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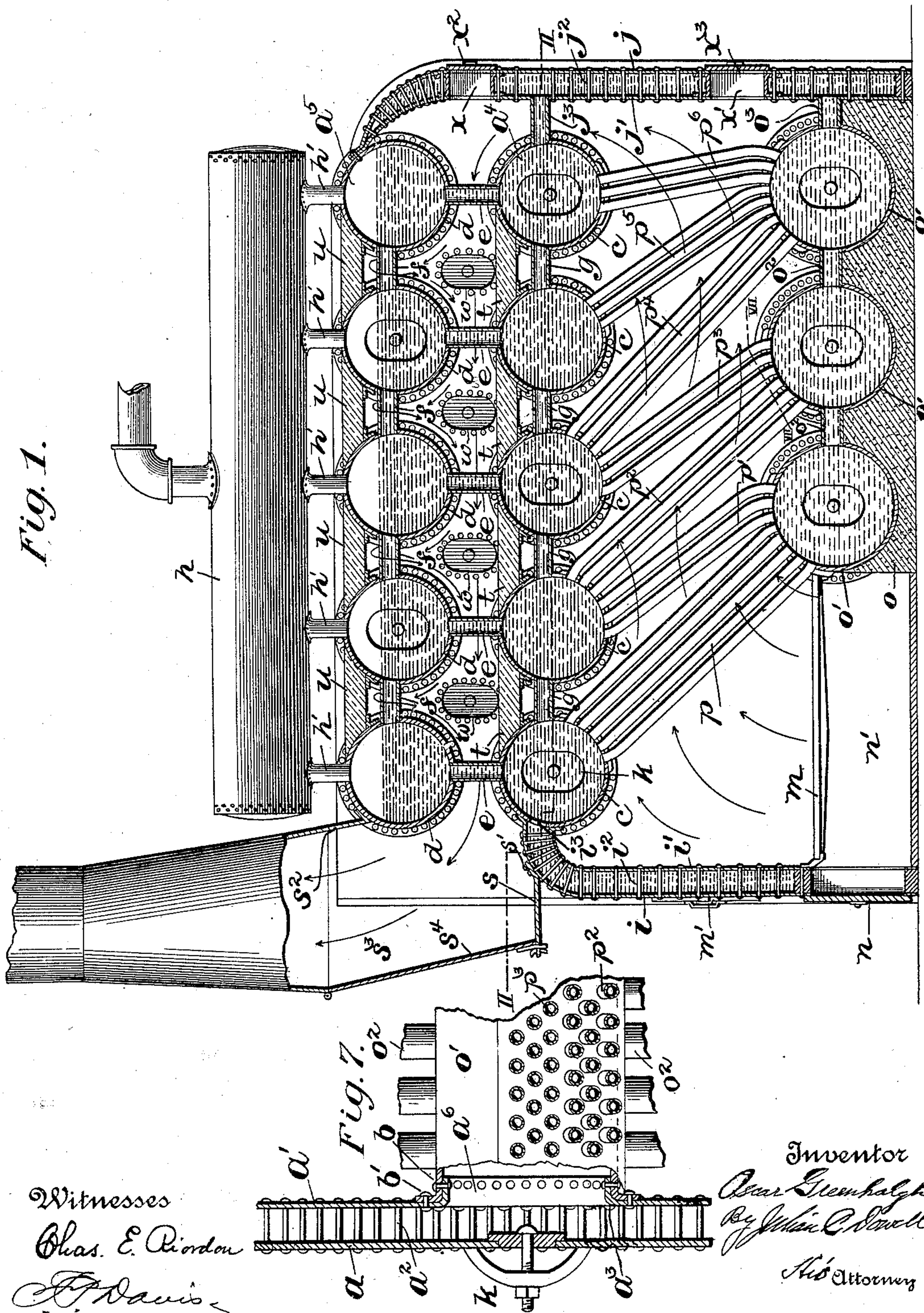
Patented Oct. 18, 1898.

O. GREENHALGH.
STEAM GENERATOR.

(Application filed Feb. 28, 1898.)

(No Model.)

3 Sheets—Sheet 1.



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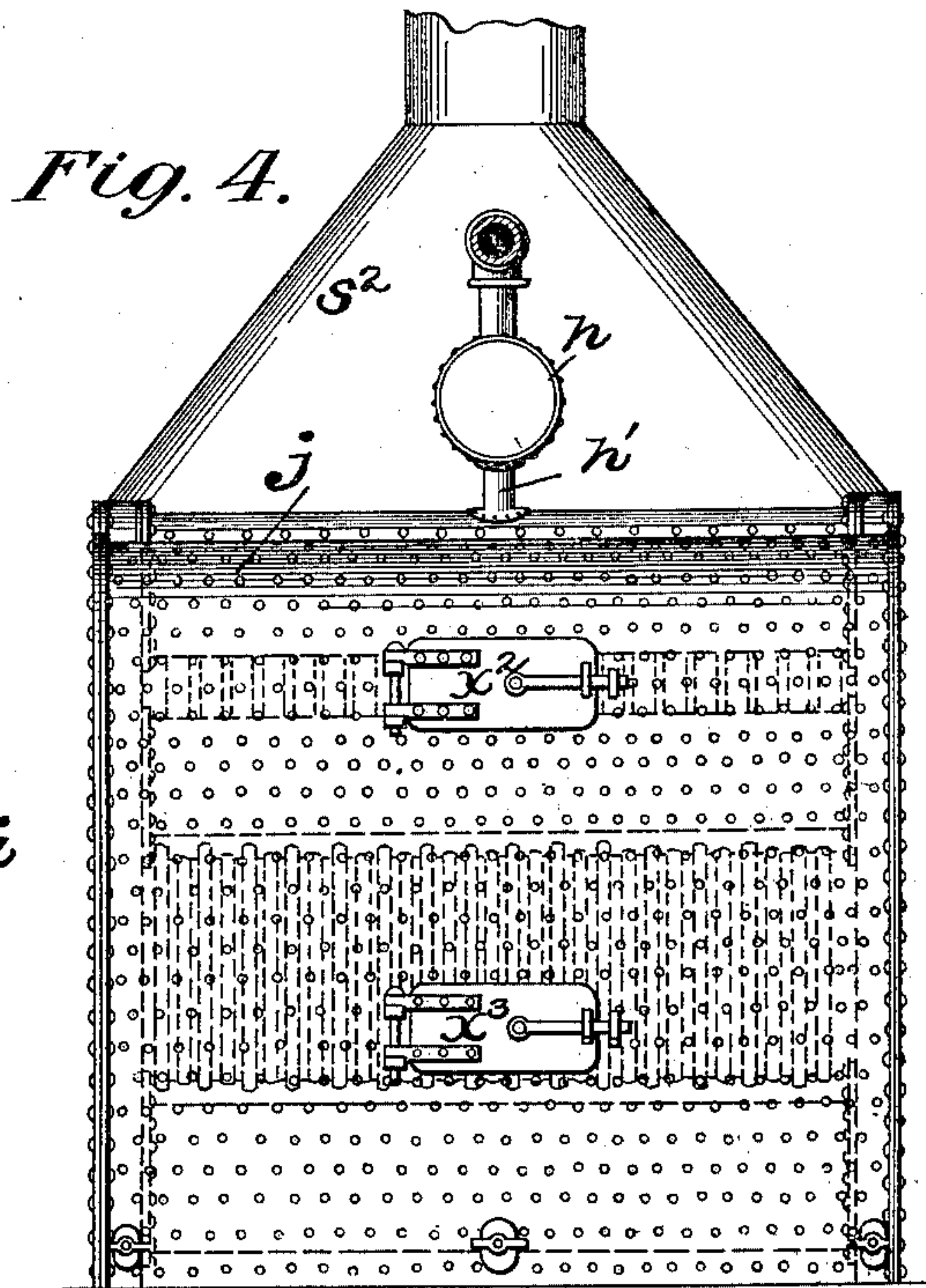
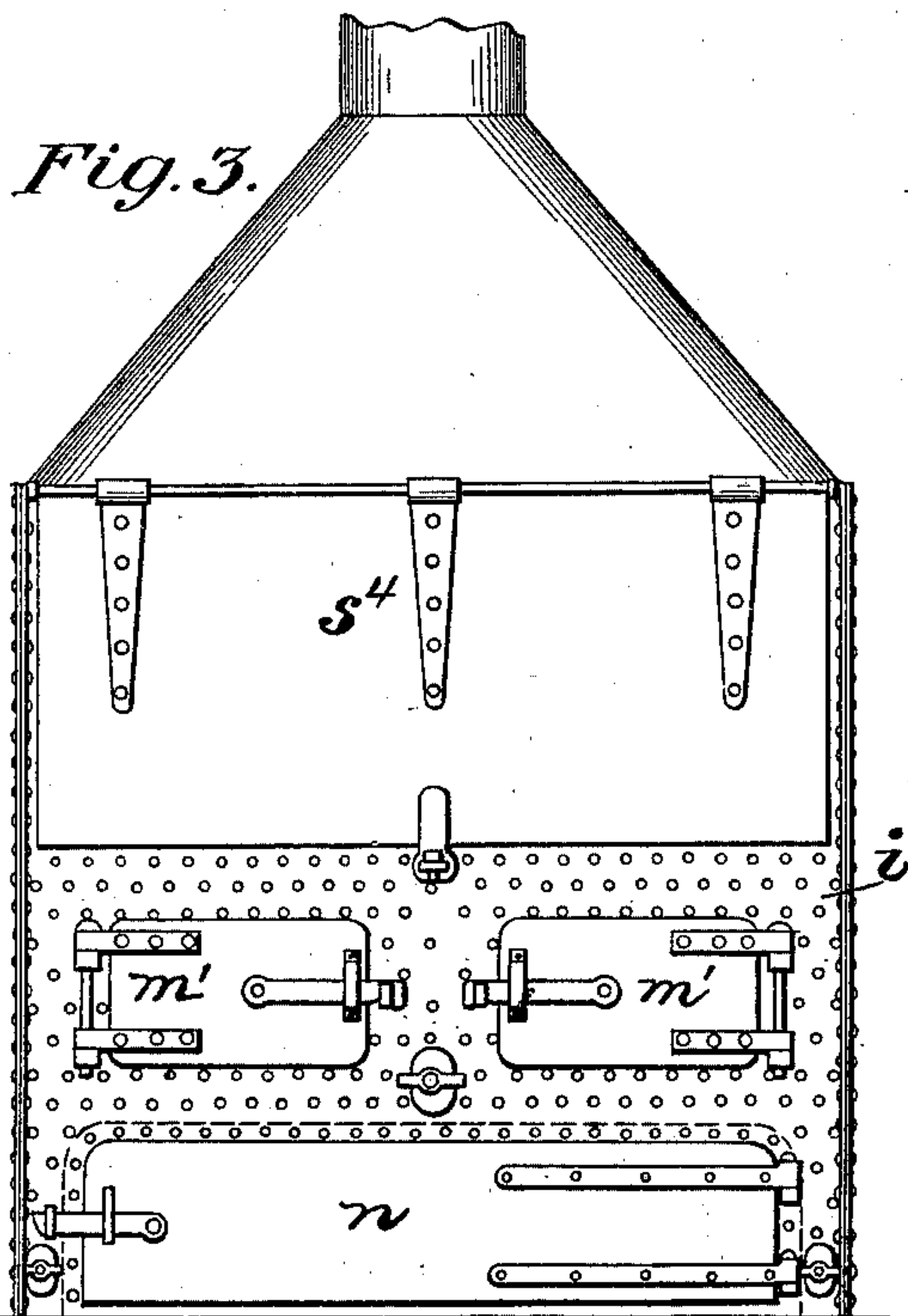
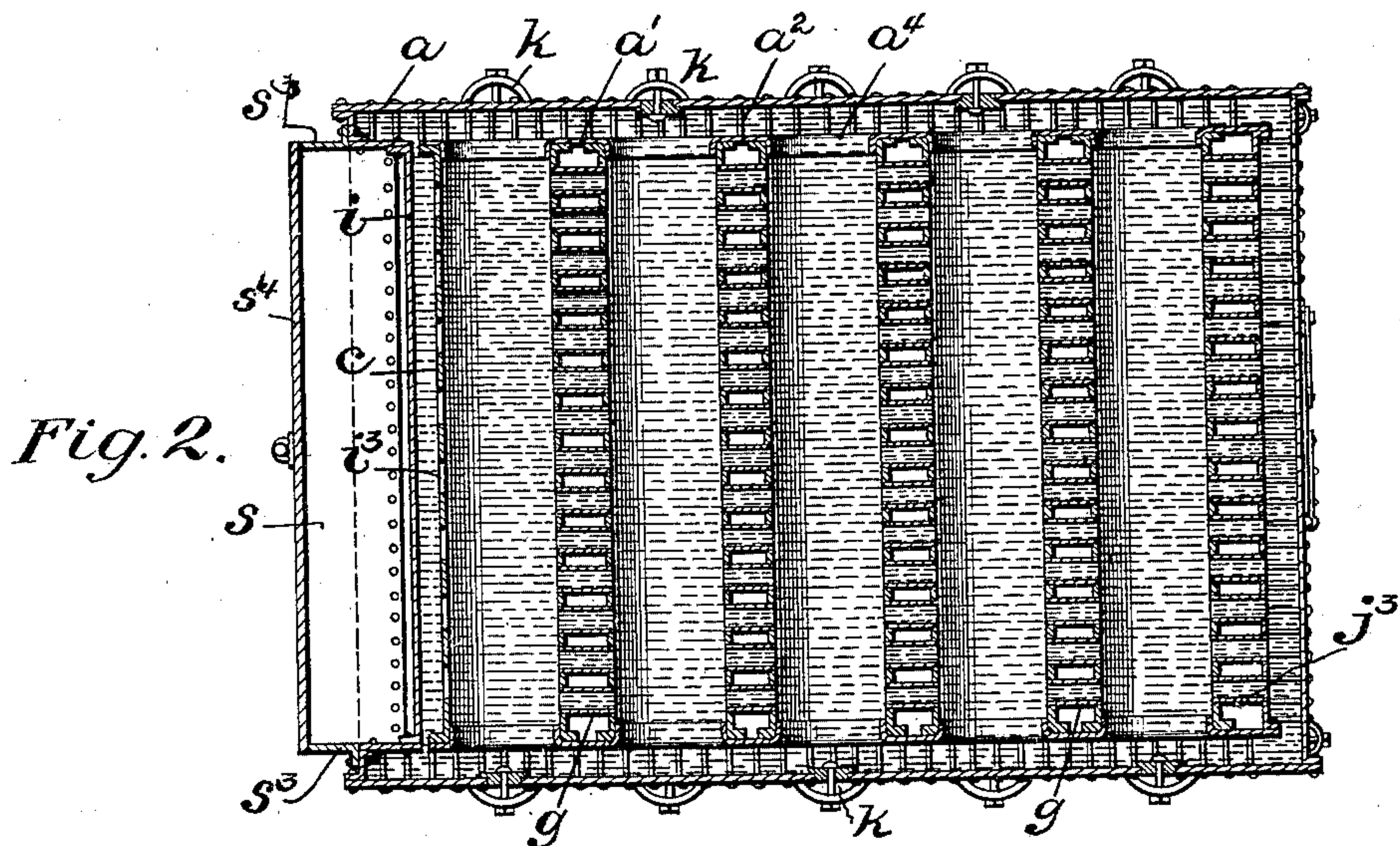
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3 Sheets—Sheet 2.



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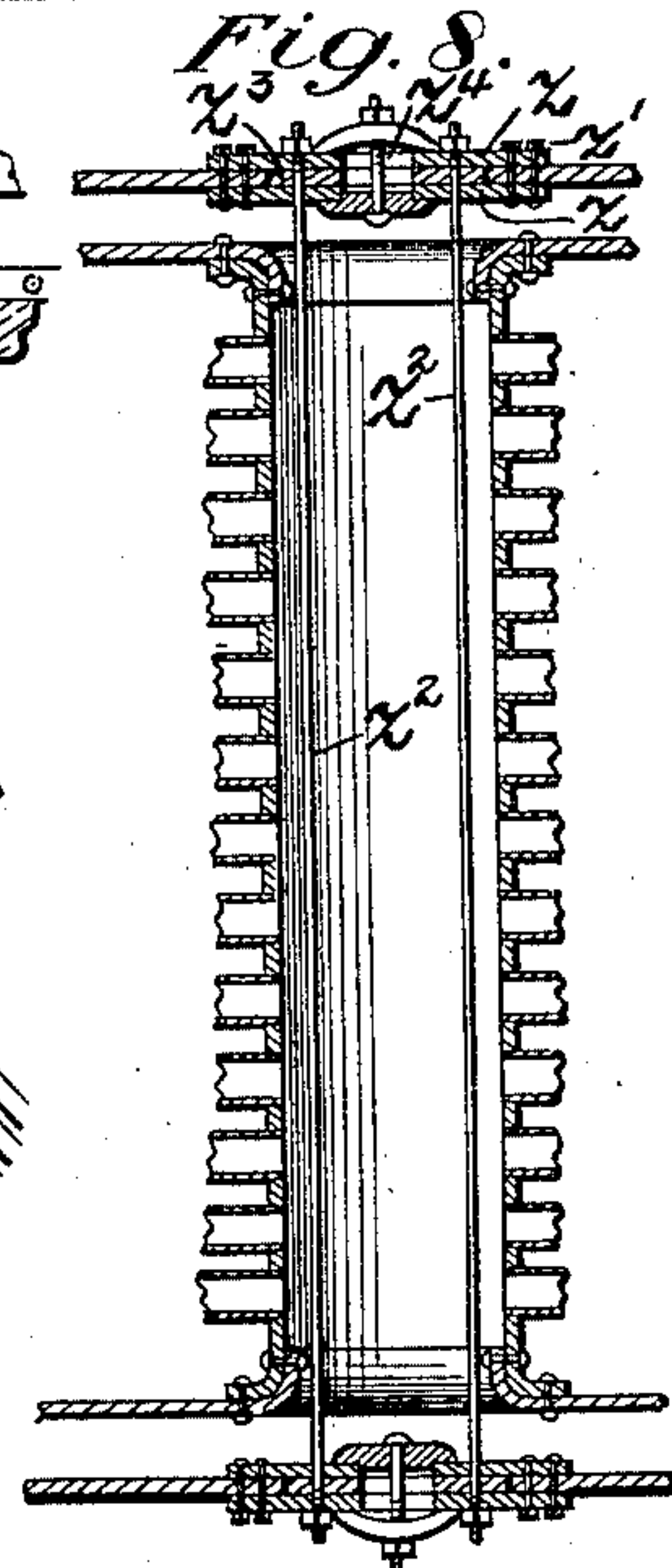
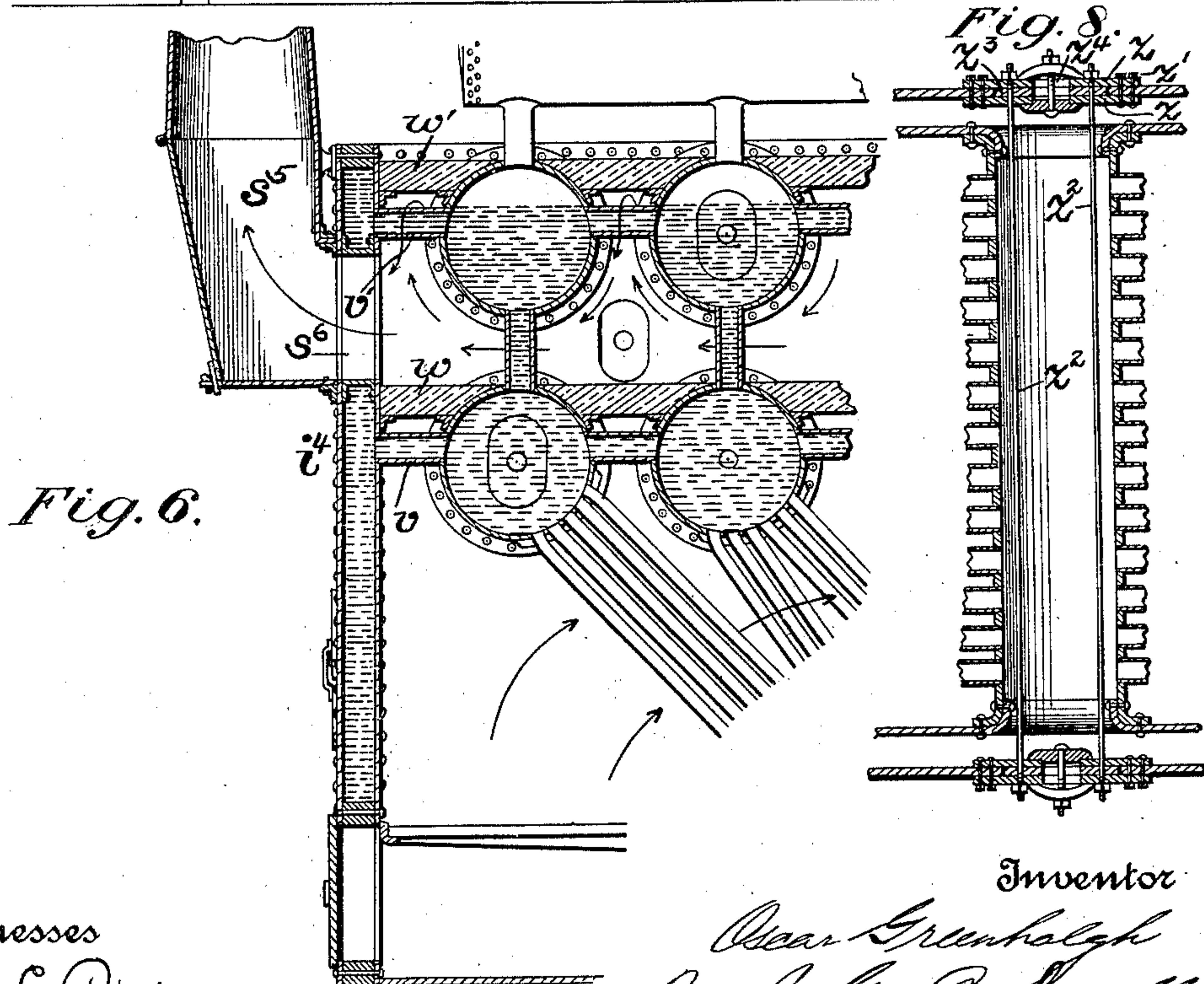
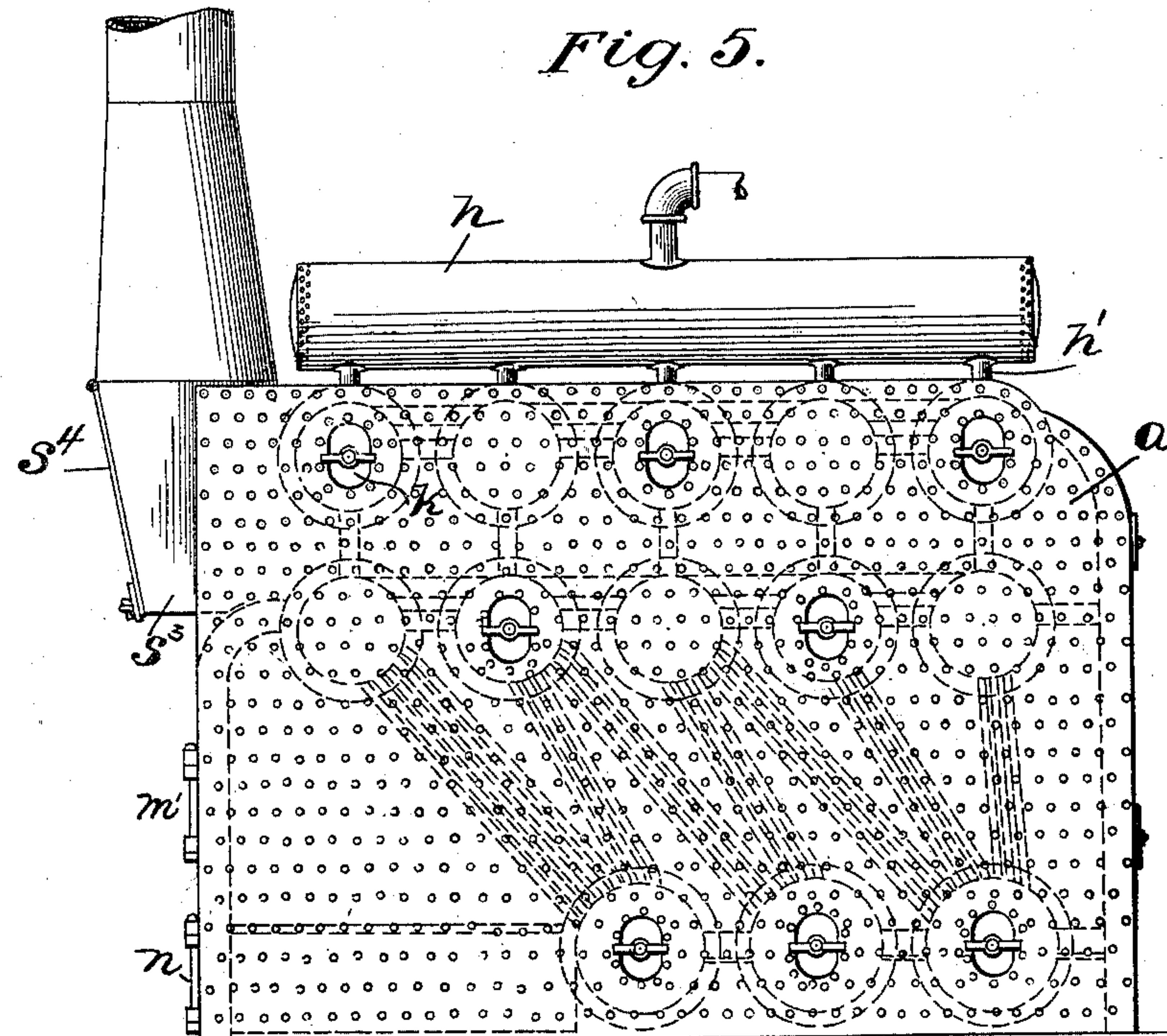
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3 Sheets—Sheet 3.



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UNITED STATES PATENT OFFICE.

OSCAR GREENHALGH, OF CHICAGO, ILLINOIS.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 612,771, dated October 18, 1898.

Application filed February 28, 1898. Serial No. 672,060. (No model.)

To all whom it may concern:

Be it known that I, OSCAR GREENHALGH, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Steam-Generators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to steam-generators; and one object is to provide a construction peculiarly adapted to marine use, fulfilling all the governmental requirements relating to marine boilers and also providing for copious generation of steam at high pressure with perfect safety.

Another object is to provide for convenient inspection of every part of the boiler, while at the same time appropriating every available heating-surface for steam-generating purposes.

The invention aims to provide the greatest possible number of avenues for circulation, so that the maximum capacity for generation of steam may be attained in a given compass, while at the same time the utmost safety is insured and provision made for preventing the increased activity in the circulation of the water subjected to the greatest heat from resulting in the emptying of any of the drums, pipes, or tubes and consequent disaster. Strength and durability are desiderata which have been kept constantly in view in evolving the present invention.

With the above-stated objects in view the invention consists in certain peculiarities of construction and combinations of parts hereinafter enumerated and specifically described and the essential elements of which are pointed out in the appended claims.

The drawings which accompany and form part of this specification illustrate preferred forms of embodiment of the invention.

Figure 1 is a central longitudinal vertical sectional view of a complete steam-generator. Fig. 2 is a horizontal section taken on the line II II of Fig. 1. Figs. 3 and 4 are front and rear elevations, respectively, of the generator. Fig. 5 is a side elevation of the same. Fig. 6 is a longitudinal vertical section similar to Fig. 1, but showing only the front portion of

the generator, this view illustrating a slightly-modified construction as compared with Fig. 1. Fig. 7 is a fragmentary sectional elevation illustrating a detail of construction, the section being taken on line VII VII of Fig. 1. Fig. 8 is a longitudinal section of a water-drum and connections, illustrating a modification in the construction of closures.

The generator is of the "water fire-box" type, the walls on all sides of the fire-space or combustion-chamber being hollow and in free communication and adapted to constitute water-legs which by their peculiar relation to other parts of the boiler, hereinafter described, are highly efficacious in preventing the emptying of the avenues of circulation exposed to the greatest heat. Each side wall is composed of outer and inner sheets (designated, respectively, by reference-letters a and a') and securely bound together by means of numerous rivets a^2 , the inner sheet being formed with three horizontal rows of openings a^3 , a^4 , and a^5 , the openings of the lower row being somewhat larger than those of the two upper rows and all the openings being of considerable size and each bounded by an inturned flange a^6 , as clearly shown in Figs. 2 and 7. Three tiers or batteries of drums extend across between the said side walls, the ends of the drums embracing the inturned flanges a^6 and being riveted thereto, as shown at b in Fig. 7, and the ends of the drums being flanged and riveted to the inner plate a' , as shown at b' in said figure. Two tiers of these drums extend across the upper part of the fire-box, and the drums of the lower one of these tiers are designated by the letter c , while those of the upper tier are designated by the letter d , and it will be seen that all of these drums freely communicate at their ends with the water-spaces in the hollow side walls. In the construction here shown there are five drums in each of the said two series, and each drum of the upper series is located immediately over a drum of the lower series and is connected therewith by short pipe-sections or nipples e , so that water may freely circulate between the two series of drums. The drums of each series are similarly connected by means of short horizontal pipe-sections or nipples f and g , and all of these connections occur frequently throughout the length of the

drums, as clearly indicated in Figs. 2 and 4. By this arrangement free circulation between all of the drums of both series is provided for, the disengagement of steam taking place in the upper series of drums at the water-line indicated in the drawings. A longitudinally-disposed steam-drum *h* is preferably mounted above the upper set of drums, being in communication with each of the latter through pipes *h'*.

The front side of the boiler is formed by sheets *i* and *i'*, connected by numerous rivets *i*² and curved over at their upper ends, so as to lie against the forward drum of the series *c*, to which drum said plates are riveted on each side of a longitudinal series of openings *i*³ in the front side of the drum and affording communication between the interior of the latter and the water-space in the front wall of the boiler. The rear wall of the boiler is composed of sheets *j* and *j'*, secured together by numerous rivets *j*² and curved over at their upper ends, where they lie upon each other and are securely riveted to the rearward drum of the upper series *d*. The water-space in the rear wall of the boiler is in communication with the rearward drum of the series *c* by means of short horizontal pipe-sections or nipples *j*³, of which there are a considerable number, as shown in Fig. 2, where it will also appear that these nipples and those connecting the drum *c* are in horizontal alinement. Manholes are provided in the outer side plates *a*, there being one for each of the drums *c* and *d* and each manhole being provided with a suitable closure, as shown at *k*. The manholes for each series of drums are preferably alternated in the sides of the boiler, access being had to the first drum of the series through a manhole at one end of the same and to the second drum of the series through a manhole at the opposite end thereof, this arrangement preventing undue weakening of the side plates of the boiler.

The outer sheets *a* of the side walls are securely riveted to the outer sheets *i* and *j* of the front and rear walls, and the inner sheets *a'* of the side walls are similarly connected with the inner sheets *i'* and *j'* of the end walls, all as shown in Fig. 2, and thus it will be seen that the walls of the boiler constitute a surrounding water fire-box.

The grate occupies a position at the lower front part of the space included by the hollow wall, said grate being designated by the letter *m* and extending below two of the drums *c*. Access is had to the upper side of the grate through suitable doors *m'* on the front wall, in which openings of appropriate size are made, the sides of such openings of course closing the water-space between the sheets of the front wall. Another door *n* gives access to the ash-pit *n'*, which extends to a bed of cement *o* back of the grate and in which is set a horizontal series of transverse mud-drums *o'*, the said drums being

for the most part below the plane of the grate and connected by short horizontal pipe-sections or nipples *o*². These mud-drums, like the water-drums *c* and *d*, communicate at their ends with the water-space in the side walls of the boiler, and manholes are provided in the outer sheets of said side walls, whereby access may be had to the interior of the mud-drums. The rearmost mud-drum also communicates with the water-box through short pipe-sections or nipples *o*³, entered in the inner sheet *j'* of the rear wall. The mud-drum immediately adjacent to the grate is connected with the front water-drum *c* by means of tubes *p*, which extend obliquely above the grate, there being a great many of these tubes and their arrangement being similar to that commonly employed in boilers of this type. Similar tubes *p'* connect the said mud-drum with the second water-drum, and the latter is also connected by tubes *p*² with the second mud-drum, the latter being connected by a tube *p*³ with the third water-drum of the series *c*. In the present instance three mud-drums are shown, and the rearward one is connected by tubes *p*⁴, *p*⁵, and *p*⁶, respectively, with the third, fourth, and fifth water-drums. All the connecting-tubes above specified are staggered, as shown in Fig. 7, and it will be observed that their joinder with the drums is effected without much bending of the tubes and that as many straight tubes are used as possible, all of which facilitates the removal and replacing of the tubes and enhances the practicability of the structure.

The course of the products of combustion is rearwardly among all the tubes, as indicated by the arrows in Fig. 1, the spaces between the water-drums *c* being closed over by bridgework, which may be composed of fire-brick and is designated in the drawings by reference-letter *t* and is represented as resting upon suitable brackets secured to the drums. Such products pass upwardly between the rear wall of the boiler and the rearmost drum *c*, and thence forward between the drums *c* and *d*, bridgework *u*, similar to that employed between the drums *c*, closing the spaces between the drums *d*.

The smoke-flue is located at the front side of the boiler above the front wall or water-leg, and its bottom plate *s* is bolted to the latter, as shown at *s'*, while its rear side *s*² is bolted to the forward drum *d* of the upper series, the lower portion of the smoke-flue extending practically the full width of the boiler and its sides *s*³ being shaped to upper corners of the side walls of the latter, to which they are bolted. A large door *s*⁴ is preferably provided at the front side of the enlarged lower portion of the smoke-flue to give access for cleaning purposes. Armholes are also provided in the side walls of the boiler, as indicated at *w*, these armholes being suitably located to give access to the fire-brick *t*, so that repairs can conveniently be made. In the rear wall of the boiler clean-out openings are

provided, as shown at x and x' , and are closed by suitable doors x^2 and x^3 , whereby access may be had to the upper and lower parts of the combustion-chamber at the rear.

5 In Fig. 6 a construction is shown which is somewhat modified as compared with that already described, in that the front wall i^4 of the boiler is not curved over to meet the front water-drum c , but extends to the top of the boiler, communicating with said front drum c through a horizontal series of nipples v and
10 also with the front drum d through a horizontal set or series of nipples v' . Additional bridgework w and w' closes the spaces between these drums and the front wall, and
15 the smoke-flue s^5 is bolted to the outer plate of the front wall of the boiler around a suitable opening s^6 , below the nipples v' , and through which the products of combustion
20 escape to the smoke-flue.

In Fig. 8 a special construction is illustrated for closing the ends of the drums, whereby manholes are dispensed with, while at the same time provision is made for gaining access as required to the interior of the drum.
25 Openings approximating in size the circumference of the drum are made in the outer sheets of the hollow side walls opposite the ends of the drum, and larger circular plates
30 z close these openings, said plates fitting against the inner and outer sides of said sheets and being bolted thereto, as shown at z' , and also being bound together by tie-rods or long bolts z^2 , which extend through the drum.
35 Between each pair of plates z , where they project from the edges of the opening in the outer boiler-sheet, is inserted an annular filling-plate z^3 , through which the bolts z^2 pass. Armholes are provided in the plates, as indicated at z^4 , through which access for any ordinary purposes may be had. Should it become necessary for a man to enter the drum, the plates z can be unbolted and removed;
40 but it is calculated that this will rarely be necessary. This modified construction of drum closure is more especially intended for small boilers, which would be impaired by the removal of material to form manholes.

It will be seen that a construction of boiler
50 such as above described is well calculated to fulfil all the requirements of a marine as well as a stationary boiler and is entirely capable of thoroughly accomplishing the objects primarily stated.

55 The free communication between the water, fire-box, and the drums insures the latter being fully charged at all times when the boiler is in operation, and hence there is no danger of the emptying of any of the avenues of circulation by excessive activity of the water where the greatest heat is felt. The arrangement for communication between the drums by the short pipe connections is also beneficial in this connection.
60

65 The arrangement of the double tier of drums at the upper part of the combustion-chamber with pipe connections between every pair of

adjacent drums provides for a circulation between these drums which is highly efficacious in the copious generation of steam.

70 Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a steam-generator, the combination of a plurality of horizontal tiers or batteries of drums transversely arranged at the upper part of the combustion-chamber, connections between adjacent sides of said drums establishing communication between all of them, and bridgework closing the spaces between the drums of the lower tier to deflect the products of combustion, substantially as described.

2. In a steam-generator, the combination of a series of transverse mud-drums set in a suitable foundation back of the grate of the fire-box; a horizontal series or battery of transverse water-drums at the upper part of the fire-box, the forward one of said series being directly over the grate, tubes connecting said forward drum with the forward mud-drum, tubes connecting the latter with the second water-drum, tubes connecting the second mud-drum with the second and third water-drums, and tubes connecting the last mud-drum with the third, fourth and fifth water-drums.

3. In a steam-generator, the combination of hollow walls surrounding the combustion-chamber and providing water-spaces all around the latter, mud-drums set in a suitable foundation back of the grate and communicating at their ends with the side water-spaces, a plurality of horizontal series or batteries of water-drums transversely arranged at the upper part of the fire-space and communicating with the side water-spaces and with each other, tubes connecting the lower series of the said water-drums with the mud-drums, and deflecting bridgework between the batteries of water-drums.

4. In a steam-generator, the combination of a water fire-box, a set of water-drums transversely arranged at the upper part of the combustion-chamber and communicating at their ends with the water-spaces in the side walls of said fire-box, said drums also communicating directly with each other through connections between their adjacent sides and the end drums of the series communicating with the water-spaces in the end walls of the fire-box; one or more mud-drums back of the grate, and tubes connecting the mud-drums with the water-drums.

5. In a steam-generator, the combination of a water fire-box, a set of water-drums transversely arranged at the upper part of the combustion-chamber and communicating at their ends with the water-spaces in the side walls of said fire-box, said drums also communicating directly with each other through connections between their adjacent sides and the end drums of the series communicating with the water-spaces in the end walls of the

fire-box; a series of mud-drums transversely arranged back of the grate and communicating at their ends with the water-spaces in the side walls of the fire-box, the rearmost mud-drum also communicating with the water-space in the rear wall of the fire-box; and tubes connecting the mud-drums and the water-drums.

6. In a steam-generator, the combination of a water fire-box, a set of water-drums transversely arranged at the upper part of the combustion-chamber and communicating at their ends with the water-spaces in the side walls of said fire-box, said drums also communicating directly with each other through connections between their adjacent sides and the end drums of the series communicating with the water-spaces in the end walls of the fire-box; a second set of drums above the first set and communicating therewith and with each other and also communicating at their ends with the water-spaces in the side walls of water fire-box, the front drum of the second series also communicating with the water-space in the front wall of the said fire-box; one or more mud-drums back of the grate, and tubes connecting said mud-drums with the water-drums of the first-named set or series.

7. In a steam-generator, the combination of a grate at one end of the combustion-chamber, a smoke-stack at the same end of the latter, two series of connected water-drums arranged transversely at the upper part of the combustion-chamber above and below the entrance to the smoke-stack, bridgework be-

tween the drums whereby the products of combustion are caused to pass through the combustion-chamber below one series of drums, thence around one end thereof, and back between the two sets or series of drums to the stack, mud-drums back of the grate, and tubes connecting said mud-drums with the lower set of water-drums.

8. In a steam-generator, the combination of a water fire-box, the outer sheets of whose side walls are formed with alining openings, a drum extending between the inner sheets of said side walls in line with said openings, plates bolted to the outer sheets and closing the openings therein, said plates having armholes with suitable closures and tie rods or bolts connecting the plates, substantially as described.

9. In a steam-generator, the combination of hollow side and end walls providing water-spaces, drums extending between the side walls and communicating at their ends with the water-spaces therein, connections between adjacent sides of the said drums establishing communication between them, and connections between one of the drums and the hollow end wall establishing communication between the said drum and the water-space in the end wall.

In testimony whereof I affix my signature in presence of two witnesses.

OSCAR GREENHALGH.

Witnesses:

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