

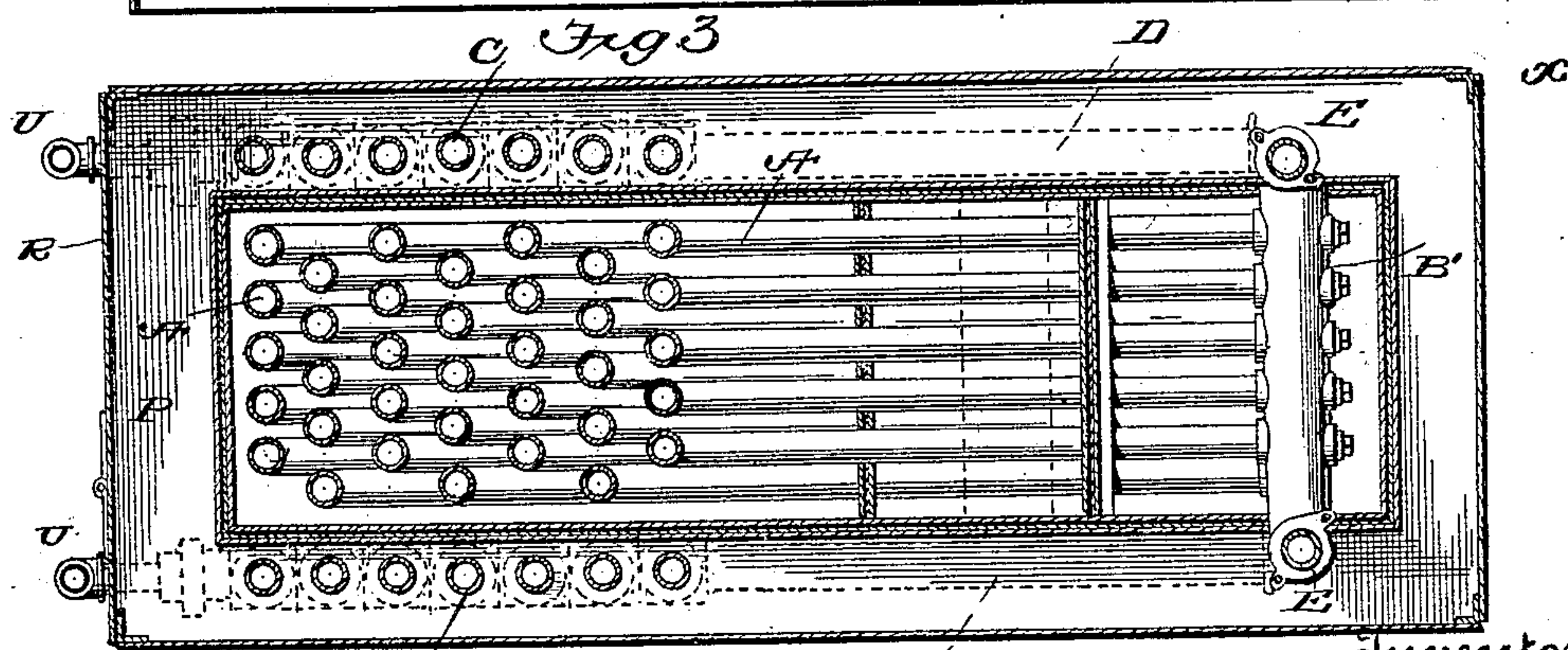
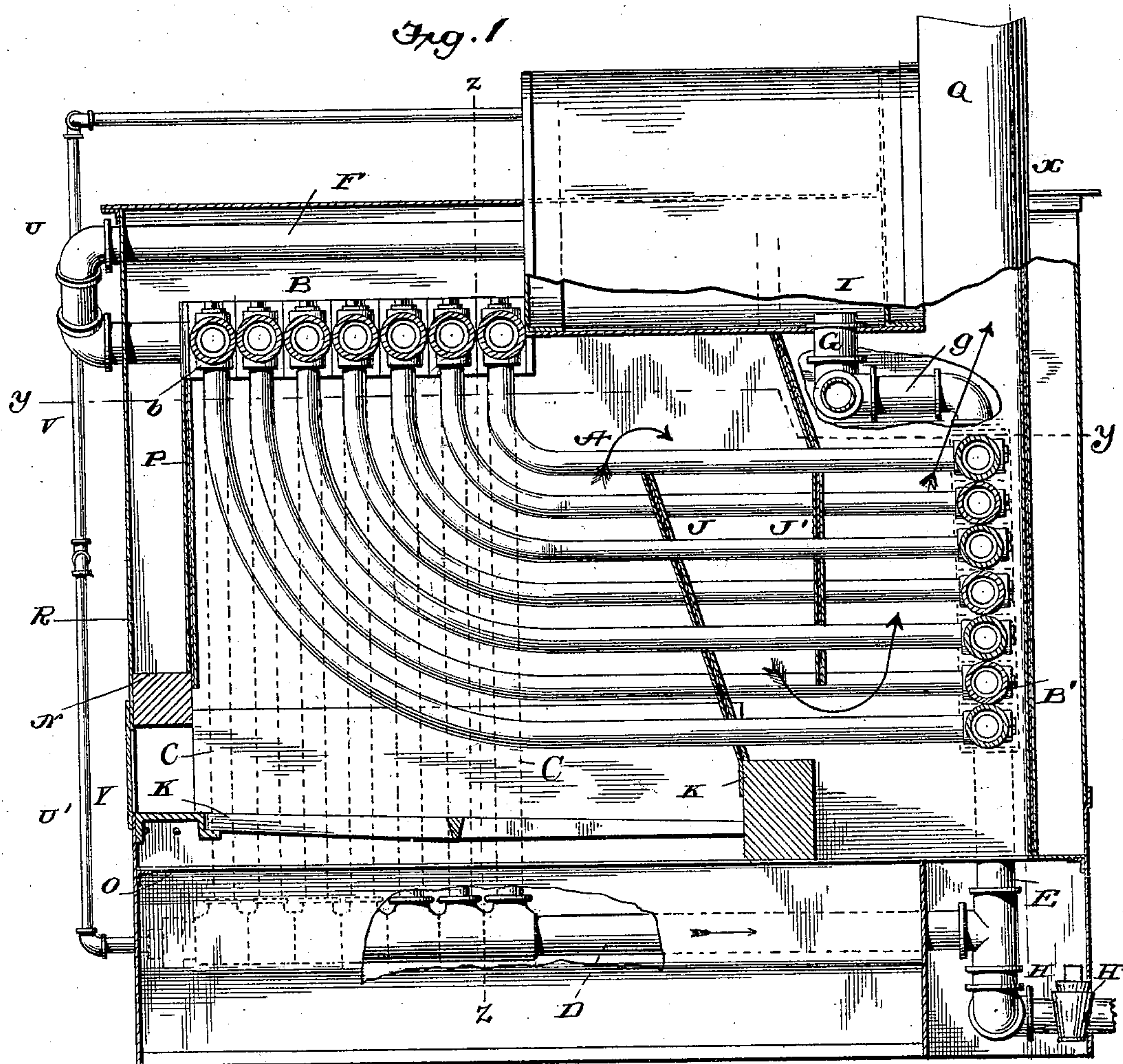
(No Model.)

2 Sheets—Sheet 1.

D. BIRDSALL.
STEAM GENERATOR.

No. 521,329.

Patented June 12, 1894.



Witnesses

John Irvine
Thos. E. Robertson.

Inventor
David Birdsall
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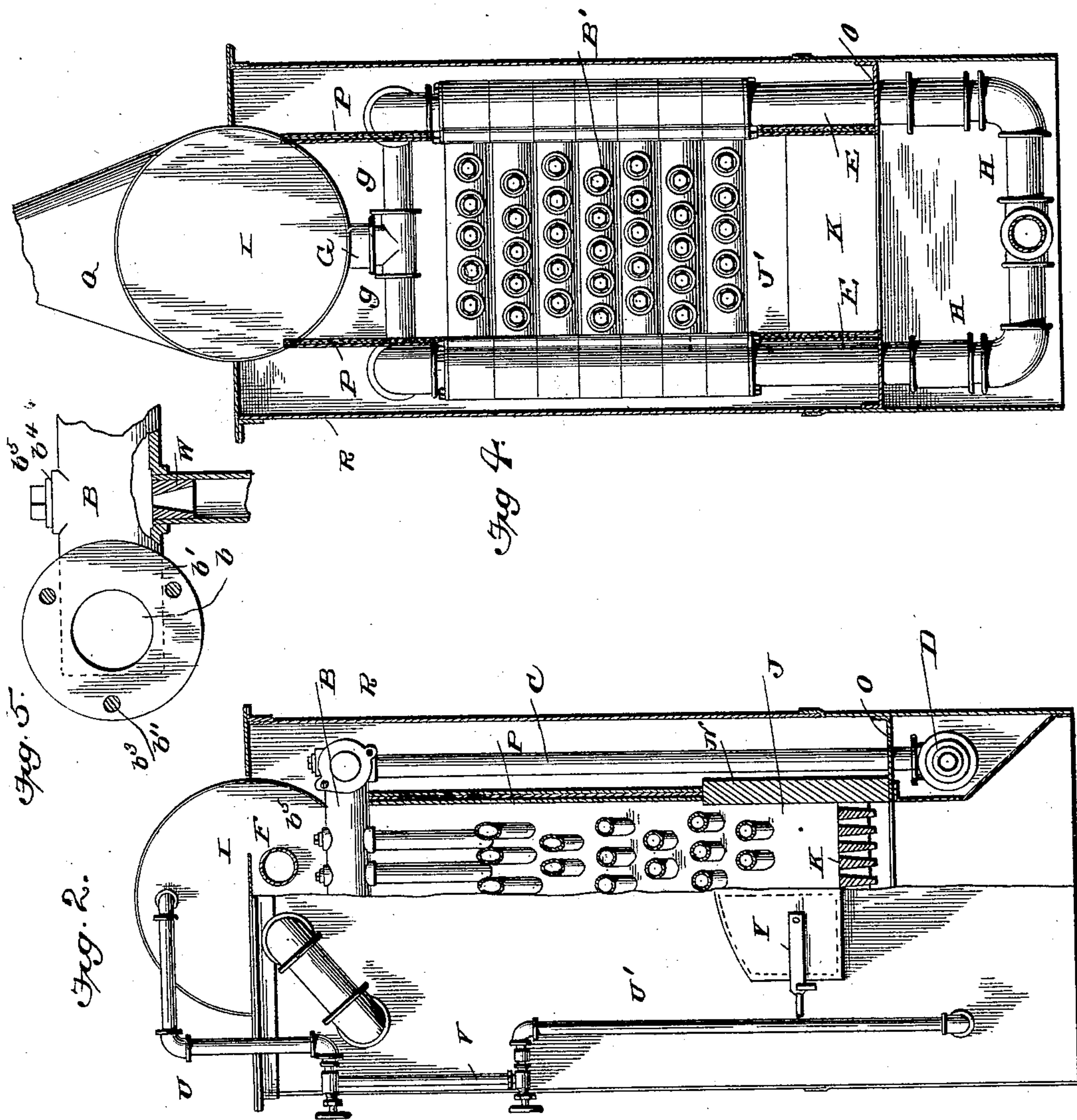
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UNITED STATES PATENT OFFICE.

DAVID BIRDSALL, OF JERSEY CITY, NEW JERSEY.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 521,329, dated June 12, 1894.

Application filed April 17, 1893. Serial No. 470,650. (No model.)

To all whom it may concern:

Be it known that I, DAVID BIRDSALL, a citizen of the United States, residing at Jersey City, Hudson county, New Jersey, have invented certain new and useful Improvements in Steam-Generators, of which the following is a specification, reference being had therein to the accompanying drawings.

My improvement relates to that class of steam boilers or generators known as water tube and of that style of this class which has curved tubes, the lower ends of which are connected with the back vertical portion of the boiler or generator and its upper ends with a horizontal front portion; and the invention consists in the peculiar construction, arrangement and combinations of parts hereinafter more particularly described and then definitely pointed out in the claims.

In the accompanying drawings—Figure 1 is a longitudinal vertical central section of a generator and furnace constructed according to my improvement. Fig. 2 is a partly sectional front view, the section being taken on the line *zz*, Fig. 1. Fig. 3 is a horizontal section on the line *yy* in Fig. 1. Fig. 4 is an end view, with the rear of the casing removed. Fig. 5 is a detail on a larger scale, which will be more fully described hereinafter.

Referring now to the details of the drawings by letter—A represents the main generating tubes which are curved as shown and set into top and back headers B B', preferably by means of an ordinary tube expanding tool. These tubes are arranged compactly in a series of rows, and are so set that each inner tube of one row will be over the space between two tubes of the row below it, as will be clearly seen in Figs. 2 and 4.

The headers B B' are tubular in form and of cast metal, preferably of steel, the upper or front series B being similar to the rear series B', except that in addition to the openings to receive the generating tubes, they have additional openings to receive the return water pipes C. The headers are of a length corresponding to the width of the generator and are provided with openings *b* surrounded by flanges *b'* at each end, by which they may be secured together by bolts *b''* passing through holes *b³* in the flanges *b'*, and are arranged one above the other in the rear series, or hori-

zontally in the front series, thereby forming a continuous tubular connection at both ends between the members of each series respectively. They are also provided with openings *b⁴* opposite each generator tube to admit the use of the expanding tool before mentioned, which openings are closed by stoppers *b⁵*.

C are the return water pipes inserted near each end of the upper headers and lead downward and into the base circulating pipes D D'.

D D' represent two strong tubes of wrought iron or steel extending longitudinally on each side respectively, and serve as a base for the generator as well as a conduit for the water flowing through the tube C toward the back series of headers.

At E are shown two short pipes which complete the connection between the base pipes D and D' and the back headers, and at F are two pipes which connect the upper series of headers with the steam drum and provide for the free passage of steam to the drum I, where it collects for use.

At G is a pipe, the end of which projects into the bottom of steam drum I for a short distance, and by means of right and left hand branches *g g* connects with the top of the back series of headers, thereby providing for the retention of a small quantity of water in the bottom of the drum where the same is exposed to the heat of the furnace gases, and for the flow by gravity of the surplus water into the back headers, and the maintenance of the water equilibrium in the generator thereby. By means of this connection in combination with the steam pipe F F the drum I is rigidly held in position.

There is a short tubular connection H, between the back ends of pipes D D', which by means of elbows is carried down to a lower level, and serves the purpose of a sediment trap into which all earthy deposits from the water fall, and should be provided with the usual cock H', by which the sediment may be blown off.

J J' are deflecting plates arranged across the combustion chambers from side to side, back of the bridge wall and are provided with holes for the passage of the tubes, &c. These plates serve to arrest the direct flow of the incandescent gases to the chimney and direct them in a tortuous course around the

generator tubes until the heat of the gases shall have been absorbed. Plate J rests on the top of the bridge wall K and extends upward, inclining toward the front up to the upper row of tubes, which deflects the hot gases upward into the chamber above the tubes. Plate J' is arranged some distance back of plate J and leads from the lower surface of the drum I downward to near the lowermost row of generator tubes, thereby arresting the direct flow of hot gases to the chimney, and leading them in the direction shown by the dark arrows in Fig. 1. These plates J J' are composed of thin sheets of iron upon each side of which is cemented a thin coating of asbestos fiber or other refractory material, thereby protecting the central sheet of iron from speedy destruction.

N N represent walls of fire brick which inclose the lower part of the furnace on the front and on each side back to the bridge wall. The side walls are built inside of the vertical tubes C and rest upon plates O which are riveted to the outer covering, and extend upward only about two feet, so as to inclose the hottest part of the furnace.

At P is shown the casing which completely incloses the curved tubes on each side and on the front, from the walls N upward to the upper headers and steam drum. This casing is of similar construction to the deflecting plates J J' and is adapted to retain the heat within the furnace and tube chamber.

The back system of headers when bolted together and in position serves as the rear wall of the furnace, and the upper system of headers serves a like purpose for the upper front of the same.

The rear part of the combustion chamber above the horizontal part of the generator tubes is mostly covered by the steam drum as before mentioned, and which in combination with suitable connecting casing finally guides the spent gases up the chimney Q.

R represents an outer casing of thin sheet iron which incloses the generator on all sides, leaving an intermediate air space which reduces the escape of heat to a minimum.

U U' indicate pipes leading from the water pipe D' and from the steam drum, respectively, and terminate in the proper fittings to receive the ends of the water gage V.

W, Fig. 5, shows a thimble which is inserted in the back ends of the generator tubes for the purpose of reducing the flow of water through the same, thereby preventing the flooding of the upper headers with water, it being desirable to permit only the admission of such a quantity as shall supply an excess above the steam generating capacity of each tube, sufficient to prevent the formation of sedimentary scale on their inner surfaces.

The furnace is provided with the ordinary grate bars K and furnace door Y, and the boiler should of course be provided with an injector or feed pump, and the drum should have the usual safety valve, an outlet for the

steam, and a valve closing it, but as these are common there is no necessity for further description of the same.

Having now described the construction of my generator, I will now proceed to explain its operation.

The generator having been filled in any suitable manner until the water in the gage has risen about half way to the top, I then start a fire in the furnace in the usual manner, and the heat of the furnace at once begins to act upon the water in the generator tubes, while the hot gases, as they give off their heat, flow in the direction shown by the long arrows in Fig. 1, upward and around plate J and under plate J', finally escaping up the chimney. Very soon after the fire has been started, the small amount of water contained in the tubes begins to boil and the steam thereby generated will at once flow by way of the vertical portion of the tubes, as in this direction it encounters the least resistance. The steam thus formed passes into the upper headers and thence flows into the end passages common to the whole series, and then by way of pipes F to the steam drum. As soon as the heat of the furnace increases and a violent generation of steam commences along the entire length of the tubes, the escaping steam will carry along in its current a considerable volume of water and project it into the upper headers. As this water cannot return against the constant rush of steam up the generator pipes, it flows toward the ends of each header respectively and falls through pipes C into base pipes D and D' and thence into the back headers. By means of this provision for the free separation of the steam from the water in the upper headers, the steam flows to the drum nearly free from globules of water. As soon as the water in the generator tubes begins to be exhausted in the process of generating steam just described, more water flows in from the back header system by way of the contracted openings in the back ends of the generator tubes. A constant and rapid circulation of water is thus kept up throughout the whole system of tubes, pipes and headers, with a velocity in proportion to the intensity of the fire maintained in the furnace. The long vertical curve of the generator tubes directly above the hottest part of the furnace greatly accelerates the circulation of the water in said tubes and consequently greatly increases the steam generating capacity of the same. This rapid circulation also prevents the lodgment of sedimentary scale upon their inner surfaces and thereby avoids the principal cause of the destruction of the tubes by burning as well as of diminution of steam generating efficiency. All earthy matters, lime and magnesian deposits which enter the generator with the feed water are kept by this rapid movement from finding a lodgment upon the internal surfaces exposed to the action of external heat whereby it may become fixed. The sedimentary matter be-

ing thus deprived of its soluble condition in passing through the generator tubes becomes at once heavier than water, and as soon as it is projected into the pipes C connecting with the back system of headers by means of base tubes D D', the sediment falls by gravity downward and into cross pipe H from whence it may be blown out in the form of mud at any time as may be required. The water rising through pipes C will be comparatively free from sediment so long as the deposit constantly filling the pipe H is kept blown off and the water circulating through the system above kept from becoming overcharged with earthy matter. When the heat of the furnace is raised to a high degree and the steam generating capacity approaches the maximum, globules of water are carried over into the steam drum and collect in the lower part of the same, but as soon as the accumulation shall reach the level of the projecting end of drain pipe G, it falls by gravity into the back system of headers by means plainly shown in Fig. 4. The facility and rapidity with which the water carried up into the front headers in the process of steam generation, returns to its normal level, prevent the fluctuation of equilibrium so often shown by the water gage in generators of this type.

As the circulation in each one of the generator tubes is independent of each and all of the other tubes, the circulation within all being toward the upper headers, there is no action known as "steam binding" in this generator, as is often shown by the internal disturbances and shocks occurring in generators composed of horizontal tubes connected between vertical tiers of headers, front and rear.

Owing to the small cross section of the generator tubes, and the very large amount of heating surface which this system makes it possible to crowd into a small furnace space, steam can be raised to a high pressure in a short time, which makes this generator especially adapted for use on shipboard where lightness and safety are of prime consideration. Also by reason of the small cross section of its tubes and connections, it will withstand an exceptionally high internal pressure with safety, thus adapting it to the most modern requirements.

This generator can be made of any capacity up to hundreds of horse-power by simply lengthening the design of the headers which correspond to the width of the generator, furnace, &c.

There are no joints exposed to the destructive action of the heat of the furnace, and the curve in the generator tubes leaves freedom to the influence of expansion and contraction, and consequently prevents the springing and other derangements so common in other generators.

I do not intend to limit myself to the exact construction shown at all points, as it may be varied considerably without departing from

the spirit of my invention. For instance, I have shown the base pipes D D' continuous from end to end in full lines, but they may be made in sections—a section to each down pipe C—as indicated in dotted lines in Fig. 1, if preferred. Or if the boiler is to be used as a heater, the base tubes may be dispensed with entirely by making suitable connections with the radiator system of pipes.

What I claim as new is—

1. The combination in a generator, of a series of horizontal rows of bent tubes having their lower ends connected to the rear portion of the generator and their upper ends connected to a series of headers arranged close together and horizontally and transversely of the furnace and forming a closed wall thereof, said headers having flanges and openings to connect each header with the adjacent headers, and all the tubes of each horizontal row being connected to the same header, substantially as described.

2. The combination in a generator, of a series of headers arranged in a vertical plane, a series of headers arranged in a horizontal plane and the members of each series being arranged close together to form a closed wall of the furnace and smoke passage and communicating near their ends, both series transversely of the generator, and a series of horizontal rows of bent tubes connecting said headers, all the tubes of each horizontal row being connected to the same pair of headers, substantially as described.

3. The combination in a generator, of a series of rear headers arranged in a vertical plane, a series of front headers arranged in a horizontal plane, and the members of each series being arranged close together to form a closed wall of the furnace and smoke passage and communicating near their ends, both series transversely of the generator, and a series of horizontal rows of bent tubes having their lower ends entering the vertical sides of the rear headers, and their upper ends entering the under sides of the front headers, and all the tubes of each horizontal row being connected to the same pair of headers, substantially as described.

4. The combination in a steam generator, of a series of upper tubular headers arranged in a horizontal plane, a corresponding series of lower headers arranged in a vertical plane and both transversely of the generator, a series of bent tubes connecting said headers, a pair of base tubes connected to the rear headers, and a series of pairs of vertical tubes connected to the opposite ends of the upper headers, each upper header having a connection with the base tubes by a pair of vertical tubes, independently of the others, substantially as described.

5. The combination in a generator and with the horizontal series of transverse headers B, the curved tubes A and base tubes D D', connections between the base tubes and the lower ends of the curved tubes of a series of pairs

of down tubes C connecting each of said headers to the base tubes by an independent connection, substantially as described.

6. The combination in a generator, of the horizontal series of headers B, the vertical series of headers B', the bent tubes A running from one series of headers to the other, the base pipes D D' connected with the rear series of headers, and a series of pairs of down tubes C connecting each top header with the base pipes independently of the other headers, substantially as described.

7. The combination in a steam generator, of a vertical series of headers B', a horizontal series of headers B, curved tubes A connecting said two series of headers, a drum I arranged at the end of the horizontal series and connected with both series, pipes D D' connected with the vertical series of headers, a series of pairs of pipes C connecting the horizontal series of headers to the pipes D D', each upper header being connected to the pipes D by a separate pair of pipes, and a casing P between the pipes C and the furnace, substantially as described.

8. The combination of a series of upper headers B, arranged in a horizontal plane, a corresponding series of lower headers B' ar-

ranged in a vertical plane and both series set transversely of the furnace, horizontal rows of tubes A, each tube having one of its ends turned upward and connecting the two series of headers, all the tubes in each horizontal row entering one header in the vertical series and their up-turned ends entering a header in the horizontal series, a drum I arranged at the end of the horizontal series of headers and connected with both series, pipes D D' connected with the vertical series of headers, a series of pairs of pipes C connecting the horizontal series of headers to the pipes D D' each header of the upper series being connected to the pipes D D' by a separate pair of said pipes C, walls N and casing P between the pipes C and furnace, the bridge K at the end of the furnace, and plates J J for directing the currents of the products of combustion, all constructed and arranged substantially as shown and described.

In testimony whereof I affix my signature, in presence of two witnesses, this 15th day of April, 1893.

DAVID BIRDSALL.

Witnesses:

JOHN C. INWRIGHT,
WALTER K. BIRDSALL.