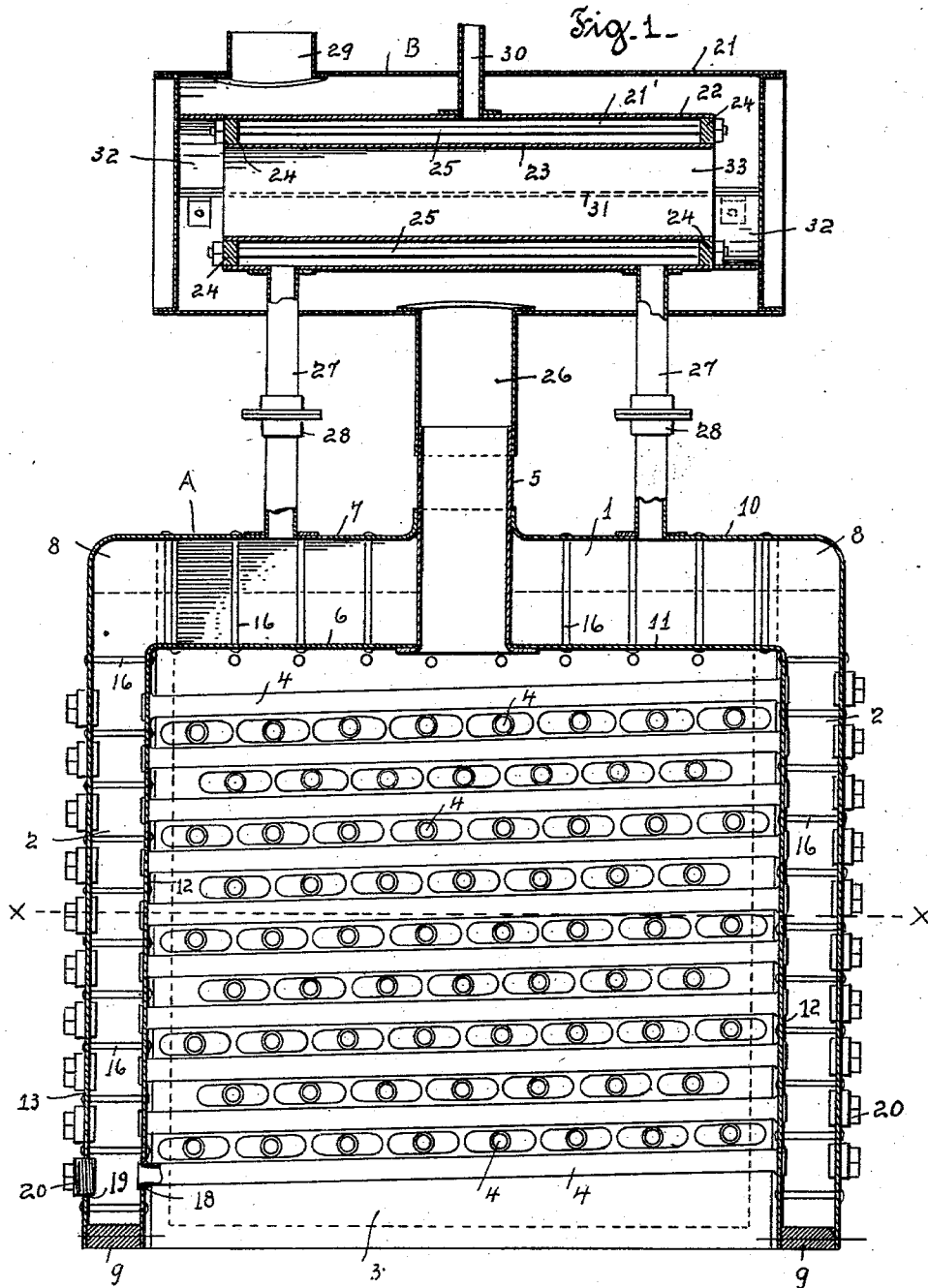


J. DENEAL.
STEAM GENERATOR.

APPLICATION FILED DEC. 23, 1901.

NO MODEL.

2 SHEETS—SHEET 1.



Witnesses—
Chas. A. Boake
Geo. A. Whitney

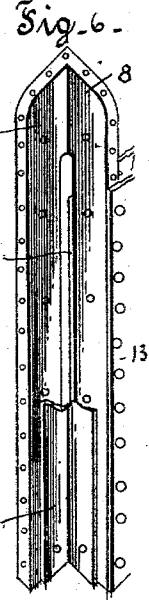
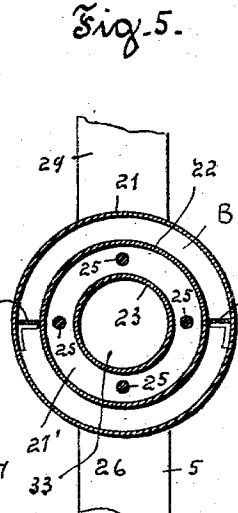
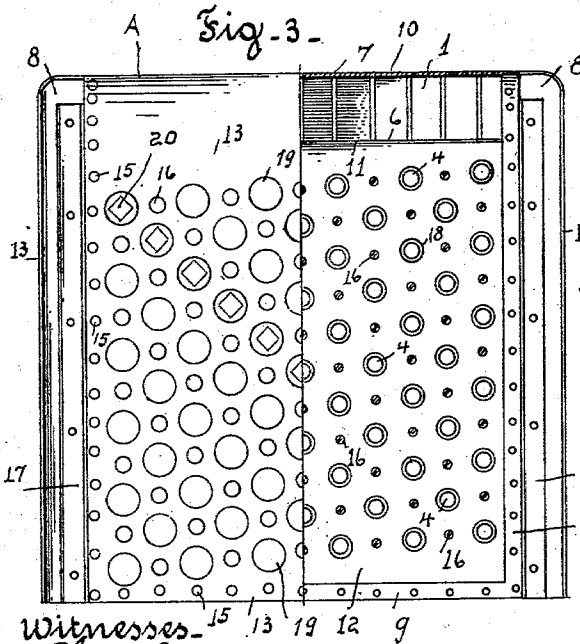
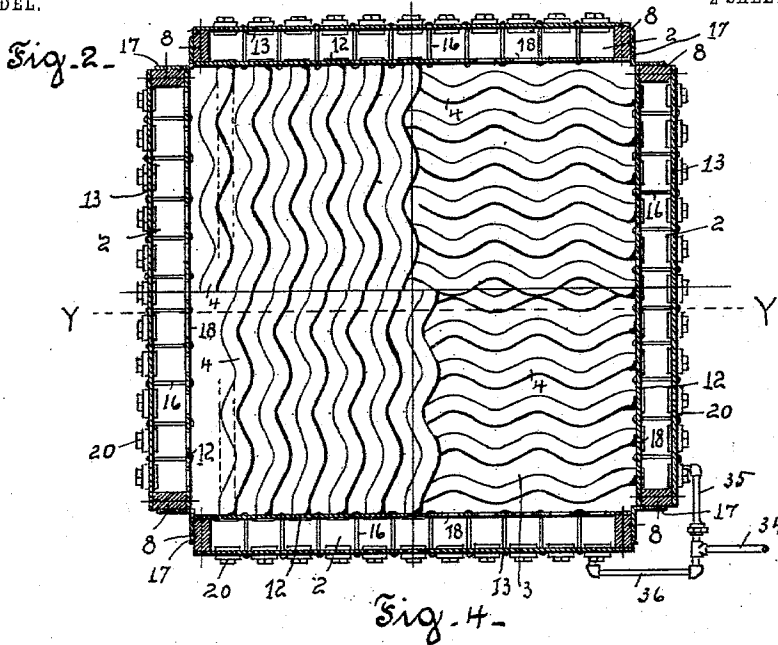
Inventor—
Jackson Deneal
By Wilson & Martin
his Attorneys

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2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

JACKSON DENEAL, OF TOLEDO, OHIO, ASSIGNOR OF TWO-FIFTHS TO
STEPHEN BROPHY, OF TOLEDO, OHIO.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 717,823, dated January 6, 1903.

Application filed December 23, 1901. Serial No. 86,914. (No model.)

To all whom it may concern:

Be it known that I, JACKSON DENEAL, a citizen of the United States, residing at Toledo, in the county of Lucas and State of Ohio, have invented a new and useful Improvement in Steam-Generators, of which the following is a specification.

My invention relates to a steam-generator of the water-tube type, and has for its object to provide a compact, durable, economical, and highly-efficient generator of the kind having a proportionately large area of heating-surface and adapted to rapidly generate steam and utilize an increased percentage of the heat produced from the fuel.

A further object is to provide a generator of the kind in which the water-tubes are readily accessible for cleaning, easily detached for repair, and adapted to expand and contract without causing leakage.

I accomplish these objects by constructing a generator as hereinafter described, and illustrated in the drawings, in which—

Figure 1 is a vertical section through the boiler on line Y Y of Fig. 2. Fig. 2 is a horizontal section through the same on line X X of Fig. 1. Fig. 3 is a part elevation and part section of the boiler. Fig. 4 is a modified form of water-tube shown in Fig. 1. Fig. 5 is a cross-section through the heater, and Fig. 6 is an isometric view of a corner-frame.

In the drawings, A is a generator comprising the boiler 1, having the water-legs 2, forming the inclosed combustion-chamber 3 and connected by the water-tubes 4, and B is a heater mounted on the boiler and connected to the combustion-chamber 3 by the flue 5 and adapted to further utilize the heat escaping through the flue. The boiler 1 and water-legs 2 are formed, preferably, of the crown-sheet 6, the outer sheet 7, the corner-frames 8, and the bottoms 9, as hereinafter described. Sheets 6 and 7 are each shaped in the form of the heraldic cross humette and are each formed by cutting equal squares from the corners of a square sheet of metal, the outer sheet 7 being formed from a proportionately larger sheet than sheet 6 is cut from. The arm portions of sheet 7 are of equal width with the arm portions of sheet 6, but are of greater length, and the central squares 10

and 11 of the two sheets are equal. The sheets 6 and 7 being thus shaped to form the boiler and legs, the arms of sheet 6 are bent at right angles to its center square 11 at their junction therewith to form the inner or tube sheets 12 of the legs, and the arms of the sheet 7 are curved outward and downward from their junction with the center square 10 of the sheet to form the outer or plug sheets 13 of the legs perpendicular to the plane of the square 10. Thus formed, sheet 7 is imposed over sheet 6, standing on its bent arms, with the plug-sheets 13 parallel with the tube-sheets 12 and the square 10 parallel with the square 11. In this position the bifurcated corner angle-frames 8 of the form shown in Fig. 6 are inserted between the plates 12 and 13 at each corner and secured therein by rivets 15, extending through both plates and the frame. The bottom openings of the legs thus formed are closed by bars 9, similarly riveted, which completes the boiler-shell and its legs 2. At suitable intervals throughout the area of the shell and the legs are provided stay-bolts 16, extending through the sheets. The open corners between the legs are closed by the detachable angle-plates 17, secured to the corner-frames 8 by tap-bolts threaded into the frames. Opposite tube-sheets 12 are provided with transverse orifices 18 for the tubes 4, which are alined in rows slightly inclined from the horizontal at regular intervals from the top to the bottom throughout the area of the sheets, the rows of orifices of one sheet being relatively lower than the rows of orifices in the opposite sheet of the pair, whereby when the ends of the tubes 4 are secured in the orifices of opposite sheets 12 each of the tubes will be inclined at the same angle as the individual tubes relative to the sheets of the other pair, the orifices of which are set in inclined rows opposite the intervals between the rows of the first pair.

In the outer sheets 13, in alinement with and opposite each end of the tubes 4, are provided the threaded orifices 19, into which are threaded the plugs 20, of a diameter slightly greater than the orifices of the tubes. When the ends of tubes 4 are inserted in the orifices 18, they are secured therein by an expander inserted through the orifices 19, by which the

tubes are expanded and beaded to engage the tube-sheet in the usual manner, and the plugs 20 of any tube being removed the tube may be tightened or removed without interfering with or removing any other tube or tubes. By the arrangement of the tubes as shown and described the area of heating-surface is very greatly increased proportionate to the dimensions of the generator. The tubes are preferably formed laterally sinuous, with the sinuations all on one side of the line of the tube, as shown in Fig. 2; but they may be alternate on opposite sides, as shown in Figs. 1 and 4, whereby the linear expansion of the tubes is taken up by the curves of the tubes without straining or loosening their connections with the tube-sheets 12, and the heating-surface is thereby further increased. When the curves are on one side of the tubes only, as in Fig. 2, the tubes of each row are set with the curves in one direction, the direction being reversed in alternate rows between each pair of legs, as illustrated in Fig. 2, wherein in the upper left quarter is shown the top row between one pair of legs, in the upper right quarter the top row between the other pair of legs, and in the lower left and right quarters, respectively, the second row between each pair of legs, by which arrangement it will be seen that there are no direct vertical lines of draft between the tubes and that a larger number of tubes may be used, thereby increasing the heating-surface as well as increasing direct contact of each tube with the heated gases, utilizing a larger percentage of the heat and causing a more rapid generation of steam. In such construction the tubes of each pair of legs are set in vertical rows as well as in rows inclined from the horizontal; but where tubes of the form shown in Fig. 5 are used the orifices for the tubes and plugs are preferably staggered, as shown in Figs. 1 and 3. I do not limit myself, however, to the use of sinuous tubes, and all the tubes may be straight or part straight and part sinuous, as shown in Fig. 1.

The heater B comprises the cylindrical shell or drum 21 and an annular steam-drum 21', concentric within the drum 21 and comprising the outer shell 22, the inner shell 23, concentric to the outer shell, and the annular heads 24, closing the ends of the annular drum and secured therein in any suitable manner and stayed by bolts 25 lengthwise of the drum. Central of its length drum 21 is provided with a flue 26 of a diameter to fit over the end of flue 5, whereby the drum 21 is supported above the boiler 1 and connected with the combustion-chamber 3, and the steam-drum 21' is connected with the steam-space of the boiler 1 by the pipes 27, formed of sections suitably coupled by unions or flanged couplings 28, and each having one end threaded into a suitable orifice through the outer sheet 7 of the boiler and the other end extending through the wall of the outer drum 21 and similarly secured in the outer shell 22

of the steam-drum 21'. The outer drum 21 is provided with the exit-flue 29 at one end, and the steam-drum 21' is provided with the steam-main 30, extending through the wall of the outer drum. Between the inner and outer drums there are interposed the diaphragms 31, extending longitudinally from end to end of the outer drum and having their ends connected by the reversely-disposed arches 32, by which the heat and gases from the flue 5 are compelled to pass around and along the lower half of the drum 21 and through its central flue 33 and over the upper half of the drum to reach the exit-flue 29, as indicated by arrows in Fig. 1, thereby utilizing the waste heat to superheat the steam if the waste gases are of higher temperature than the steam or reduce radiation if the temperature of the steam is higher than that of the escaping gases.

By the inclination of the water-tubes 4, the water-line being above the crown-sheet, as shown in Fig. 1, I attain a free circulation from the lower toward the higher ends of the tubes and thence upward through the legs to which the higher ends are secured, over the crown-sheet, and downward through the legs to which the lower ends of the tubes are attached, the resultant currents being diagonally across the crown-sheet to the next adjacent leg instead of through the opposite legs, from which it is apparent that the return flow from the tubes of each pair of legs is back through the tubes of the other pair.

The water-feed pipe 34 is connected by branch pipes 35 and 36 to the legs to which the lower ends of the tubes 4 are secured, near their bottoms, by which the water having the lowest temperature is made to circulate through the lower rows of tubes nearest the fire.

It is apparent that a generator of reduced capacity may be made by simply omitting one pair of legs and their connecting-tubes and that such omission may be made without requiring other than the omission of the side plates 13 of such legs and a simple and obvious change in the forms of the frames 8 and the plates 17. For generators of small size and capacity they are preferably so constructed.

What I claim to be new is—

1. In a steam-generator, the combination of an outer and an inner plate having equal center portions parallel and horizontal, and end portions of equal width, the end portions of the inner plate being bent at right angles to the central portion and of the outer plate curved outward and downward parallel with the end portions of the inner plate; end plates closing the top, side, and bottom openings between the outer and inner plates and riveted thereto around their edges, and forming with the outer and inner plates a boiler-shell having vertical rectangular water-legs opening into the water and steam space between the horizontal central portions of the outer

and inner plates; plates secured to end plates of the legs and forming with the inner plate a combustion-chamber for the shell; a flue for the combustion-chamber extending centrally through the top of the shell; parallel rows of inclined water-tubes connecting opposite legs; plugs in the outer plate opposite the ends of the tubes; stay-bolts at intervals through the outer and inner plates of the shell and secured thereto; a water-feed pipe connected to one or more legs of the shell and a steam pipe or pipes tapping the steam-space.

2. In a steam-generator, the combination of an outer and an inner plate having equal center portions parallel and horizontal and end portions of equal width, the end portions of the inner plate being bent at right angles to the central portion and of the outer plate curved outward and downward parallel with the end portions of the inner plate; end plates closing the top, side, and bottom openings between the outer and inner plates and riveted thereto around their edges, and forming with the outer and inner plates a boiler-shell having vertical rectangular water-legs opening into the water and steam space between the horizontal central portions of the outer and inner plates; plates secured to adjacent end plates of the legs and forming with the inner plate a combustion-chamber for the shell; a flue for the combustion-chamber extending centrally through the top of the shell; parallel rows of laterally-sinuuous inclined water-tubes connecting opposite legs; plugs in the outer plate opposite the ends of the tubes; stay-bolts at intervals through the outer and inner plates of the shell and secured thereto; a water-feed pipe connected to one or more legs of the shell and a steam pipe or pipes tapping the steam-space.

3. In a steam-generator, a water-boiler supported on vertical rectangular water-legs at the sides of the boiler, connected together at their inner corners by plates and having separate openings thereto from the body of the boiler, and forming a combustion-chamber; inclined water-tubes connecting opposite legs, and extending through the combustion-chamber; plugs in the outer plates of the legs opposite each end of each tube, a central vertical flue for the combustion-chamber extending through the boiler; a heating-drum mounted on the flue; a steam-drum having a central flue, concentric with the heating-drum and having pipe connection with the steam-space of the boiler, and a steam-main; diaphragms in the heating-drum adapted to direct the heat from the flue around and through the steam-drum; and an exit-flue for the heating-drum.

4. In a steam-generator, a water-boiler supported on vertical rectangular water-legs at the sides of the boiler, connected together at their inner corners by plates, and having separate openings thereto from the body of the boiler, and forming a combustion-chamber; inclined water-tubes connecting opposite legs, and extending through the combustion-chamber; plugs in the outer plates of the legs opposite each end of each tube, a central vertical flue for the combustion-chamber extending through the boiler; a heating-drum mounted on the flue; a steam-drum having a central flue, concentric with the heating-drum and having pipe connection with the steam-space of the boiler, and a steam-main; diaphragms in the heating-drum adapted to direct the heat from the flue around and through the steam-drum; and an exit-flue for the heating-drum.

rate openings thereto from the body of the boiler, and forming a combustion-chamber; inclined water-tubes provided with a series of lateral bends or curves, connecting opposite legs, and extending through the combustion-chamber; plugs in the outer plates of the legs opposite each end of each tube, a central vertical flue for the combustion-chamber extending through the boiler; a heating-drum mounted on the flue; a steam-drum having a central flue, concentric within the heating-drum, and having pipe connection with the steam-space of the boiler, and a steam-main; diaphragms in the heating-drum adapted to direct the heat from the flue around and through the steam-drum, and an exit-flue for the heating-drum.

5. In a steam-generator, the combination of an outer and an inner plate having equal center portions parallel and horizontal and end portions of equal width, the end portions of the inner plate being bent at right angles to the central portion and of the outer plate curved outward and downward parallel with the end portions of the inner plate; end plates closing the top, side, and bottom openings between the outer and inner plates and riveted thereto around their edges, and forming with the outer and inner plates a boiler-shell having vertical rectangular water-legs opening into the water and steam space between the horizontal central portions of the outer and inner plates; plates secured to end plates of the legs and forming with the inner plate a combustion-chamber for the shell; a flue for the combustion-chamber extending centrally through the top of the shell; a series of laterally-sinuuous water-tubes connecting opposite legs, the tubes being all inclined from the horizontal and arranged in parallel rows laterally inclined from the horizontal, with the rows of tubes of one pair of legs alternating with the rows of the other pair across the combustion-chamber; plugs in the outer plate opposite the ends of the tubes; stay-bolts at intervals through the outer and inner plates of the shell and secured thereto; a water-feed pipe connected to one or more legs of the shell and a steam pipe or pipes tapping the steam-space.

6. In a steam-generator, the combination with water-legs located on opposite sides of a combustion-chamber, of water-tubes connecting the water-legs and extending through the combustion-chamber at an inclination from the horizontal and having coincident lateral situations all on one side of a line axial to the ends of the tubes.

In witness whereof I have hereunto set my hand this 16th day of December, A. D. 1901.

JACKSON DENEAL.

Witnesses:

I. E. MACOMBER,
CHAS. A. BOAKE.