3 Sheets—Sheet 1.

R. J. NUNN.

STEAM GENERATOR.

No. 64,355. **Patented Apr. 30, 1867.**

Fig. 2.

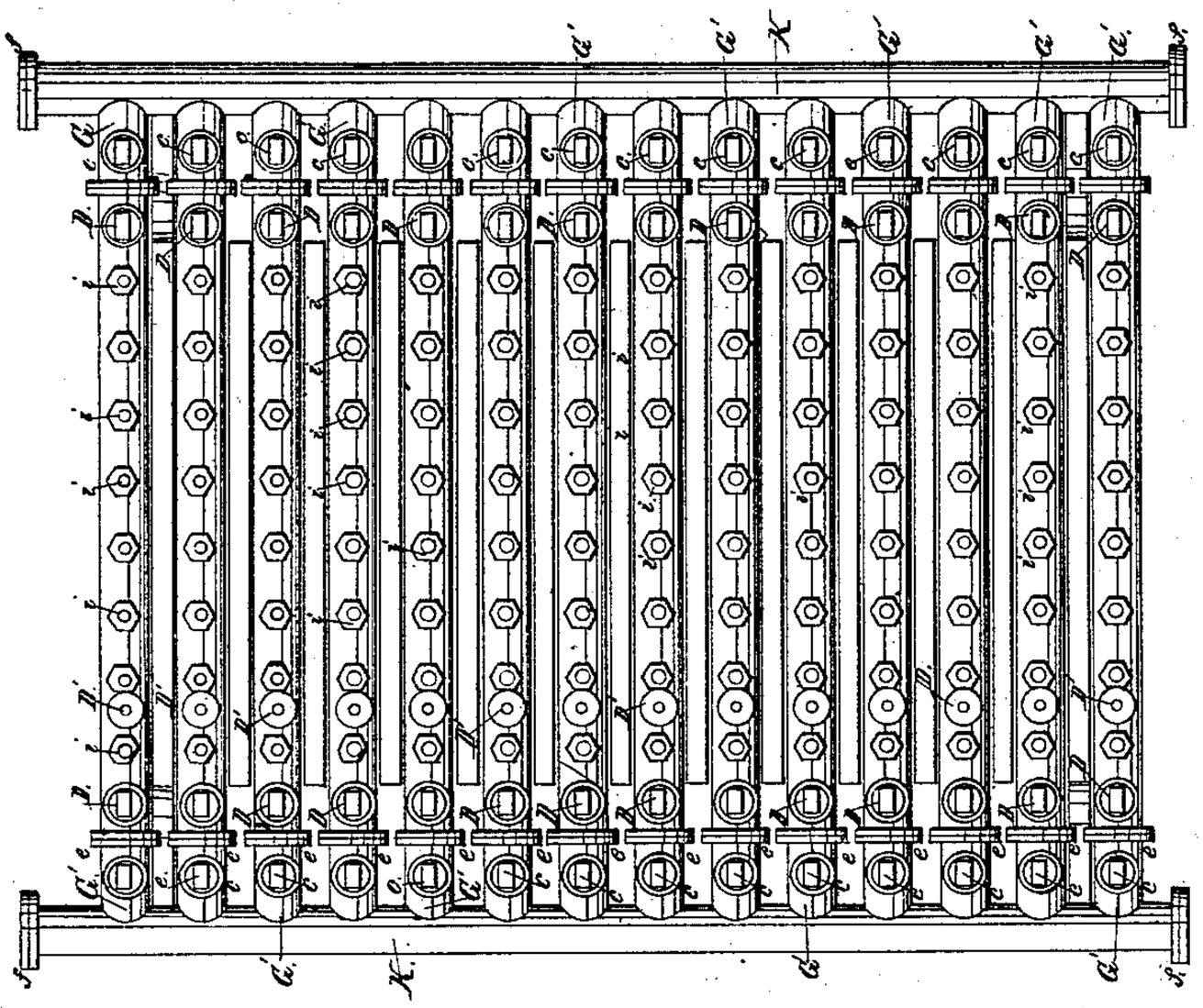
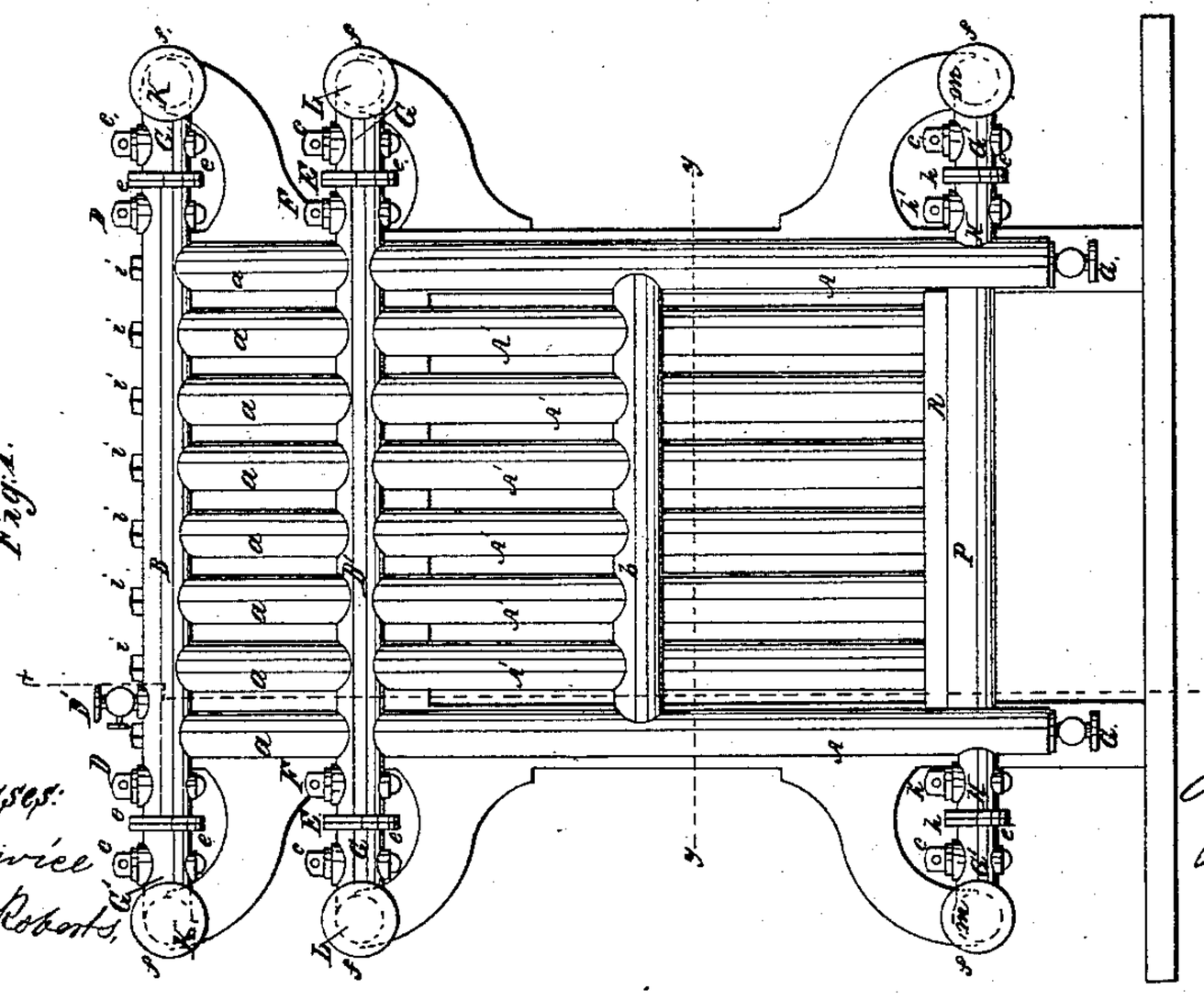


Fig. 1.



Witnesses:
J. A. Service
Alex. F. Roberts

Inventor:
R. J. Nunn
Per
Munn & Co
Attorneys

3 Sheets—Sheet 2.

R. J. NUNN.

STEAM GENERATOR.

No. 64,355. Patented Apr. 30, 1867.

Fig. 2.

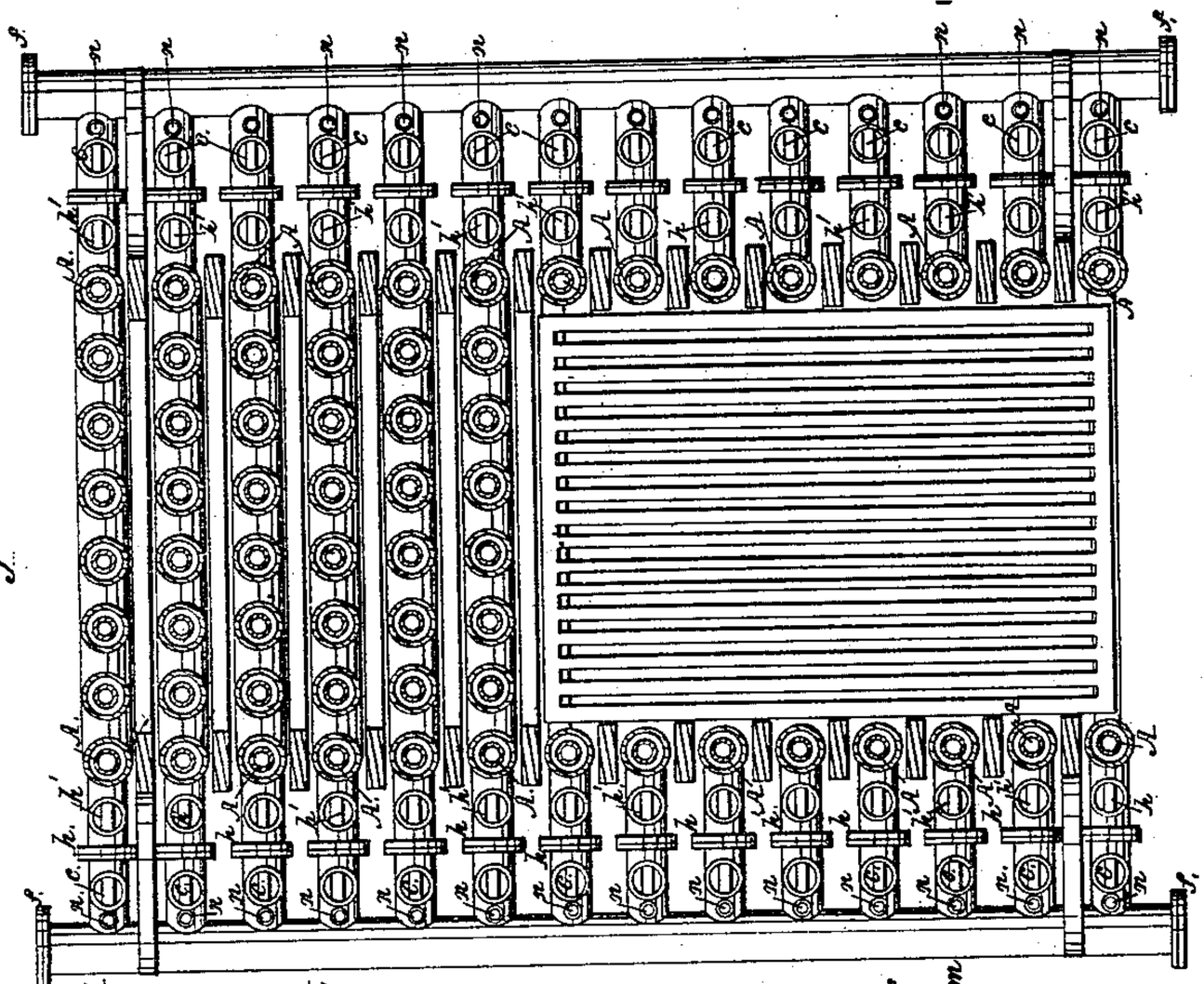
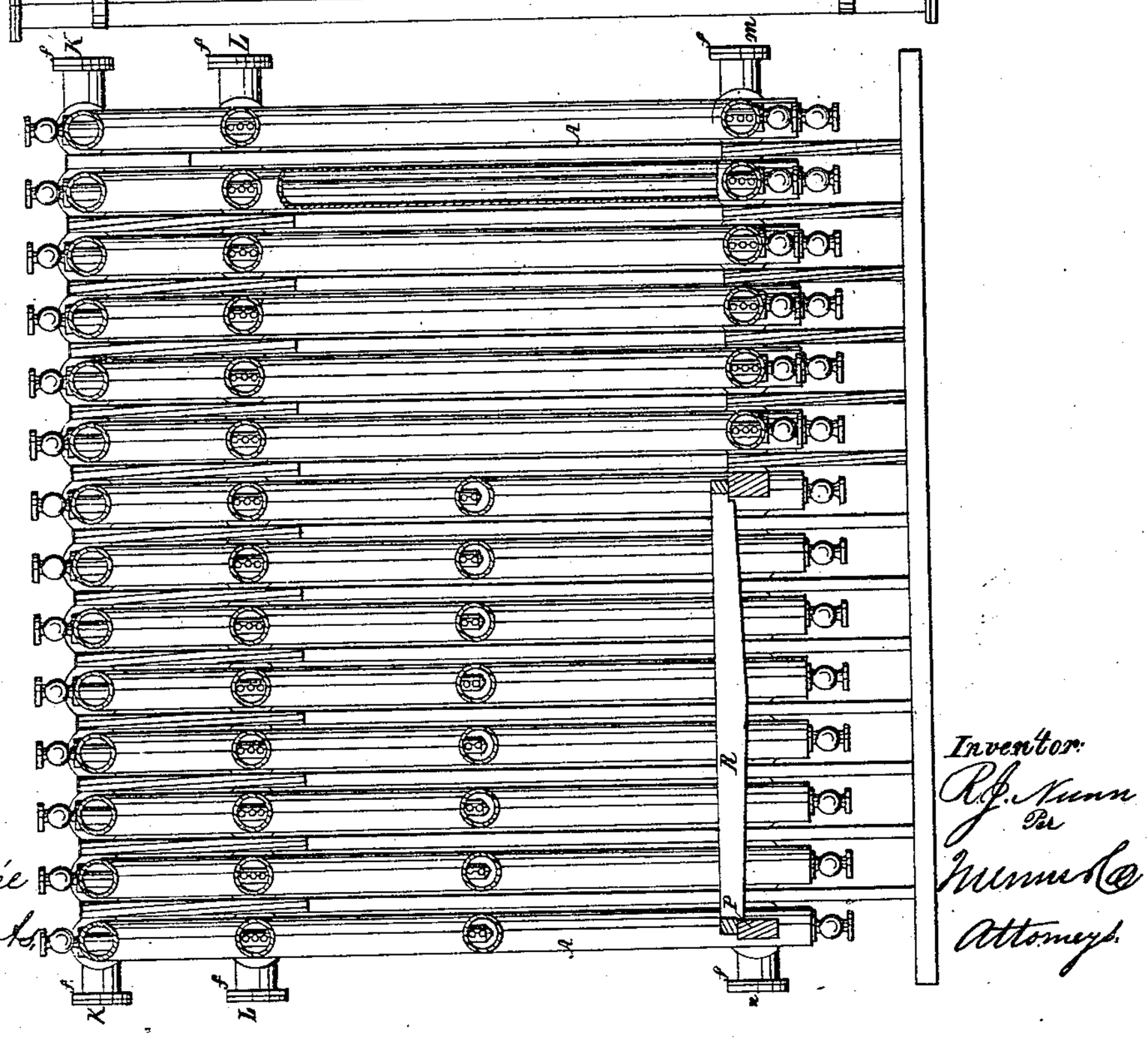


Fig. 3.



Witnesses:
J. Abernéee
A. F. Roberts

Inventor:
R. J. Nunn
Per
Munn & Co
Attorneys.

3 Sheets—Sheet 3.

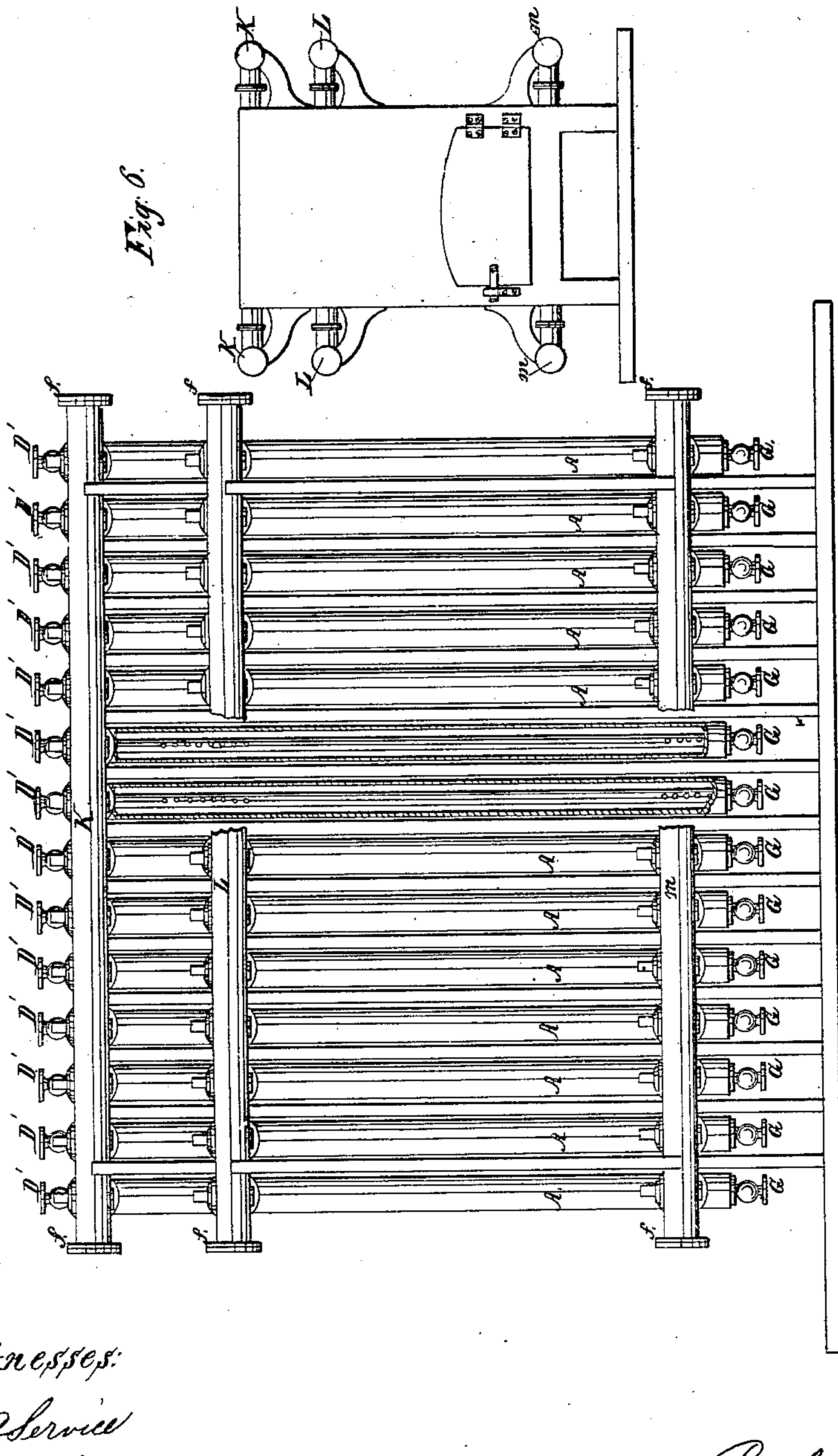
R. J. NUNN.

STEAM GENERATOR.

No. 64,355. Patented Apr. 30, 1867.

Fig. 6.

Fig. 5.



Witnesses:

J. A. Service

Alex F. Roberts

Inventor:

R. J. Nunn

Per Munn & Co

Attorneys

United States Patent Office

RICHARD J. NUNN, OF SAVANNAH, GEORGIA.

Letters Patent No. 64,355, *dated April* 30, 1867.

IMPROVEMENT IN STEAM GENERATORS.

The Schedule referred to in these Letters Patent and making part of the same.

TO ALL WHOM IT MAY CONCERN:

Be it known that I, RICHARD J. NUNN, of Savannah, in the county of Chatham, and State of Georgia, have invented a new and useful Improvement in Steam Generators; and I do hereby declare that the following is a full, clear, and exact description thereof.

The object of my invention is to furnish a steam boiler, (or generator,) which shall combine the essential requisites of compactness, strength, and safety to a greater degree than any other steam boiler in use, and which, while it shall be more economical as regards the weight of material used in its construction, and the quantity of fuel required for a given amount of steam, shall furnish a much greater extent of steam-generating surface in proportion to its weight and dimensions; and the invention consists in constructing the boiler entirely of tubes of such dimensions and calibre that the danger from explosion shall be diminished at least fourfold when compared with the ordinary boilers now in use; and in arranging and combining the tubes in such a manner that I can stop off or remove a defective tube with very little difficulty or delay, maintaining, at the same time, a perfect circulation of the water, and but slightly interfering with the efficiency of the boiler.

To enable others skilled in the art to make and use my invention, I will now proceed to describe its construction and operation, reference being had to the accompanying drawings, forming a part of this specification, and to the letters of reference marked thereon.

Figure 1 represents a front elevation.

Figure 2, a plan or top view.

Figure 3, sheet 2, is a vertical section through the line *x x* of fig. 1.

Figure 4 is a horizontal section through fig. 1 at *y y*.

Figure 5, sheet 3, is a side elevation partly sectional.

Figure 6 is a small front view of the arch plate of the boiler.

Similar letters of reference indicate like parts in the drawing.

The tubes of which my boiler is composed are all either vertical or horizontal in this example of my invention, but they may be placed at any angle, as may be desired. The horizontal tubes lie both in a longitudinal and transverse position. The longitudinal tubes, (three on each side,) are placed one above the other on the outside of the boiler. The transverse tubes run through the boiler, and are invisible with the exception of those at the ends and on the top, as seen in the drawing. I construct my boiler of a series or succession of bents or slabs, each slab having a given number of vertical and horizontal tubes, the vertical tubes standing in a row, and the horizontal tubes lying at given intervals one over the other, and each bent or slab consisting of but one row, or the thickness of one tube. In the drawing the slab is represented as consisting of eight vertical and three horizontal tubes. It would, perhaps, be more proper to say that each slab is composed of sixteen vertical tubes, for one of the horizontal tubes cuts the row and separates the vertical tubes, leaving eight long tubes and eight short ones. The upper horizontal tubes may be called the steam tube. The next horizontal tube below is the low-water tube, and the next below, or at the bottom, is the cold-water tube, excepting where it forms the top of the fire-chamber or furnace.

I will now commence at the front end of the boiler, fig. 1, and describe one of these slabs more particularly. The one in view is the first of a series of slabs which form the fire-box or furnace.

A represents the two outside or right and left-hand vertical tubes; A′, the lower row of vertical tubes between the outside ones, and *a* represents the upper row of vertical tubes. B represents the upper horizontal or steam tube; B′ the low-water tube, and *b* the lower horizontal tube forming the top of the fire-chamber or furnace as far back as the furnace extends. The steam tube B extends out over the right and left-hand vertical tubes, and each end terminates with a flange, *c*. There is a cock, D, at each end between the flange and the vertical tubes. It also has another cock, D′, near its left-hand end. The low-water tube B′ has the same flanges at E E, and cocks F, between the flanges and the vertical tubes. The upper tier *a* of vertical tubes is connected with these horizontal tubes, and the tier below, including the right and left-hand vertical tubes, is connected with the tube B′ at its under side, and all stand in line with those above. The tube *b*, as well as the cold-water or lower tube of the other slabs which lie beyond the furnace, terminates in the right and left-hand vertical tubes A A. These vertical tubes A A are closed at the bottom ends, but near their lower ends short

horizontal tubes II are attached, which terminate in flanges *h*, and have each a cock, *h'*, between the flange and the vertical tube. The shaded tubes, seen in the drawing, represent the back end of the furnace. The vertical tubes being cut or separated by the low-water tube B', and the separated portion being represented in two rows or tiers, occupying positions directly over each other, they form for all practical purposes but one tier, or eight tubes, as regards their interior portion, and I avail myself of this arrangement by introducing tubes of much smaller diameter, which stand in the axial centres of each vertical tube. I designate these tubes circulation tubes. The top end of each passes through the steam tube B, and is closed and secured in its proper position by screws whose heads bear upon the top of the steam tube. These screws are represented by *i* in the drawing. One of these circulation tubes passes down through the closed ends of each of the vertical right and left-hand tubes of each slab forming the fire-chamber or furnace, and terminates in a cock, G. The lower ends of the rest of these tubes pass through the top of the horizontal tube *b*, and terminate in closed pointed ends, as seen in the drawing, fig. 3, sheet 2. These circulation tubes are perforated with holes, the holes commencing about half way between the steam tube B and the low-water tube B', and continue to the bottom of the tube B'. In the right and left-hand tubes the holes through the lower ends of these circulation tubes commence at the bottom of the flue and continue to the end of the tubes which enclose them. In the six other vertical tubes of the slabs forming the furnace the perforations commence at the top of the horizontal tubes *b* and continue to their ends. The circulation tubes, in the vertical tubes of the slabs back of the furnace, pass entirely through the lower horizontal tubes, and are secured by screws, and terminate in cocks the same as those in the outside right and left tubes, the lower holes commencing at the bottom of the flue and continuing to their ends. The slabs, which form that portion of the boiler back of the furnace, are constructed in the same manner, only the tube *b*, which here forms the top of the furnace, is dropped down in the slabs which stand beyond, and is situated at the bottom of the boiler, and is there the cold-water or supply tube, lying on a level with other outside horizontal tubes, to be described hereafter, which are also cold-water or supply tubes. The flanges upon the ends of the steam and low-water tubes B and B', are for the purpose of attaching those tubes to other horizontal tubes, which extend longitudinally on each side of the boiler. There are three of these tubes on each side, corresponding in height with the steam and low-water tubes, and also with the short tubes H, which are attached to the right and left-hand vertical tubes. I will here add that those short tubes H have check-valves communicating with the longitudinal tubes, and seen at *n*, fig. 4. These longitudinal tubes are indicated in the drawing by the letters K L M. Their ends are closed, and terminate in flanges *f*. Upon the side of each are short tubes G', corresponding in number and position with the number and position of the flanges on the slabs. Each of these short tubes terminates with a flange, and each has a cock between the flange and the main tube. These flanges are marked *e* and the cocks *c* in the drawing. These flanges correspond in number and position with the flanges attached to the slabs, as before stated. The intention, of course, is to connect them together, and by so doing connect the whole system of tubes in the boiler, thus allowing the water to circulate through every portion of the water-space, and the steam to occupy the steam-space. The upper longitudinal tubes K K, being but a continuation of the steam-space in the upper tube B of the slabs, a portion of the vertical tubes is designed also to be steam-space, that portion being about half the space between the steam and low-water tubes B and B'.

It is obvious that by disconnecting the flanges of any one slab, the slab can be removed from the boiler. In that case the cocks *c* would be closed, thus shutting the slab off from the rest of the boiler. When the slab is removed, the boiler is again ready for use, and after only a few minutes' detention, if any. Should a slab leak, and it is not deemed advisable to remove it, the cocks D, F, and *h* would be closed, which would shut it off from the rest of the boiler. In this case the working of the boiler would not be interrupted at all, the cock D' being opened to prevent overpressure in that slab. To increase the size and capacity of the boiler, it is only necessary to increase the length of the longitudinal tubes K L M, and add more slabs. The small interior circulation tubes perform another duty besides aiding the circulation. They act as bolts to bind the slabs together, being secured, as they are, at top and bottom by screws. At the bottom, the end passes through a screw-nut before the cock is attached.

My system of tubes is now complete. The steam-space and the low-water space are both surrounded with horizontal tubes, and the cold-water or supply tubes also surround the boiler, with the exception of the front. Each set of horizontal tubes is in free communication with the others, as well as with all the vertical tubes in the boiler. As the vertical tubes do not stand so as to touch each other, it is necessary to fill up the spaces between the outside right and left-hand tubes, and of all the spaces in the tier of tubes which surround the boiler in order to form a perfect flue. The whole interior steam-space, or the space between the low-water tube B' and the steam tube B, is also filled with non-combustible material to protect the surfaces of the tubes from the direct action of the fire. The right and left-hand tubes are likewise protected from the action of the fire. The cold-water or supply tubes of all the slabs back of the furnace are protected in like manner, but here the non-combustible material forms the bottom of the flue. In the drawings, I have shown solid metal plates as filling the spaces between the vertical tubes, and as also protecting the steam-space of the boiler. These plates also form the bottom of the flue. Two of these metallic plates (the front and the back ones) have arms or brackets, extending out from the outside vertical tubes, which brackets are made to support the three longitudinal tubes on each side of the boiler. There may be more or less of these brackets, as may be deemed necessary. Neither is it considered very important that there should be as many cocks in the horizontal tubes as is represented. Such as may be found unnecessary in actual service of the boiler may be dispensed with. The front or arch plate of the boiler is represented in fig. 6, showing the brackets and the ends of the longitudinal tubes, and a portion of the transverse horizontal tubes. The bar that holds the front end of the grate is repre-

sented at P. The grate itself by the letter R. The steam may be discharged from any part of the steam-space as may be most convenient, and the force-pump may be attached to the cold-water or supply pipe in the same manner.

I do not confine myself to any particular size, length, or number of tubes, nor to any particular position for them to occupy, nor to any particular form or shape of boiler, so long as it is composed entirely of tubes or pipes connected together in the manner I have described, or in any manner substantially the same, for I am aware that tubes may be connected by screws as well as by flanges, and that the small interior circulation tubes may be attached and secured in other ways from that which I have described. My method of construction or forming the joints and connections is the best which occurs to me now; it may be varied as experience and practice may dictate.

I do not broadly claim constructing steam boilers or generators exclusively of tubes or pipes, nor do I broadly claim the use of interior circulation tubes, as I am aware that they are not new; but, having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A steam generator or boiler, constructed entirely of tubes or pipes, when such tubes or pipes are arranged and connected togther, and protected from the direct action of the fire, substantially in the manner herein described.

2. I claim the interior circulation tubes, herein described, when the said tubes are perforated in the manner and secured in their position in the manner substantially as described, when used in the vertical tube of a boiler as and for the purposes set forth.

RICHARD J. NUNN.

Witnesses:

WILLIAM T. BLACK,

J. H. PARSONS.