(No Model.) 3 Sheets—Sheet 1.

N. B CLARK & F. B. KING.

STEAM BOILER.

No. 421,387. Patented Feb. 18, 1890.

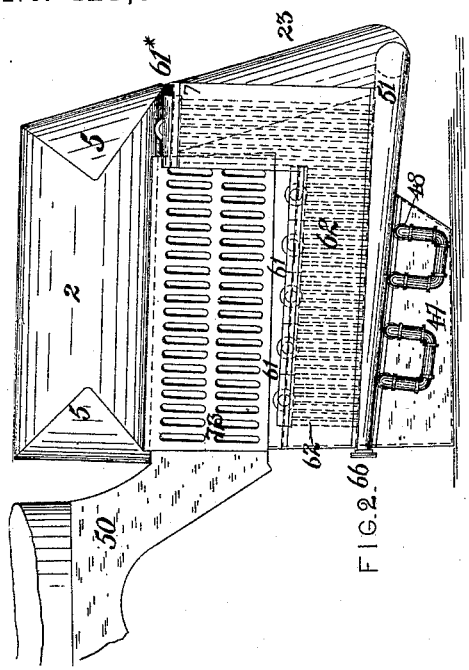

FIG. 2.

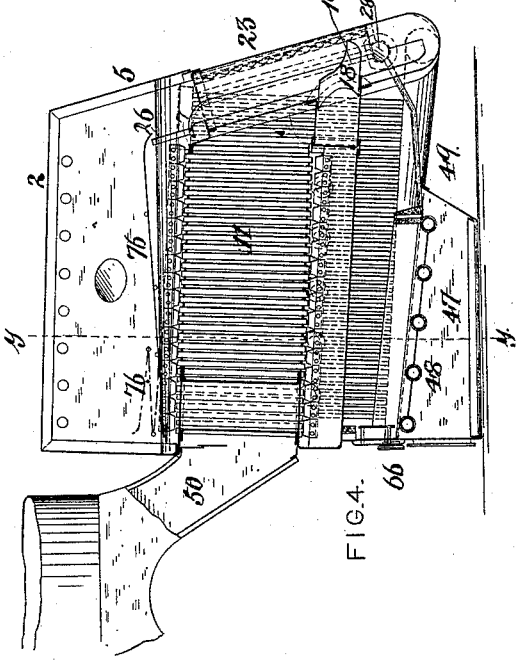

FIG. 4.

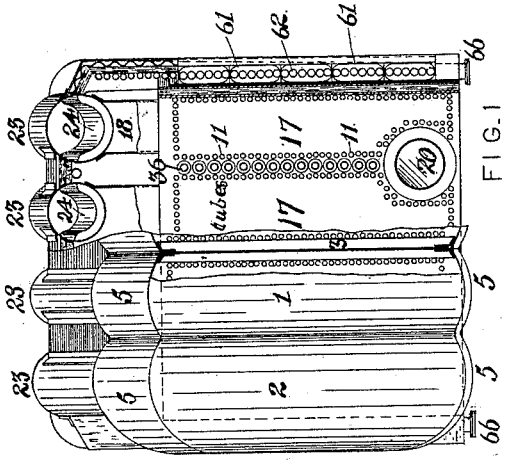

FIG. 1

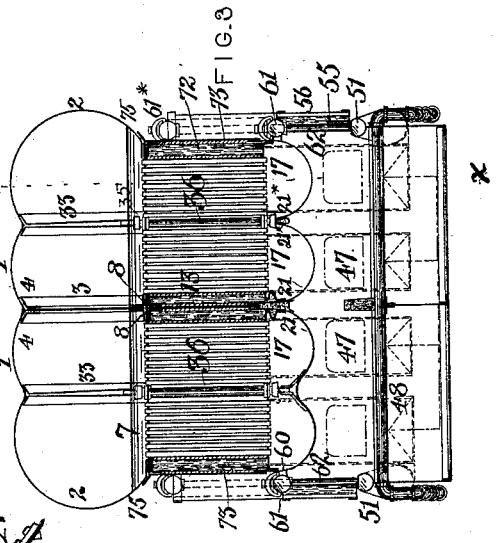

FIG. 3

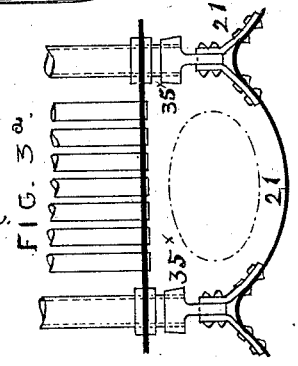

FIG. 3a.

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STEAM BOILER.

No. 421,387. Patented Feb. 18, 1890.

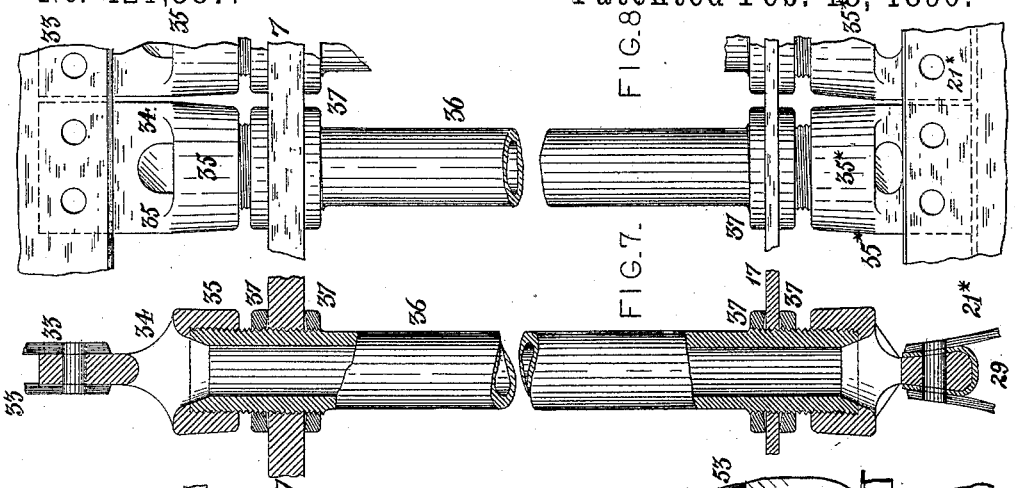

FIG. 8.

FIG. 7.

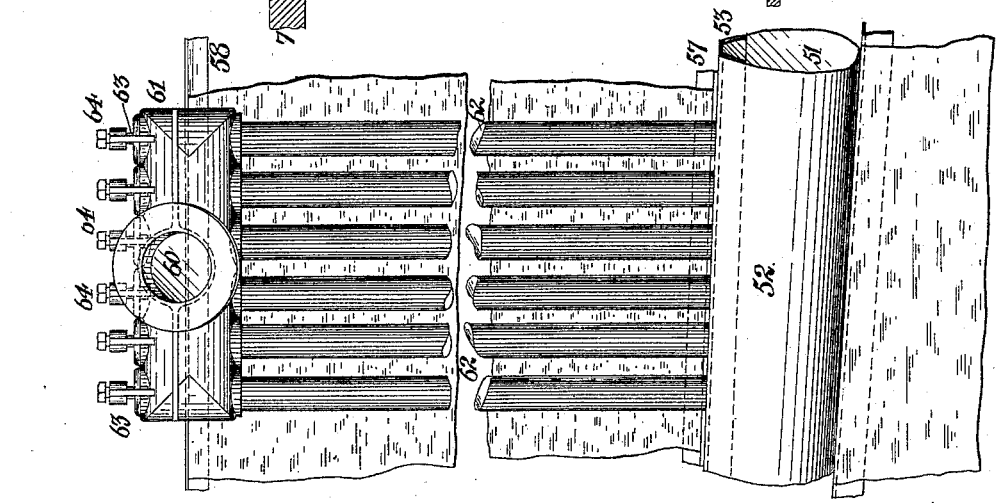

FIG. 6.

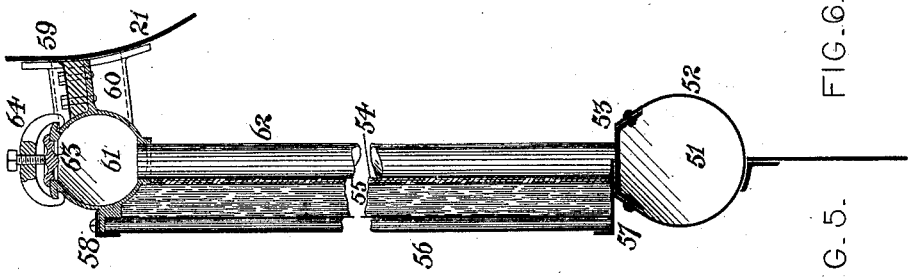

FIG. 5.

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STEAM BOILER.

No. 421,387. Patented Feb. 18, 1890.

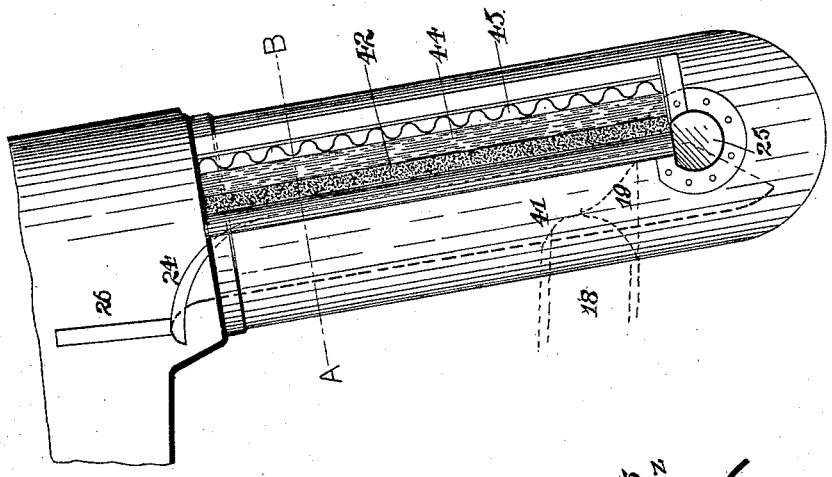

FIG. 11.

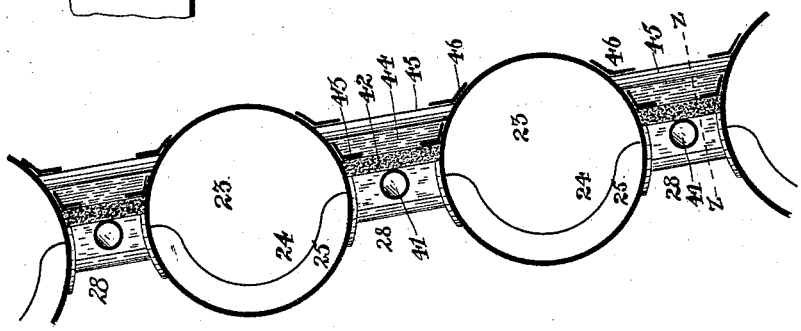

FIG. 10.

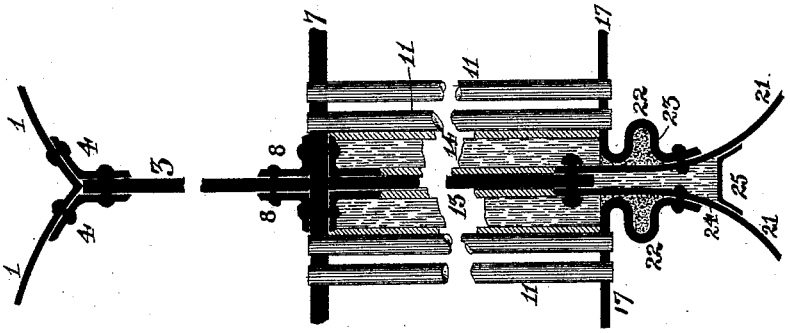

FIG. 9.

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UNITED STATES PATENT OFFICE.

NATHAN B. CLARK, OF UNITED STATES NAVY, AND FRANK B. KING, OF WASHINGTON, DISTRICT OF COLUMBIA.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 421,387, dated February 18, 1890.

Application filed June 8, 1889. Serial No. 313,548. (No model.)

To all whom it may concern:

Be it known that we, NATHAN B. CLARK, United States Navy, and FRANK B. KING, both residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to steam-boilers, and is especially intended for marine boilers, although applicable to other uses.

The object of the invention is to produce a boiler in which the parts shall be strong and somewhat elastic, the circulation rapid, and the casing exposed to the fire shall be largely protected by water-tubes.

Figure 1 is a top plan with part broken away to show a longitudinal section on the level of the water-tubes, which are partly omitted. Fig. 2 is a side elevation with part of casing removed. Fig. 3 is a cross-section about on the line of one of the water-pipes forming grate-supports, say on line *y y*, Fig. 4. Fig. 3ª is an enlarged detail of Fig. 3. Fig. 4 is a longitudinal section about on line *x x*, Fig. 3. Fig. 5 is a broken sectional detail of the manifold and side casing. Fig. 6 is a broken inner side elevation of manifold and casing. Fig. 7 is a broken detail of one of the connecting-tubes and ties, partly in section. Fig. 8 is a similar side view of detail, Fig. 7. Fig. 9 is a broken cross-sectional detail of central tie-plate and fastenings. Fig. 10 is an enlarged horizontal section of downcast conduit protecting tubes and casing on lines A B, Fig. 11. Fig. 11 is a section about on line *z z*, Fig. 10.

The shell of the boiler is composed of continuous convoluted sheets of metal, the convolutions consisting of arches or curves of different radii, there being a reverse curve of small radii between each two arches of large radii. Tie-braces are attached tangentially to the large arcs. The small arcs may be very small, and need not necessarily conform to a circle.

The numeral 1 indicates the shell-plate of the intermediate top sections, of which any convenient number may be employed.

2 2 denote the side shell-plates.

The plates forming the top shell may be integral or not. The plates at the junction of the arches 1 1 are secured to a tie-plate 3, the joint-pieces being stayed or strengthened by angle-plates 4 4, held by rivets or bolts in any usual manner. The front and rear end walls of the arched portions of the shell are formed of convolute plates 5 5, as indicated in Figs. 1 and 2 of the drawings. The tie-plate 3 is held to the tube-sheet 7 at the lower edge by angle-pieces 8 8. The bottom member of the boiler is somewhat similar to the top member, having arches or convolutions in reverse direction and having the edges of the arches connected to the bottom tube-sheet 17. The space between the tube-sheets 7 and 17 is pretty well filled with vertical water-tubes 11. A plate 13 below the tie-plate 3 connects the tube-sheet 7 to the bottom member of the boiler. The lower edge of plate 13 is riveted or otherwise fastened to the upturned edges of the arched or convolute plates 21, which form the shell of the lower member of the boiler. (See Fig. 9.)

The tie-plate and casing at the sides of the space filled by tubes 11 are substantially like the tie-plate 13, but protected on the inner surface only. The plate 3 is preferably perforated, and plate 13 may also be perforated for lightness. Plate 13 is protected by asbestus, soapstone, or other refractory slabs or sheets 14, and the water-tubes 11 next these protective sheets serve to protect them also from the intense heat of the flame which passes between the tubes 11. The edges of the lower tube-sheet 17 are corrugated at 22, and riveted to the arch-plates below the corrugations to permit a slight elasticity and difference of expansion in the parts. The space 23 within the corrugations may be filled with asbestus or other refractory packing, and the space 24 between the edges of the arch-plates may be similarly filled, the latter filling being retained by binding-strips 25, secured to the arches. The side plates 2 and the central shell-plates 1, Fig. 3, are riveted or otherwise fastened to tie-plates 33—one at each side of the entering angle or curve. Tie-plates 33 reach down nearly to the

tube-sheet 7. The lower edges of the plates 33 are bolted or otherwise fastened to flanges 34 on open thimbles 35, which thimbles have internal screw-threads. Tie-tubes 36 extend from the upper thimbles 35 to a corresponding set of thimbles $35^{\times}$, to which the upturned edges $21^{\times}$ of the lower arched plates 21 are bolted or riveted. (See Figs. 7 and 8.) The convolute plates are secured at the convolutions by angle-plates $21^{\times}$ to the thimbles. Thus the plates constituting the arches may be of any width which is a multiple of an arch, the edges of sheets being secured and the convolutions braced. The openings through the tube-sheets 7 and 17, through which the tie-tubes pass, may be stopped by packing bushes with grommets 37, which engage the external screw-threaded portion of the tie-tubes 36 and hold the tube-sheets fast to the tie-tubes. As the upper arched plates 2 throw a heavy stress on the tube-plate 7, it is advisable that this tube be thicker than plate 17. This plate 7 forms a transverse tie between the sides of the boiler. The upper arched sections of the boiler are connected to the lower reversed sections, at the rear of the fire-box, by downcast conduits 23, which may connect with a slight offset at the rear of the tube-sheet 7. The downcast conduits 23 extend below the level of the lower arches 21, and each downcast connects with a corresponding lower arch by a conduit 18, which terminates inside the downcast in a scoop or spoon 19. The downcasts 23 are of ample capacity and convey large volumes of water from the upper to the lower arches, the scoops 19 tending to deflect the downwardly-moving current into the lower arches.

As the side of the downcasts 23 toward the fire-box will be exposed to intense heat, there will be a tendency to the formation of an upward current of mixed steam and water on this face of the downcasts. Curved shields 24 are therefore placed in the downcasts near this face, forming curved chambers 25, up which the steam and water may pass, as shown in Figs. 10 and 11. These plates 24 are curved forward at the upper ends to catch the steam, and pipes 26 extend upward to convey steam up into the steam-space of the boiler. The downcasts 23 are connected together below the pipes 18 by cross-pipes 28, and below the conduits may form sediment-traps. The cross-pipes 28 are connected to the tube-sheet 7 by tubes 41, Figs. 10 and 11. These tubes serve as supports for the refractory plates of the tile soapstone or similar packing 42, which are held against the tubes and downcasts by angle-plates 43, secured to the downcasts. Non-conducting filling 44 may be placed outside these refractory fire-plates, and corrugated metallic sheets 45, with inclosed air-spaces, will still further prevent radiation. The outer angle-plates 46 hold all this part of the casing to the downcasts.

While asbestus and like materials are not very durable when exposed to the intense heat of such a furnace as we employ if fully exposed to the flame, it is found that a protection by water-pipes covering a part of the surface adds greatly to the durability. Thus the downcasts 23 and water-tubes 41 protect the casing 44 45 46 quite efficiently. (See Figs. 10 and 11.) Should the length of the arches be great, the front of the top member may be connected to the bottom member by a large downcast 20, extending from tube-sheet 7 to tube-sheet 17. The theory of upward circulation through small water-tubes and downward circulation through large tubes is well understood.

The direction of the hot gases is from the furnace 47 backward under the bottom boiler member to the downcasts 23, then upward and forward between the tubes 11 and 36, and out at the uptake 50 to the slack or elsewhere.

The inside walls of the furnace are protected by manifolds of peculiar construction, which materially augment the heating-surface of the boiler.

From the downcasts 23, at each side of the boiler, pipes 51 extend forward to the front end of the furnace to supply water to the vertical tubes of the manifold. (See Fig. 2.) These pipes should taper, as the water-supply will be proportioned to the distance from the downcast, and a convenient construction is shown in Figs. 5 and 6, where the bottom and sides of the pipe are shown composed of a horseshoe curved plate 52 and the top of a flat plate 53, flanged downward, the joints being riveted.

The lower boiler member has branches 60 leading to manifold boxes 61 about on a level with the top of the furnace and parallel with pipes 51. The boxes 61 are short sections and can be separately replaced. The rear box $61^{\times}$ is connected to the top member of the boiler instead of the bottom member. The boxes 61 are made of short lengths, with single points of attachment, in order to overcome the effects of expansion and contraction.

Each manifold box 61 has a number of water-tubes 62 connected to pipe 51, these water-tubes forming the inner side wall of the furnace. The box 61 should be long enough to contain about six of these tubes 62, and at the top of the box, over each tube, there is a hole covered by a cap 63, held down by a suitable clamp 64. The caps 63 may be removed and the tubes 62 withdrawn through the opening, the tubes being secured or expanded into place in usual manner.

Outside the tubes 62 we place plates of soapstone, fire-brick, or other refractory material 54, then a packing of asbestus or similar material 55, and then a covering of corrugated metallic plates 56, this outer covering being supported by angle-plates 57 and removable fastenings 58. The space between tubes 60 may be closed by a refractory covering 59.

The side walls of the tube-space filled with

tubes 11 are covered by light open plates 73, similar to plate 13, said plates 73 being protected by the adjacent tubes 11, against which the refractory covering 72 rests. The joints are strengthened by angle-plates 75.

The front ends of pipe 51, Figs. 1, 2, and 4, should have removable caps 66, through which the pipes may be cleaned.

Inside the top member of the boiler there may be an anti-priming shield 76, composed of thin metallic plates jointed together, so as to fold back inside the shell, as shown in dotted lines, Fig. 4, thus giving access to the upper ends of tubes 11 for cleaning or replacement. It will thus appear that the skeleton of the furnace is composed of the grate, vertical water-tubes at the sides, and nearly vertical downcasts at the rear, the top of the furnace being the arches of the lower boiler member. The heat from the furnace passes backward, then upward between pipes 18, then forward among water-tubes 11 and 36, and so to the uptake. The tubes 36 are heavy, and will not require replacement. Tubes 11 can be readily replaced.

It will be seen that there is considerable elasticity allowed in some parts of the structure, as in the connections of shell-plates 2 21 to their respective tube-sheets. All small parts exposed to high temperature can be removed and readily replaced. The boxes 60 are preferably malleable castings. The shell-plates are preferably rolled sheets of steel.

What we claim is—

1. A boiler consisting, essentially, of a top member composed of connected arched sections, a bottom member of sections arched in reverse direction, and downcasts at the rear connecting the two members and extending below the lower arches, thus forming a rear water-wall to the furnace, substantially as described.

2. A steam-boiler consisting, essentially, of a top member composed of connected arches, a bottom member composed of arches in reverse directions, tie-plates connecting the curves formed by the junction of the arches to the transverse tube-sheets, and ties connecting these tie-plates, and also the tube-sheets, all combined substantially as described.

3. A boiler-shell consisting, essentially, of a series of horizontal arches connected together side by side, the ends of said arches consisting of a similar number of substantially vertical arches united at their edges to the horizontal arches, substantially as described.

4. The combination of the top arched sections connected at the inturned angle to a tie-plate, the bottom arches connected to a tie-plate, and a connection uniting the said tie-plates to the top and bottom members, substantially as described.

5. The combination of the top arched member, the bottom arched member, tube-sheets to which the arches are connected, and a tie-plate extending from one tube-sheet to the other, substantially as described.

6. The combination with the top and bottom members having tube-sheets facing each other, a tie-plate between the tube-sheets, and a refractory protective covering for said tie-plate, substantially as described.

7. The combination of the top and bottom members, substantially as described, tie-plates connecting the same, a refractory covering for said tie-plates, and water-tubes connecting the boiler members and bearing against the said refractory covering, substantially as set forth.

8. The combination, with the arched shell-plates, of ties connecting the edges of the top and bottom plates to open thimbles and tubes connecting said thimbles, substantially as described.

9. The top and bottom arched members, the tube-sheets facing each other, ties connecting the edges of the arches to open thimbles, as described, and tie-tubes connecting the thimbles and passing through and tied to the tube-sheets, all the elements in combination, substantially as described.

10. In a steam-boiler, the combination of an outer shell composed of convolute sheets, tie-pieces secured to the sheets at the lines of contra flexure, and ties joining these tie-pieces from the opposite sides of the boiler, substantially as described.

11. In a steam-boiler of the character described, the combination, with an inturned arch-plate, of the flue-sheet secured thereto, one of said plates having a corrugation near its edge to permit a slight elasticity and allow for expansion.

12. The combination, with the tube-sheet and the shell-plate, one of the plates having a corrugation near the joint, of a non-conducting packing filling said corrugation, substantially as described.

13. The combination, with the inturned edges of the arched plates, as 21, of a tie-plate to which said arches are secured, a non-conducting or refractory packing between the edges of the arches, and a supporting-piece for said packing, substantially as described.

14. The combination, with the top and bottom members, of the downcast conduits connecting the two and a shield inside the downcast, forming a partition separating that part next the fire from the main part of the downcast.

15. The combination, with the downcasts, of deflecting curved shields inside the same and steam-pipes 26, extending through and above the deflecting-shields.

16. The combination, with the arched top and bottom members and downcasts connecting the arches of said members, of cross-tubes connecting said downcasts, substantially as described.

17. The combination, with the top and bot-

tom members, downcasts, and connecting-pipes, of the refractory covering resting on said pipes and secured to said downcasts, substantially as described.

18. The top and bottom members, downcasts connecting the same, and cross-pipes and vertical pipes connecting said cross-pipes to the top member, and a refractory covering or casing resting against said vertical pipes and downcasts, all combined substantially as described.

19. The combination of the upper and lower members and downcasts, the refractory casing between the downcasts, the outer covering of said casing, consisting of corrugated plates, and the angle-plates by which said casing is secured to the downcasts, substantially as described.

20. The combination, with one of the boiler members and a box at the side thereof, of a tapering pipe extending nearly parallel with said box and connected to the main boiler-sections and to said box by vertical tubes, substantially as described.

21. The combination, with the arched boiler member, the box connected therewith, and vertical tubes leading to said box, of the downcast and branch pipes 51, leading therefrom to said tubes, said pipes composed of a tapering horseshoe-shaped trough, and a flat flanged cap through which the vertical tubes pass, as set forth.

22. The combination, with the arched bottom member, the boxes connected thereto, and the downcast and branch pipes, of the vertical tubes connecting said boxes and branch pipes and the refractory casing resting against said vertical tubes.

23. The combination, with the top and bottom members and vertical water-tubes, of a jointed deflecting-plate in said top member, substantially as described.

24. The steam-boiler described having a shell composed of continuous convoluted plates disposed horizontally and vertically forming similar arches, the concave faces of said arches being toward each other at top, bottom, and sides of the boiler, all secured together and tied in by braces attached so as to draw tangentially on the curved surfaces.

In testimony whereof we affix our signatures in presence of two witnesses.

NATHAN B. CLARK.
FRANK B. KING.

Witnesses:
WILLIAM W. BROWN,
JOHN R. FARNUM.