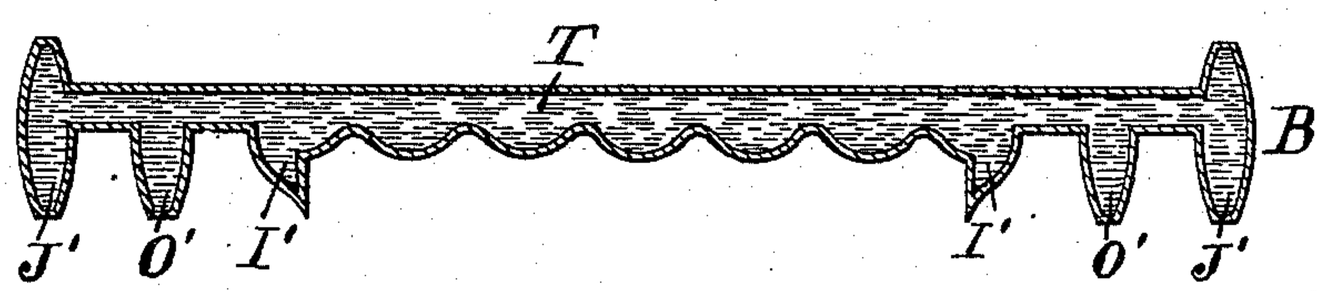
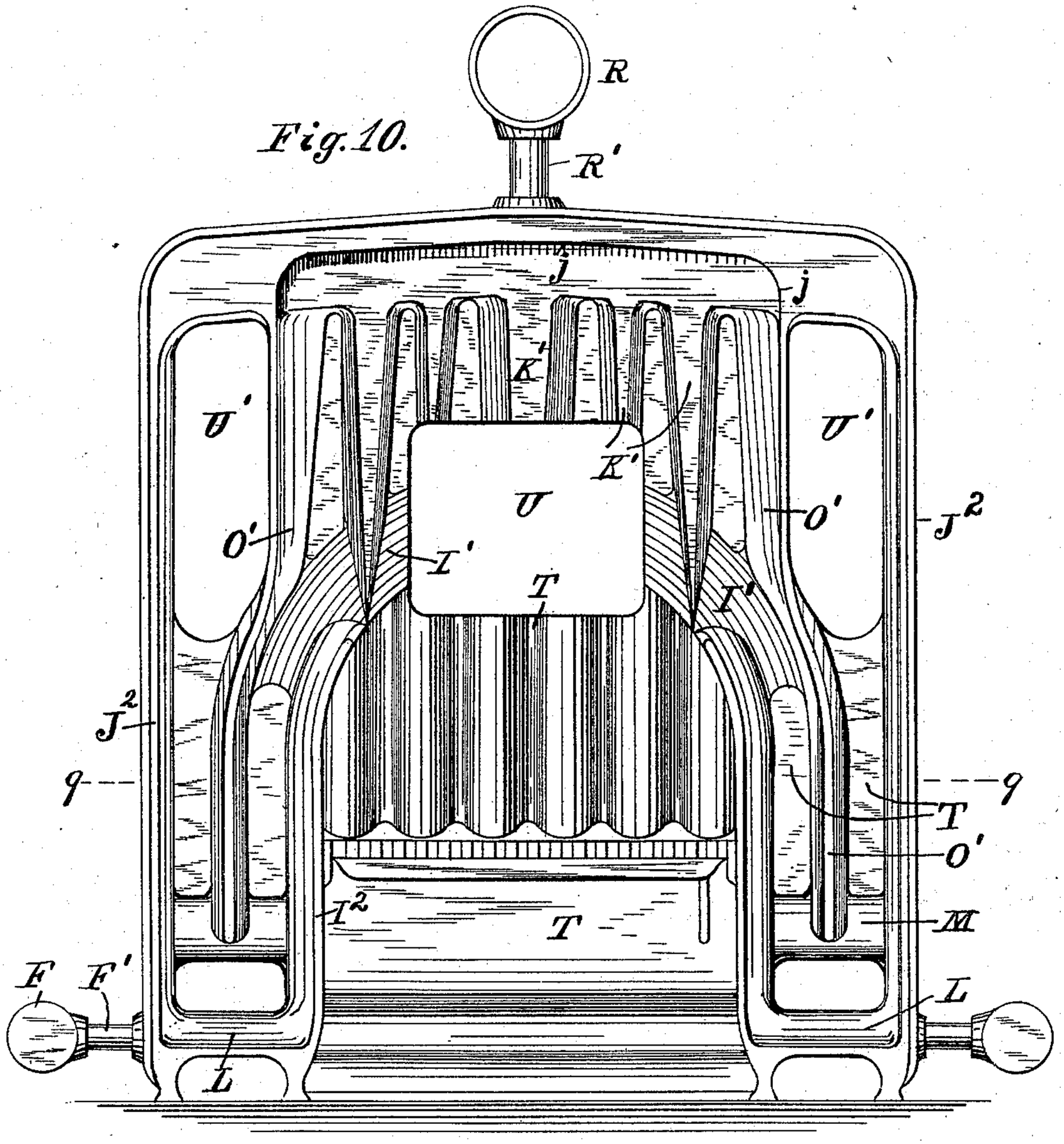


Fig. 10.



Attest:
Edw. F. Kinsley.
L. Lee.

Inventor.
Lawrence R. Blackmore,
per Thomas S. Crane, Atty.

UNITED STATES PATENT OFFICE.

LAWRENCE R. BLACKMORE, OF NEWARK, NEW JERSEY.

HEATING-BOILER.

SPECIFICATION forming part of Letters Patent No. 540,228, dated June 4, 1895.

Application filed October 4, 1894. Serial No. 524,882. (No model.)

To all whom it may concern:

Be it known that I, LAWRENCE R. BLACKMORE, a citizen of the United States, 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 hot water boiler formed of flat vertical sections, each of which has water-legs at the sides of a fire box, a transverse steam or water passage at the top, a water arch of less thickness over the fire, and a series of vertical tubes connecting the transverse passage with the water arch. By such construction of the sections, a very large portion of the entire heating surface in the boiler is disposed adjacent to the fire so as to utilize the radiant heat as fully as possible. By this construction I also convert the entire boiler above the fire box into a combustion chamber where the flames have direct access to the heating surfaces, and where the gases are almost wholly consumed before their temperature is reduced by leading them into lateral passages. The sections are combined with suitable front and rear plates to close the ends of the fire box, and either of such plates may be made hollow for the circulation of water. The construction is shown herein with a solid front having suitable fuel and cleaning out doors, and with a hollow water-plate at the rear where the draft of the fire concentrates the heat rather more than at the front.

The invention consists in various details of construction, which will be fully understood by reference to the annexed drawings, in which—

Figure 1 is a side elevation of the complete boiler; Fig. 2, a front elevation; Fig. 3, a rear elevation of the same. Fig. 4 is an elevation of one of the main sections. Fig. 5 represents the same cut vertically through the center line. Fig. 6 is a transverse section on line 6 6 in Fig. 4. Fig. 7 is a transverse section on line 7 7 in Fig. 4. Fig. 8 is a vertical longitudinal section through the center line of the boiler. Fig. 8ª is a section of two vertical tubes. Fig. 9 shows the rear section cut horizontally through the water-plate on line 9 9 in Fig. 10. Fig. 10 is an elevation of the rear section upon the inner side. Figs. 8, 9, and 10 are upon a larger scale than the remaining figures.

In Fig. 1 A designates the main sections; B, the rear sections; C, the boiler front, and D the smoke box.

R is a header above the sections connected with each by pipe R′ and F are headers connected with each water leg near the bottom by pipe F′.

G is the fuel door; H, doors for cleaning out the bottom flues; H,′ doors for cleaning out the top flues, and K′ the ash pit door.

The main sections are shown in Figs. 4 and 5, in which I designates the water arch over the fire, J the outside water legs extended downward vertically from the ends of the transverse passage J which extends horizontally across the top of the section. The passage is inclined upward slightly toward the middle where it is provided with the outlet Q′ for connection to the header R. The disposition of the passage J and water-leg J′, gives the section a rectangular outline.

Inside water-legs I′ are extended downward from the arch I and connected, at the bottom, with the outside water-legs J′, by transverse passage L; and a column O is extended downward from the passage J, between the inside and outside water-legs, nearly to the passage L. The column and the water-legs are made of the same thickness as the section, thus forming close joints when the sections are secured together.

The fire box arch I is made of considerably less thickness than the section, as shown in Fig. 6, and is connected with the passage J by vertical tnbes K, of intermediate thickness; the lower edge of the arch, and the lower ends of the water legs being inclined or beveled as shown in Fig. 8 to expose a large surface to absorb the heat of the ascending gases. Spaces S are thus formed between the sections above the arch I, which forms a common combustion chamber extending to the under side of all of the transverse passage J, the latter being exposed to the heat at the top of the several spaces *k* between the vertical tubes; and the gases rising freely into the entire combustion chamber through the smoke

passages *s* between the several arches I, as indicated by the arrows *s'* in Fig. 8. A transverse connection M, of the same thickness as the arch I, connects the bottom end of the column O with the water legs, at its opposite sides, just above the transverse connection L; the opening L' between the two transverse connections serving to connect the space P upon the inner side of the column with the space Q upon the outer side.

The series of spaces P form diving flues and the spaces Q form ascending passages which are all connected in the upper corners of the sections by openings N which are formed through all the main sections A to furnish discharge flues. The rear section B is formed of a water plate T having apertures U' coinciding with the openings N, and a middle aperture U in the rear of the arches I.

From the front side of the plate T half arches I' and half tubes K' project slightly, and half water-legs I^2 and J^2, and half columns O' are projected to a level with the side of the transverse passage J which is made of the same thickness as in the main sections. These projections form close joints with the corresponding parts upon the adjacent section A and thus form diving flues and ascending passages between the sections A and B; as between the other sections.

A smoke box D is extended across the outer side of the rear section to collect the smoke from all of the apertures U and U', and is provided with a collar D' to fit a smoke pipe.

Grates C' are shown pivoted to sockets upon the inner sides of the water-legs I' and provided with rocking bar *c* and raker c^2. A half grate C^2 is shown fixed to the inner side of the plate T upon the rear section; the latter being corrugated above the grate to increase the heating surface. The space between the water-legs below the grate forms the ash pit, and the connections L and M, between the inside and outside water-legs are thus below the level of the grate.

The inlet headers F are connected with the transverse passages L, and the water introduced therein is heated by its contiguity to the ash pit, into which considerable heat is radiated by the grate. The connection M permits the flow of water from either water leg into the bottom of the column O, or vice versa, and thus secures a complete circuit from the transverse passage J at the top of the boiler through the column O and either of the water-legs. The passage L in like manner connects with both the inside and outside water legs and permits a circulation of water through both of the same and either end of the passage J, through the vertical tube K which joins the arch I nearest to the water-leg I'.

The normal movement of the currents within the section is indicated by arrows in Fig. 5, the arrows *a* showing the water rising in the channels which are most highly heated by their proximity to the fire, and the arrows *b* showing the current descending in the outside water-legs which are necessarily the coldest channels. The movement of the heated gases is indicated in Fig. 4 by arrows *c* which show the circulation of the gases first within the combustion chamber S thence downward as indicated by the arrows *e*, through the diving flues, and thence upward, as indicated by the arrows *f*, within the passages Q, and passing out through the discharge flues N to the smoke box D, as indicated by the arrows *g* in Fig. 6.

In Fig. 6 is plainly shown the space S between the tubes K upon each of the sections, the spaces *k* between the tubes K in each section, and the spaces *s* between the arches I of the several sections. These spaces are also shown in Fig. 8 where the tubes K are plainly shown of thickness greater than the arches and less than the body of the section; by which construction the lower ends of the tubes are prominently exposed to the heat of the gases rising between the arches. The sections are adapted for generating steam; in which case the sections would be kept filled with water to the tops of the tubes K as indicated in Fig. 5; or for heating by the circulation of hot water, in which case the sections and header R would be wholly filled with water as is shown in Fig. 8.

The fire box arch I is connected internally by passage O^3 with the column O at the base of the arch; thus permitting the movement of water to or from the column, as the conditions within the boiler may require. Such conditions are materially changed, after the boiler has been furnishing a large supply of heating fluid to an external circuit, if such circuit is suddenly cut off or greatly diminished in volume; as the operation of the heat upon the arches I and inside water-legs is then liable to overheat the surfaces, unless provision is made for an independent and active circulation. Unusual provision is made for circulation under these conditions, by the direct connection of the arch I with the top passage J through the numerous tubes K; while the current within the columns O becomes reversed in such case and assists the water legs J' in furnishing a channel for a downward current. Such downward current, moving in the opposite direction from that indicated in Fig. 5, may serve, through the passages O^3, to feed the arches I; while the downward current through the outside water-legs serves to feed the inner water legs I'; the supply from the headers F being cut off (as supposed above) and the inner water-legs and arches I being therefore wholly dependent upon internal circulation to protect them from overheating and the boiler from an excessive generation of steam.

Plates o^2 are shown at the middle of the passages P and Q; but they perform no function, except to strengthen or support the adjacent parts. The bottoms of all the sections are provided with feet W cast integral therewith as shown in Figs. 3, 4 and 5 and the bot-

toms of the sections are thus preserved from the effects of dampness.

Any number of sections may be combined to form a boiler of the desired capacity, and the capacity of such a boiler may be increased at any time by adding additional sections.

With the construction described, the flames and the radiant heat of the fire have direct access not only to the arches I; but owing to the thinness of such arches, as shown in Figs. 6 and 8, the flames and radiant heat strike against the lower ends of the tubes K, against the sides of the passages *k*, and against the walls of the tubes adjacent to the chambers S. The flames and radiant heat also operate upon the inner side of the column O; as the downward flues are in such close proximity to the fire box that combustion is maintained within such flues. The inner and outer sides of the water-legs I′ are thus rendered most efficient in the transmission of heat to the water; while the movement of the gases through the vertical passages Q and the discharge flues N, transmits the heat to the outer sides of the column O, and the heat is thus wholly extracted from the gases before they are discharged from the boiler.

By reference to Fig. 4, it will be observed that the vertical tubes K taper laterally from the top to the bottom, thus intercepting more effectively the gases which rise within the spaces *k*, and therefore absorbing the heat in a greater degree. The tubes are also tapered laterally upon their adjacent sides, as shown in Fig. 8, for the same reason, and where the boiler is used for generating steam, the latter may be slightly heated within the passage J, by forming upon the sides of the same recesses *j* which are extended inward to the outer sides of the vertical tubes K. Such construction is shown in Fig. 8ª, and indicated by the line *j* in Fig. 10, which indicates the boundary of the recess at its ends and upper side.

The recesses may be used with equal advantage in boilers for heating water, as it slightly increases the heating surface of each section.

By my invention, the sections can be made very cheaply and form a most efficient and economical boiler.

Having thus set forth the nature of my invention, what I claim herein is—

1. In a vertical sectional boiler, a flat section formed at the top with the transverse passage J, the water legs J′ extended downward from the ends of the same, the fire box arch I connected to the transverse passage by the series of vertical tubes K and having the water legs I′ connected at the bottom with the water legs J′, substantially as herein set forth.

2. In a vertical sectional boiler, a flat section formed at the top with the transverse passage J, the water legs J′ extended downward from the ends of the same, the fire box arch I connected to the transverse passage by the series of vertical tubes K and having the water legs I′ connected at the bottom with the water legs J′, and the columns O between the water legs, having connection with both at the bottom, through the passage M, and with the transverse passage J at the top, substantially as set forth.

3. In a vertical sectional boiler, a flat section having a transverse passage at the top with vertical water legs at the ends, a fire box arch of less thickness than the section with vertical connections to the transverse passage, and inside water legs connected at the bottom with the outside water legs, a transverse connection between the inside and outside water legs above the bottom, a column between the water legs having connection with both at the bottom, and with the transverse passage at the top, and flue openings in the upper corners of the section outside of the said columns, substantially as set forth.

4. In a vertical sectional boiler, a flat section having the transverse passage J at the top with vertical water legs J′ at the ends, the fire box arch I of less thickness than the sections with vertical connections K of intermediate thickness, between the arch and the passage J, inside water legs I′ and transverse passage L of the same thickness as the section, the transverse connection M a little above the same and of less thickness than the section, flue openings N in the upper corners of the section, and the columns O connecting the transverse passage J with the connection M between the water legs and of the same thickness as the section, to form with the water-legs I′ diving-flues P and passages Q leading to the openings N, substantially as set forth.

5. In a vertical sectional boiler, a flat section having a transverse passage at the top and a fire box arch connected thereto by vertical tubes K and having inner and outer water legs with partition adapted to form the diving-flue P and ascending passage Q, and having flue openings in the corners of the section adapted to lead the gases from all of the passages to the rear end of the boiler, substantially as set forth.

6. In a vertical sectional boiler, a rear section having the water plate T formed with the flue apertures U, U′ the passage J at the top having the full thickness of the section, with the half water leg J′, and half column O′ projected downward from the same, the transverse passage L with half water leg I′ having the full thickness of the section, and the section having inlet and outlet apertures at the top and bottom, substantially as herein set forth.

7. In a vertical sectional boiler, a rear section having the water plate T, with the passage J at the top, the water leg J′, the column O′, transverse connection L, and the inside water leg I′, projecting at one side of the plate to the edge of the section, the half arch I′ and

half tubes K′ projecting from the plate in a lesser degree and the flue apertures U, U′ formed through the plate, substantially as herein set forth.

8. A vertical sectional boiler composed of a series of flat sections secured together and comprising the arches I with intermediate smoke passages *s* above the furnace, a series of diving flues and ascending passages at the sides of the furnace, and openings through the corners of the sections forming in each corner a discharge flue for the ascending passages.

9. A vertical sectional boiler composed of a series of flat sections secured together and comprising the series of arches I with intermediate smoke passages *s* over the furnace, a series of transverse passages J at the top with outlets Q′, openings through the corners of the sections forming a discharge flue, vertical tubes connecting the arches I and passages J, and a series of diving flues connected at the bottom with a series of ascending passages opening into the discharge flue, substantially as herein set forth.

10. A vertical sectional boiler composed of a series of flat sections secured together, and comprising transverse passages J at the top, water legs I′, J′, and columns O fitted in contact with one another, the arches I and transverse connections M of less thickness than the sections, and vertical tubes connecting the arches with the passages J, the sections having diving flues P and ascending passages Q at the sides of the furnace, and discharge flues formed in their upper corners, substantially as set forth.

11. A vertical sectional boiler composed of a series of flat vertical sections secured together and comprising transverse passages at the top, water legs I′, J′ and columns O fitted into contact with one another, the arches I and transverse connections M of less thickness than the sections, vertical tubes K of less thickness than the sections, forming smoke chambers S between the sections with connecting apertures *k*, the sections having the series of diving flues P and ascending passages Q at the sides of the furnace, and discharge flues formed in their upper corners, substantially as set forth.

12. A vertical sectional boiler composed of a series of flat sections secured together, and comprising the series of arches I with intermediate smoke passages *s* above the furnace, a series of diving flues and ascending passages at the sides of the furnace, openings through the corners of the sections forming discharge flues from the ascending passages, a suitable front with fuel and draft doors, and a rear section fitted at its edges to the main sections and formed with half arches and suitable projections to form diving flues and ascending passages, and apertures through the corners of the rear sections, with a smoke box to collect the smoke from such openings substantially as set forth.

13. A vertical sectional boiler composed of a series of flat sections secured together, and comprising the series of arches I with intermediate smoke passages *s* and smoke chambers S between the sections, transverse passages at the top of the sections connected with the arches by vertical tubes K having the intermediate openings *k*, openings through the corners of the sections for discharge flues, the series of diving flues P and ascending passages Q at the sides of the furnace, the latter connecting with the discharge flues, a suitable front with fuel and draft doors and doors for cleaning out the discharge flues, and a rear section formed with the flue apertures U, U′, with the damper V applied to the aperture U, and a smoke box covering the three apertures, as and for the purpose set forth.

14. A vertical sectional boiler composed of a series of flat sections secured together, and comprising the series of arches I with intermediate smoke passages *s* and smoke chambers S between the sections, transverse passages at the top of the sections connected with the arches by vertical tubes K, openings through the corners of the sections for discharge flues, the series of diving flues P and ascending passages Q at the sides of the furnace, the latter connected with the discharge flues, the front plate C with doors for fuel, ashes, and for cleaning out the flues, and a rear section fitted at its edges to the main sections and formed with half arches and suitable projections to form diving flues and ascending passages, apertures U′ through such rear section with corresponding openings through the corners of all of the sections, a direct draft opening U through the middle of the rear section, with the damper V applied thereto, and a smoke box to collect the smoke from all of the apertures, substantially as herein set forth.

15. A vertical sectional boiler composed of a series of flat sections secured together, and comprising a series of transverse passages J at the top, outside water legs extended downward from the ends of the same, the series of fire box arches having vertical connections with the transverse passages, and formed with intermediate smoke passages S, and having inside water legs connected with the outside water legs at the bottom by passages L, the columns O connected with the transverse passages and extended downward between the water legs, with connection to both above the passages L, the cleaning out space L′ above the said passages, the drum R and the outlets R′ connecting the same with the passages J, openings through the corners of all the sections to form discharge flues, and suitable front and rear plates, with a smoke box to collect the smoke from such flues, the whole arranged and operated substantially as herein set forth.

16. A vertical sectional boiler composed of a series of flat sections secured together and comprising the series of transverse passages

J, arches I connected therewith by tubes K, the water-legs I′ and J′ connected by the passages L and M, and the columns O connected to the arches intermediate to their ends by the passages O^3; the whole combined with front and rear plates to close the ends of the fire box, substantially as herein set forth.

17. A vertical sectional boiler composed of a series of flat sections secured together and having outer water-legs connected with a transverse passage at the top, inner water-legs united by arches over the fire and connected at the bottom to the outer water-legs, and columns O extended from the transverse passage at the top downwardly between the water-legs and connected thereto at its lower end, substantially as set forth.

18. A vertical sectional boiler composed of a series of flat sections secured together, and having outside water legs J′ connected with a transverse passage at the top, inside water legs I′ united by arches I over the fire and connected at the bottom to the legs J′, and columns O extended from the passage J at the top downwardly between the water-legs and connected thereto at its lower end, and to the arches I intermediate to its ends, substantially as set forth.

19. In a vertical sectional boiler, a flat section having a transverse passage J at the top with vertical water-legs J′ at the ends, a fire box arch of less thickness than the section, vertical tubes K of greater thickness than the arch connecting the same with the transverse passage J, the lower ends of the tubes being beveled toward the bottom of the arch, and the arch having water-legs connected at the bottom with the water-legs J′, substantially as herein set forth.

20. In a vertical sectional boiler, a flat section having a transverse passage J at the top with vertical water-legs J′ at the ends, a fire box arch of less thickness than the section with its lower edge beveled toward the fire, vertical tubes K of greater thickness than the arch connecting the same with the passage J, with their lower ends beveled toward the bottom of the arch, and the arch having water-legs connected at the bottom with the water-legs J′, substantially as herein set forth.

21. In a vertical sectional boiler, a flat section having a transverse passage J at the top with vertical water legs J′ at the ends, a fire box arch of pear-shape transversely and less thickness than the section, with its tapering edge presented to the fire, vertical tubes K of greater thickness than the arch connecting the same with the passage J, and the arch having water legs I′ connected at the bottom with the water legs J′, substantially as herein set forth.

22. In a vertical sectional boiler, a flat section having a transverse passage J at the top with vertical water legs J′ at the ends, a fire box arch of pear shape transversely and less thickness than the section, with its tapering edge presented to the fire, vertical tubes K of greater thickness than the arch connecting the same with the passage J, with their lower ends beveled to the bottom of the arch, and the arch having water legs I′ connected at the bottom with the water legs J′, substantially as herein set forth.

23. In a vertical sectional boiler, a flat section having a transverse passage J at the top with vertical water legs J′ at the ends, a fire box arch of pear shape transversely and less thickness than the section, with its tapering edge presented to the fire, vertical tubes K of greater thickness than the arch, and tapered laterally from the top to the bottom, with their lower ends beveled toward the bottom of the arch, and the arch having water legs I′ connected at the bottom with the water legs J′, substantially as herein set forth.

24. In a vertical sectional boiler, a flat section having a transverse passage J at the top with vertical water legs J′ at the ends, a fire box arch of pear shape transversely and less thickness than the section, with its tapering edge presented to the fire, vertical tubes K of greater thickness than the arch, and tapered laterally from the top to the bottom, with their lower ends beveled toward the bottom of the arch, inner water legs I′ united by the arch and connected at the bottom with the outer water legs, and columns O extended from the transverse passage at the top downwardly between the water legs and connected thereto at their lower ends, substantially as herein set forth.

25. In a vertical sectional boiler, a flat section having a transverse passage J at the top with vertical water legs J′ at the ends, a fire box arch of pear shape transversely and less thickness than the section, with its tapering edge presented to the fire, vertical water tubes K of greater thickness than the arch, and tapered laterally from the top to the bottom, with their lower ends beveled toward the bottom of the arch, inner water legs I′ united by the arch and connected at the bottom with the outer water legs, and columns O extended upon each side of the section from the transverse passage at the top downwardly between the water legs, and connected thereto at its lower end and to the arch I intermediate to its ends, substantially as herein set forth.

26. In a vertical sectional boiler, a flat section having a transverse passage J at the top, with vertical water legs J′ at the ends, a fire box arch of less thickness than the section, vertical tubes K of greater thickness than the arch and less thickness than the section, the arch having water legs I′ connected at the bottom with the water legs J′, and the transverse passage J having in its sides the recesses *j* extending to the sides of the vertical tubes, substantially as herein set forth.

27. In a vertical sectional boiler, a flat section having a transverse passage J at the top, with vertical water legs J′ at the ends, a fire

box arch of less thickness than the section, vertical tubes K of greater thickness than the arch, and tapered laterally from the top to the bottom with their lower ends beveled toward the bottom of the arch, the arch having water legs I′ of the same thickness as the section, connected at the bottom with the water legs J′, and columns O of the same thickness as the section extended from the passage J downwardly between the legs and connected thereto at their lower ends, substantially as herein set forth.

28. In a vertical sectional boiler, a flat section having a transverse passage J at the top, with vertical water legs J′ at the ends, a fire box arch of less thickness than the section, vertical tubes K of greater thickness than the arch, and tapered laterally from the top to the bottom with their lower ends beveled toward the bottom of the arch, the arch having water legs I′ of the same thickness as the section connected at the bottom with the water legs J′, columns O of the same thickness as the section extended from the passage J downwardly between the legs and connected thereto at their lower ends, and to the arches I intermediate to their ends, and the passage J having in its sides the recesses *j* extending to the sides of the vertical tubes, substantially as herein set forth.

29. In a vertical sectional boiler, a flat section having the passage J at the top with vertical water legs J′ at the ends, a fire box arch of less thickness than the section, vertical tubes K of greater thickness than the arch and less thickness than the section, connecting the arch with the passage J, the water legs I′ having the same thickness as the section and connected at the bottom with the water legs J′, the columns O of the same thickness as the section extended from the passage J downwardly between the water legs and connected thereto at their lower ends and to the arches I intermediate to their ends, the plates O^2 connecting the water legs with the lower part of the columns, and the feet W made integrally with the sections, substantially as shown and described.

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

LAWRENCE R. BLACKMORE.

Witnesses:
IDA M. PHRANER,
THOMAS S. CRANE.