

No. 615,458.

Patented Dec. 6, 1898.

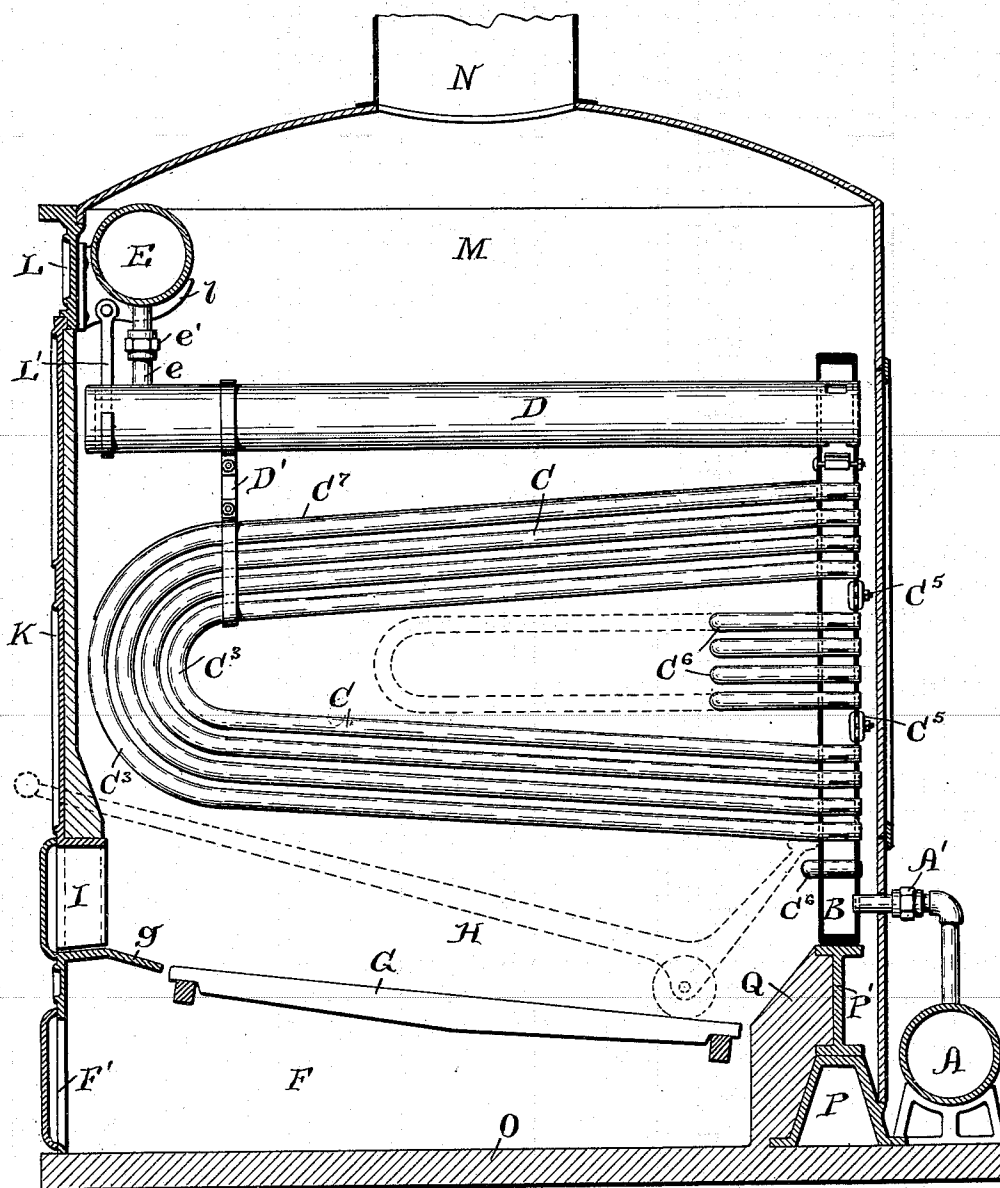
J. A. MILLER.
STEAM GENERATOR.

(Application filed Apr. 10, 1897.)

(No Model.)

3 Sheets—Sheet 1.

Fig. 1.



WITNESSES:

M. F. Bligh.
Chas. H. Luttinger

INVENTOR:

Joseph A. Miller,
Joseph A. Miller & Co.,
Atty.

No. 615,458.

Patented Dec. 6, 1898.

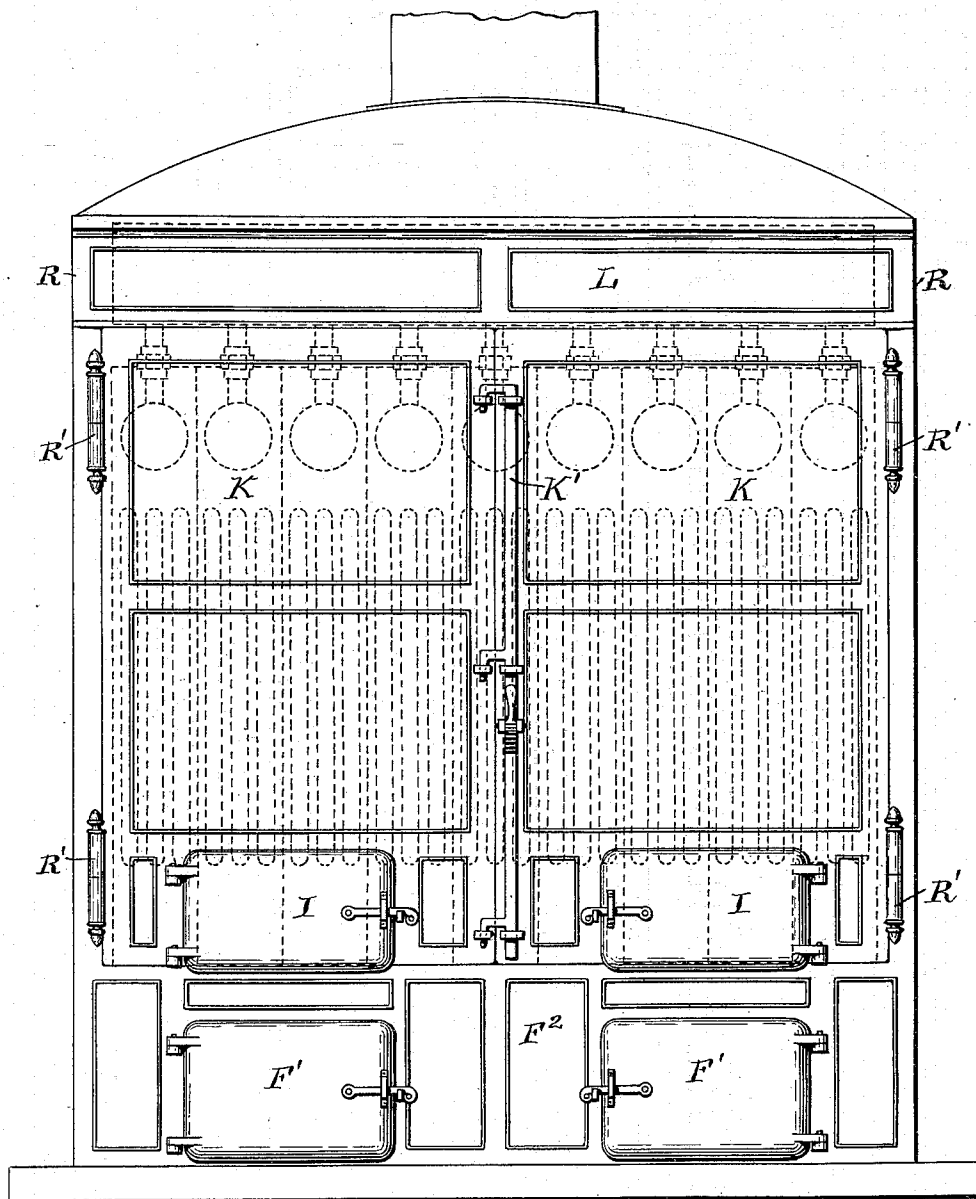
J. A. MILLER.
STEAM GENERATOR.

(Application filed Apr. 10, 1897.)

(No Model.)

3 Sheets—Sheet 2.

FIG. 2.



WITNESSES:

W. F. Bleigh.
Chas. H. Luttinger.

INVENTOR:

Joseph A. Miller,
by Joseph A. Miller & Co.,
attys.

No. 615,458.

Patented Dec. 6, 1898.

J. A. MILLER.
STEAM GENERATOR.

(Application filed Apr. 10, 1897.)

(No Model.)

3 Sheets—Sheet 3.

Fig. 3.

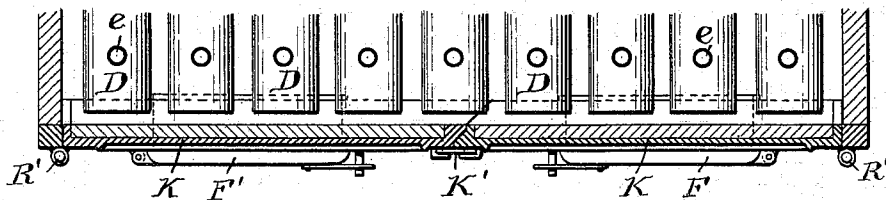


Fig. 4.

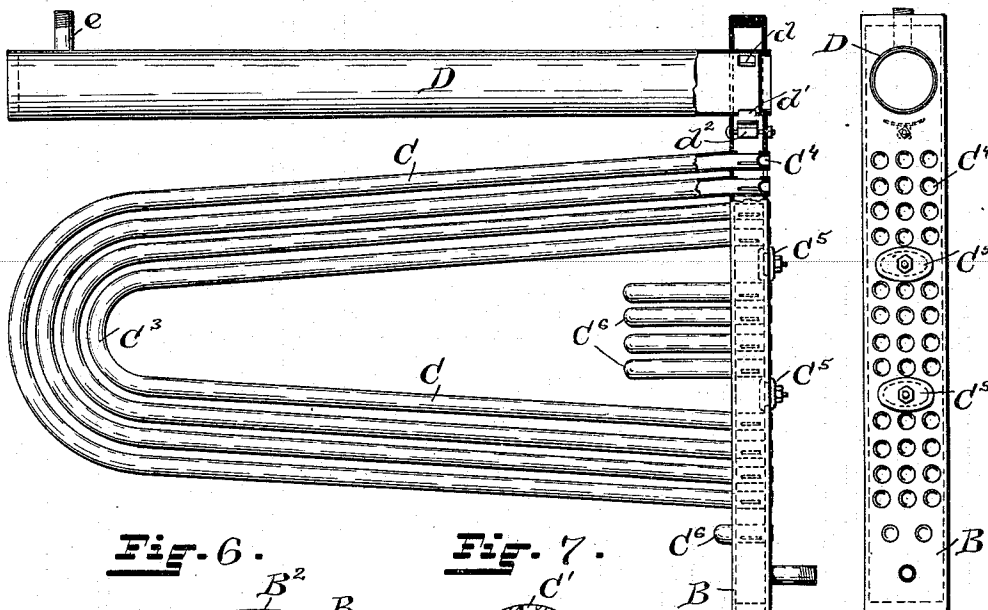


Fig. 5.

Fig. 6.

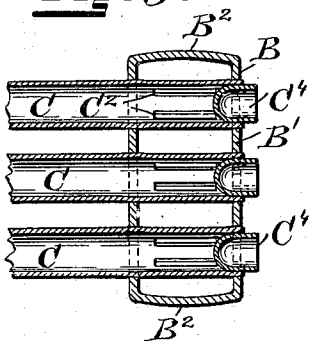


Fig. 7.

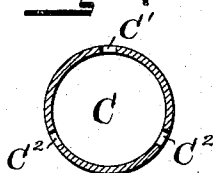


Fig. 8.

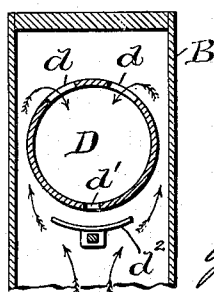
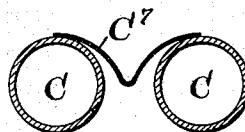


Fig. 9.



WITNESSES:

M. F. Bligh

Chas. H. Luthin

INVENTOR:

Joseph A. Miller,
by Joseph A. Miller & Co.
Attys.

UNITED STATES PATENT OFFICE.

JOSEPH A. MILLER, OF PROVIDENCE, RHODE ISLAND.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 615,458, dated December 6, 1898.

Application filed April 10, 1897. Serial No. 631,543. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH A. MILLER, of Providence, in the county of Providence and State of Rhode Island, have invented a new and useful Improvement in Steam-Generators; and I hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification.

This invention has reference to improvements in water-tubes such as are formed of a series of units or sections, each of which is connected with the feed-water supply and the steam-main.

Tubulous or water-tube boilers, and particularly such as are to be used for marine purposes on board of steamers, should combine the highest possible steam-generating capacity with the least possible weight in the smallest possible space. The room for steam-boilers on board of a ship is necessarily limited, and every ton of weight saved increases the freight capacity of the steamer. As heretofore constructed the fittings connecting the water-tubes exceeded in weight the weight of the steam-generating tubes and a very large number of joints more or less rigid and subject to the strain of the expansion and contraction of the tubes were used. In some types the tubes were expanded into the steam and water chambers, and these had to be made of large diameter, so as to permit the entrance of a person to expand the tubes. Another defect in water-tube boilers as heretofore constructed is found in the connections between the water-tubes and between the discharging ends of the water-tubes and cases, boxes, or fittings into which the steam and water are discharged, for when the ends of such tubes open into a chamber the steam and water are discharged together and means have to be provided for separating the steam from the water. Such open ends permit a free discharge equal to the capacity of the tubes, and when the boiler is forced the rapid generation of the steam forces the water out of the tubes, and the tubes are liable to be burned.

The main difficulties with water-tube boilers have been inaccessibility of the connecting-joints, the difficulty of inspecting and

cleaning the exterior and interior of the steam-generating surfaces, and the difficulty of making repairs.

One object of the invention is to construct a water-tube boiler so that all the steam-generating surfaces shall be formed of sheet metal and all the joints made by expanding the tubes, thus combining the greatest available area of heating-surface and strength to withstand internal pressure with the least possible weight of the boiler when filled with water in actual use.

Another object of the invention is to secure a large heating-surface extending over the fire at or nearly at right angles to the draft of the fire by the use of fewer tubes and fewer connections or joints than heretofore used.

A further object of the invention is to so construct a water-tube boiler that the joints or connections of the tubes shall not be subjected to strains by the expansion or contraction of the tubes.

Another object of the invention is to construct a water-tube boiler so that the units or parts to which the tubes are connected may be light and comparatively small and all the tubes may be readily expanded and secured from the exterior of the connecting-chambers.

Another object of the invention is to construct the ends of the water-tubes so that the discharge of the steam and water is limited and the steam and water separately discharged into the connecting chamber or fitting.

Still another object of the invention is to so construct a water-tube boiler that every joint or connection of the steam-generating tubes may be readily examined and reached while in position and, if desired, when the boiler is in use.

A further object of this invention is to so construct a water-tube boiler that the main heating-surface or the water and steam tubes may be readily reached for cleaning and inspection.

Another object of the invention is to so construct a water-tube boiler that the interior of the steam-generating surfaces may be readily cleaned and inspected, and a further object of the invention is to construct a water-tube boiler so that any one of the units may be

quickly removed and duplicate units inserted without entering the boiler and therefore without waiting to cool the same.

The invention consists in the peculiar and novel construction of the units or sections of which the boiler is made up and the combination of the parts by which the objects of the invention are secured, as will be more fully set forth hereinafter.

Figure 1 is a vertical sectional view of the water-tube boiler, showing one of the units or sections partly in section. Fig. 2 is a front view of the boiler, showing the main portion of the front supported on hinges arranged to open the front, so as to give access to the boiler proper and permit of the removal or insertion of any one of the units or sections. Fig. 3 is a horizontal sectional view of the front end of the boiler, showing the construction of the front doors. Fig. 4 is a side view, partly in section, of one of the sections or units of the boiler; and Fig. 5, a rear view of the section. Fig. 6 is a transverse sectional view of the unit-chamber, showing the ends of the steam-generating water-tubes expanded into both of the flattened sides of the unit-chamber and the slits in the tubes connecting the interior of the tube with the interior of the unit-chamber. Fig. 7 is a transverse section of one of the tube ends, showing the slits, on an enlarged scale. Fig. 8 is a sectional view of the upper end of one of the unit-chambers, showing the steam-separating tube, the inlet-openings for the steam, and the water-trip protected by a deflector. Fig. 9 is a transverse sectional view of two upper steam-generating tubes of two adjacent unit-chambers, showing a plate resting on the two tubes for closing the draft-opening between these tubes.

Similar letters of reference indicate corresponding parts in all the figures.

In the drawings, A indicates the water-main, from which the water is supplied to the boiler. It is provided with the usual connections to the pump and the blow-off, and these connections are supplied with the usual valves. They are not shown in the drawings, as they form no part of the present invention.

B is the section or unit chamber. It is preferably made from a steel tube having the required diameter and length by flattening the tube into the form shown in section in Fig. 6 of practically rectangular section having two flat sides B¹ of greater width than the two slightly-curved sides B². The ends of the unit-chambers B are closed, preferably, by welding a piece into the ends.

C C are the steam-generating tubes. They are bent so as to form loops, and the ends of these tubes extend through the flat sides of the unit-chambers B, being secured by expanding the tubes. The ends of the tubes are closed by means of a plug or cap.

D indicates a steam-separator tube, preferably of larger diameter than the tubes C C. The tube D is secured at one end in the unit-

chamber B, above the tubes C C, preferably by expanding the tube D into the unit-chamber B and closing the end. The opposite end of the tube D is also closed, and near the end it is connected with the steam-chamber E.

The steam-chamber E is provided with the usual steam connections and fittings, which, as they form no part of this invention, are not shown in the drawings.

F indicates the ash-pit; G, the grate; H, the furnace or combination chamber; I, the firing-doors; K K, the two parts of the front supported on hinges, so that the front may be readily opened; L, a beam extending across the front and forming part of the framing of the casing of the boiler; M, the uptake, and N the smoke-flue.

O indicates a suitable foundation for the boiler; P P', the support for the unit-chamber B, and Q the tile or fire-brick lining of the furnace.

The lower part of each unit-chamber B is connected with the water-main A by pipes in which a union-coupling A' is placed, so that any one of the unit-chambers may be readily disconnected.

The ends of the tubes C C are secured in holes bored into the flat sides of the unit-chambers by expanding the tubes. The portion of the tubes within the chamber are provided on the upper side with the long narrow slit C' and near the bottom with the two slits C² in place of the two slits E². One slit may be made into the bottom portion of the tubes, preferably of an area equal to the two slits C² C². These slits radially discharge the steam and water rushing through the upper ends of the bent tubes C C and favor the separation of the steam from the water. The aggregate area of the slits is less than the area of the tube, and the outflow of the water is retarded when the boiler is forced and facilitates the escape of the steam, which always struggles to escape upward and passes through the upper slit C'. The inclined positions of the water-tubes C C and the bends C³ facilitate the separation of the steam from the water within the tubes, thereby preventing the accumulation of steam in the tubes, particularly in the lower portions of the tubes exposed to the direct heat of the fire. The plate C⁷ is placed between the two adjacent upper steam-generating tubes C C of adjoining sections, so as to compel the gases to pass among and between the other tubes and retard the escape of the gases.

In the preferred form of construction shown in the drawings the steam-separator tube D is provided with two inlet-openings d d at the upper part of the portion of the tube D extending through the unit-chamber B and with an opening d' at the lower part of the tube D, and below this lower opening d' a deflector d² is secured, so that when in the normal condition the tube D is partly filled with water the steam and water from the steam-generating tubes C C will be deflected in its up-

ward passage, and the steam, carrying some water with it, will enter the tube D by the upper openings *dd*, as is indicated by the arrows in Fig. 8. While the water in the steam-generating tubes C C and unit-chamber B is in constant and rapid circulation, the water in the tube D is comparatively quiet and presents a large surface from which the steam made in the tube can readily escape and pass into the steam-collecting chamber E.

The steam-chamber E is firmly supported on the brackets *l*, secured to the beam *L* or some other firm and rigid support, and the connecting-pipes *e*, having the union *e'*, form sufficient supports for the ends of the tubes D. These tubes may, however, be suitable straps, such as *L'*. (Shown in Fig. 1.)

While each unit, consisting of the tube D, the unit-chamber B, and the bent tubes C C, is sufficiently rigid when in use, it may be strengthened by the strap *D'*, (shown in Fig. 1,) consisting of a bent iron strap extending around the tube D, the ends of which are bolted to a vertical bar extending from near the tubes C C to near the tube D, and a similar strap inclosing the upper parts of the tubes C C and having ends bolted to the vertical bar to which the upper strap is bolted, or some other similar stay may be used to facilitate the handling and transportation of the units.

The ends of the steam-generating tubes C C when they have been secured into the walls of the unit-chamber B by expanding the tubes with a tube-expander are closed, preferably, by expanding with a suitable expander the cup-shaped caps *C⁴* into the tubes. This firmly secures the caps and holds the same against all practical internal pressure. By extending the tubular portions of the caps beyond the ends of the tubes C a simple tool may be used to crimp the cylindrical portion of the cap *C⁴*, thereby contracting the diameter of the same and permitting the removal of the caps and their reuse. I do not wish to confine myself to the use of this form of caps, as the ends of the tubes C may be closed by screw-plugs or other means.

For the purpose of cleaning or inspection the hand-holes *C⁵* are placed in the parts of the unit-chamber B shown in the drawings or other parts and closed in the usual manner.

Any flat portion of the unit-chamber B not stayed by the tubes C may be stayed by means of the stay-tubes *C⁶*, consisting of short tubes closed at the ends extending into the furnace and open at the opposite ends. These tubes are provided with the slits *C' C²*. They are secured in the unit-chamber, exactly as are the ends of the tubes C, by expanding the tubes with an expander, and the open sides are afterward closed by the caps *C⁴* or otherwise. Bent tubes may, however, be used, as indicated in broken lines in Fig. 1, and located so as to properly stay all parts of the flat surfaces of the unit-chamber B.

The casing inclosing the boiler may be of

sheet metal lined with tile, fire-brick, or asbestos. For marine purposes it must be strongly framed, so as to firmly support all parts under the varying conditions existing on board a ship. The corner-standards *R* are preferably formed of heavy angle-iron or steel. The hinges *R'* are firmly secured to them, so as to support the doors *K K*. These doors extend from the dead-plate *g* to the beam *L*, so that when opened they give access to the furnace and the whole of the steam-generating surface of the boiler for inspection, cleaning, or repairs. When a unit or section is disconnected, a barrow, such as is indicated in broken lines in Fig. 1, may be rolled in on the grate and a section drawn out and in the same manner a section quickly inserted. The fire-doors *I* form part of the doors *K*, while the ash-pit doors *F' F'* form part of the fixed lower casing *F²*. Suitable bolts, such as the bolts *K'*, are provided to firmly secure the doors *K* when the boiler is in use.

The units or sections which form the steam-generating part of the boiler are formed entirely of sheet metal. They are for equal area of heating-surface and capacity to withstand internal pressure of less weight than water-tube boilers as heretofore constructed. All the joints are made by expanding the tubes into the tube-sheets, preferably by a roller-expander, such as is now used to expand boiler-tubes into the tube-sheets. The tubes are all free to expand and contract without exerting any strain on their fastenings due to such expansion or contraction.

When repairs are required, the doors *K K* are opened, the fire is drawn, the section requiring repair is disconnected from the steam and water chambers, and the section may be drawn out without waiting for the boiler to cool, another section may be inserted and connected, and the fires started. The repairs are made while the section is outside, and no one has to enter the boiler or crawl into any contracted spaces to tighten a joint or make any repairs. In cleaning the boiler by opening the doors *K K* all the steam-generating surface may be swept or cleaned by a broom or scraper.

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

1. A water-tube boiler made up of a series of units or sections, having each a vertical unit-chamber, a series of bent tubes forming a continuous practically U-shaped loop both the ends of which extend through the unit-chamber and are secured in both sides of the same, and connections between each unit-chamber and the water and steam mains, whereby joints and fittings are avoided and the heating-surface exposed to the fire is formed of tubes both ends of which are secured to the same vertical chamber, as described.

2. In a water-tube boiler, the combination

with the furnace, the uptake and the inclosing casing, of a series of units or sections each consisting of a vertical unit-chamber, a series of bent tubes forming a continuous
 5 loop both ends of which extend through the unit-chamber and are secured to the two sides of the same by expanding the tubes, a tube secured in the unit-chamber above the bent
 10 tubes and connections between the water and steam mains and each section or unit, whereby the steam generated in the bent tubes is separated from the water, as described.

3. In a water-tube boiler, in combination, the furnace with its grate, fire-door and ash-
 15 pit, a unit-chamber of practically rectangular cross-section supported in the rear of the furnace, its lower part connected with the water-supply, a series of bent tubes forming
 20 a continuous loop the ends of which extend through and are secured to both sides of the same unit-chamber, said bent tubes extending from the unit-chamber over the furnace, connections between the steam-main and the
 25 upper part of the unit-chamber and a casing inclosing the boiler the front of which is constructed so as to be opened, whereby the steam-generating tubes of each section or
 30 unit are free to expand and contract and convenient access may be had to the steam-generating surface for cleaning and inspection, as described.

4. In a water-tube boiler, the combination with a series of sections or units each consisting of a vertical chamber from which extend
 35 a series of bent tubes forming continuous loops the ends of which are secured to the vertical chamber, the furnace, the grate and ash-pit, of a casing inclosing the boiler, the front of which casing, from the dead-plate
 40 upward to the top of the sections, is pivotally supported and adapted to be swung open, whereby any one of the units or sections may be removed and the steam-generating surface conveniently cleaned, as described.

45 5. In a water-tube boiler, the combination with the series of units or sections consisting each of a vertical unit-chamber, a series of bent tubes forming a continuous loop both
 50 ends of each bent tube secured in the unit-chamber, said bent tubes projecting from the unit-chamber in the rear of the furnace forward over the fire, of a casing inclosing the boiler, the front of which having the door or
 55 doors K, the fire door or doors I forming part of said door or doors K, the hinges R' and the bolts K', whereby the front of the casing may be opened and free access had to all

parts of the steam-generating surface between the grate and the uptake for cleaning, inspection and repairs, as described. 60

6. In a water-tube boiler composed of a series of sections or units, the combination with the unit-chamber B having the flat sides B', B', of the bent tubes C, C, forming a continuous
 65 loop the two ends of each bent tube being secured in both of the flat sides B', B' of the unit-chamber, openings in the sides of the tubes connecting the interior of the tubes with the interior of the unit-chamber, the
 70 caps C', consisting of a tube closed at the inner end and secured by expanding the open-end tubular portion into the open end of the tubes, by which the ends of the tubes are closed, and connections between the steam
 75 and water mains and the unit-chamber, whereby the tubes forming the steam-generating surface extending from the rear to the front of the boiler over the fire are free to expand and contract and the joints are protected against the direct action of the fire. 80

7. In a water-tube boiler composed of a series of sections or units, the combination with the unit-chamber B and the series of bent tubes C, C, of the tube D, the inlet-openings
 85 d , d at the upper part of the tube, the opening d' at the lower part of the tube and the deflector d^2 , whereby the separation of the steam from the water is facilitated, as described.

8. In a water-tube boiler, in combination, 90
 a series of sections or units, each consisting of a unit-chamber of practically rectangular cross-section and extending vertically from a suitable support in the rear of the furnace, a series of bent tubes extending from the unit-
 95 chamber forward over the fire, the ends of said tubes being expanded into two of the flat sides of the unit-chamber and the extreme ends closed, a steam-separating tube secured in the upper part of the unit-chamber above the bent tubes, connection with
 100 the steam and water mains, a casing inclosing the boiler, the front of which is formed of a hinged door or doors, whereby when repairs are required a section may be quickly
 105 removed and another section inserted without entering the boiler, as described.

In witness whereof I have hereunto set my hand.

JOSEPH A. MILLER.

Witnesses:

JOSEPH A. MILLER, Jr.,
 M. F. BLIGH.