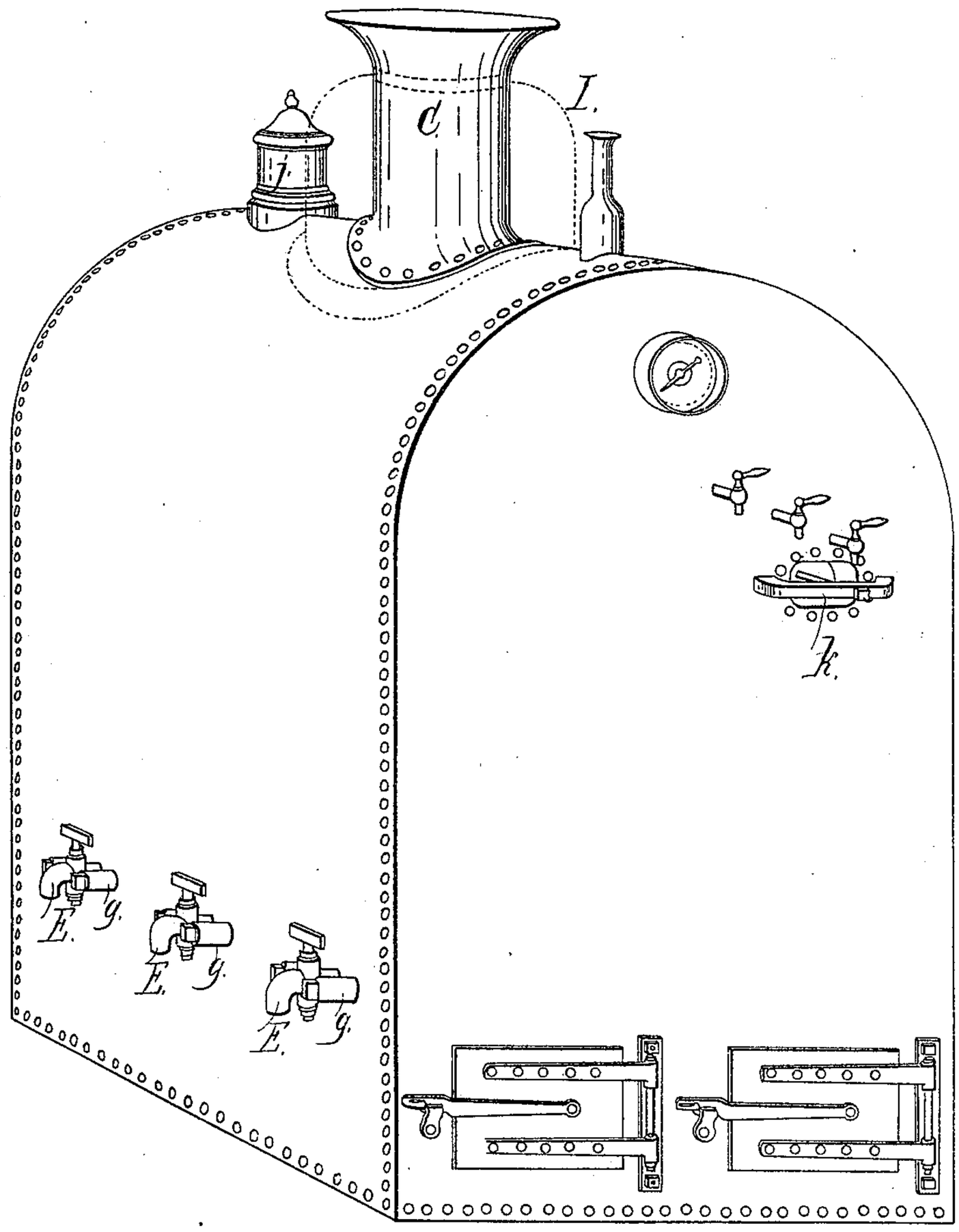
4 Sheets. Sheet 1.

E. Crane,

Steam-Boiler Water-Tube.

No. 26,021. Patented Nov. 8, 1859.

Fig. 1.



Witnesses:
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John Dowling.

Inventor:
Edward Lesesne

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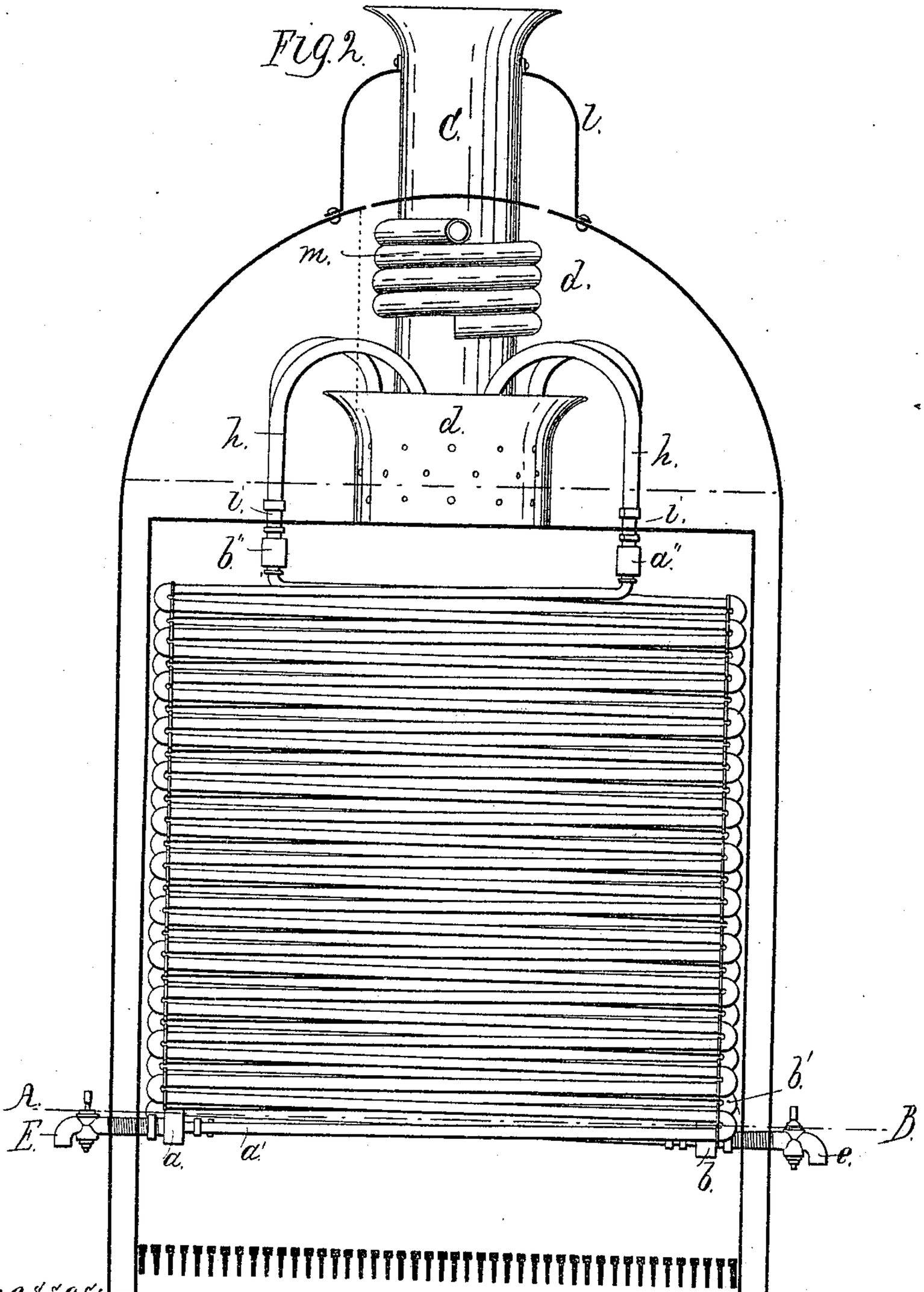
Fig. 2.



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E. Crane,

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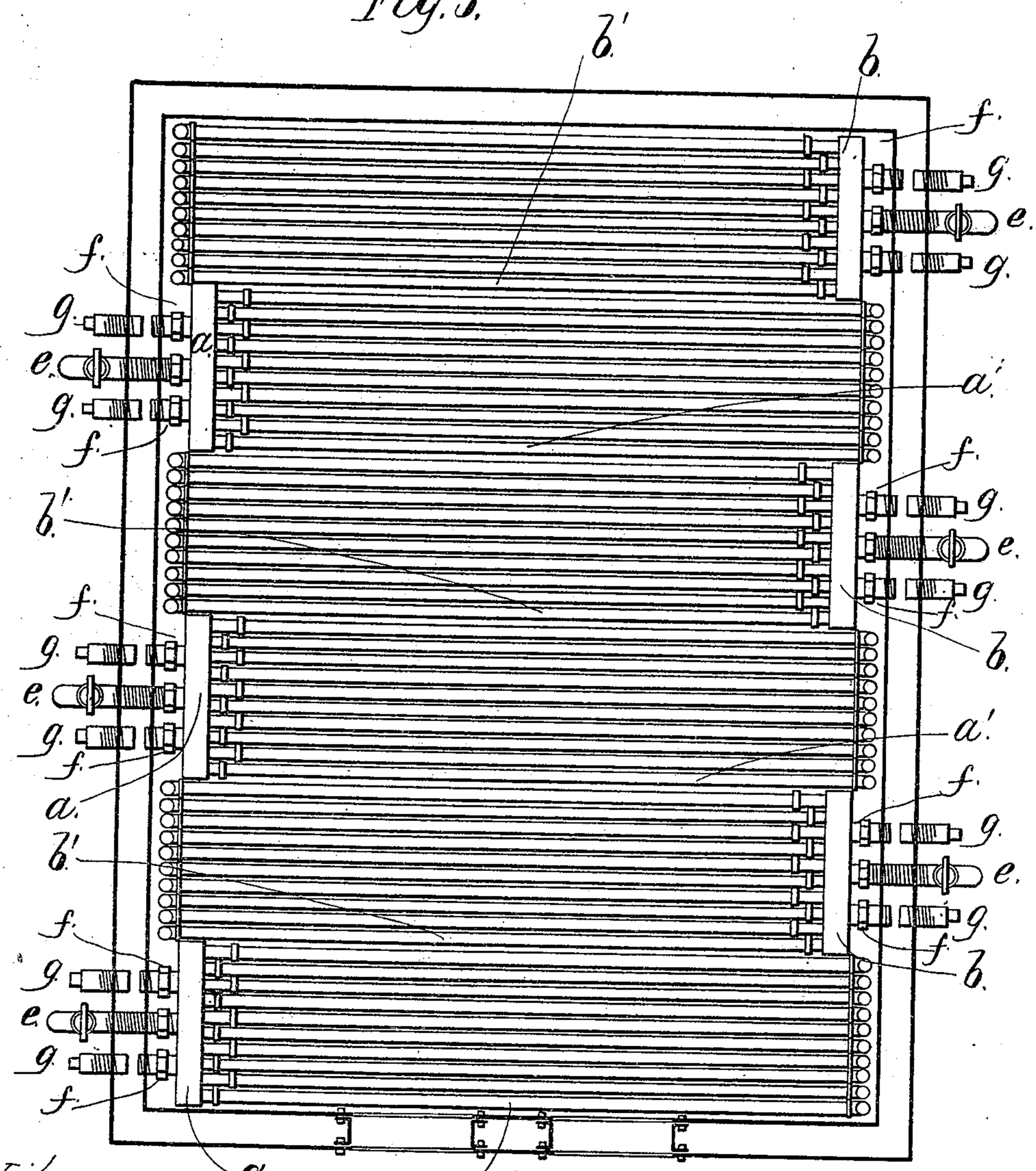
Fig. 3.



Witnesses;
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John Dowling.

Inventor;
Edward Crane

4 Sheets. Sheet 4.

E. Crane,

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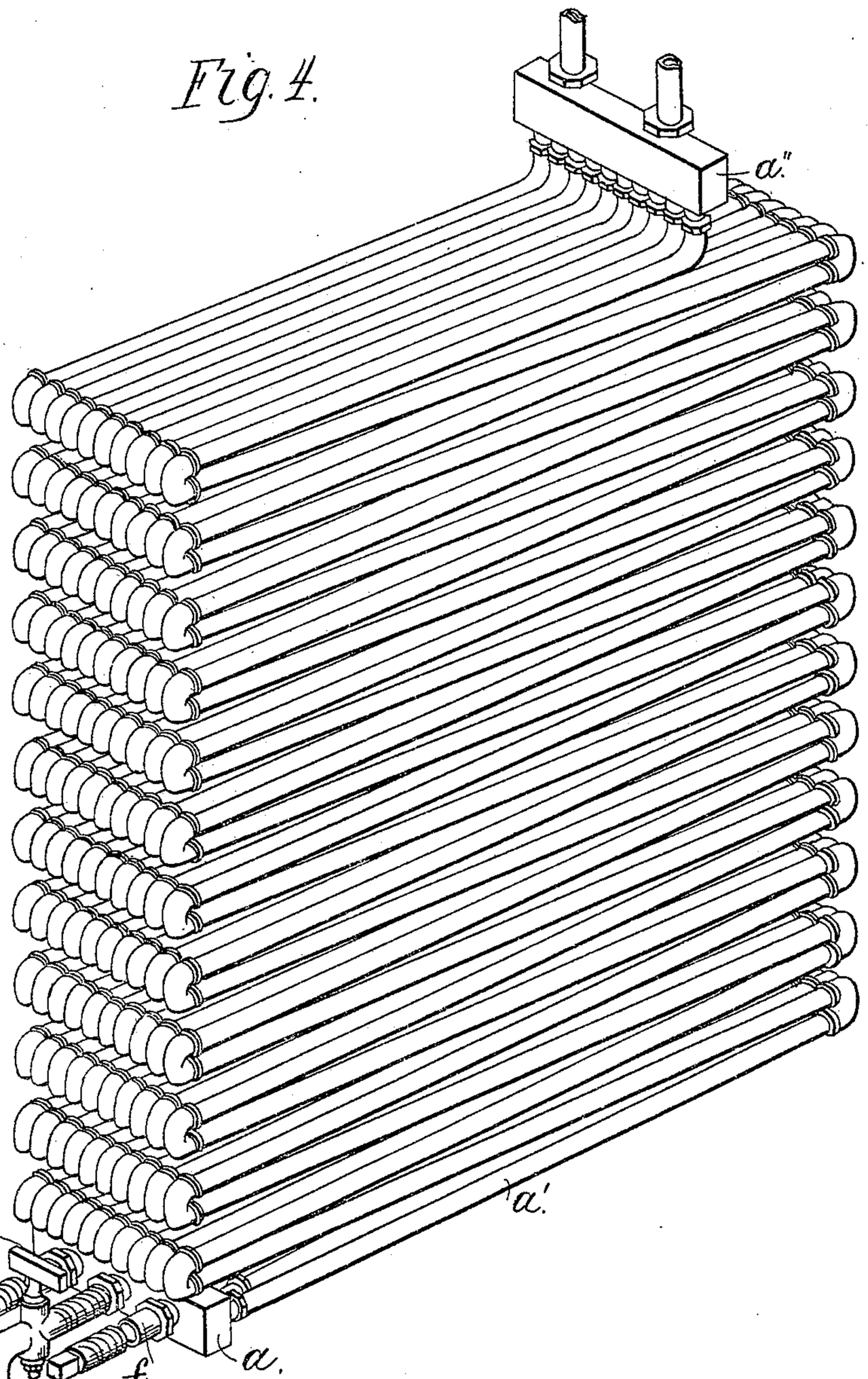
Fig. 4.



Witnesses:
Edward Hollingshead
John Dowling.

Inventor:
Edward Crane

UNITED STATES PATENT OFFICE.

EDWARD CRANE, OF DORCHESTER, MASSACHUSETTS.

IMPROVED STEAM-BOILER.

Specification forming part of Letters Patent No. **26,021**, dated November 8, 1859.

To all whom it may concern:

Be it known that I, EDWARD CRANE, of Dorchester, in the county of Norfolk and State of Massachusetts, have invented a new and useful Improvement in Steam-Boilers; and I hereby declare the following is a true and exact description thereof.

My improvement relates to the increase of the heating-surface of the boiler, together with the grate-surface, and also to the superheating of the steam, and these objects are effected as follows:

The drawings hereto attached are referred to for the purpose of rendering the description more intelligible, and the same letters are used in the different drawings or figures to designate the same parts.

Figure 1 is a perspective view of the boiler, exhibiting the blow-off cocks E, the stop-cocks *g*, and opening *k*. It also shows the outline of the steam-dome *l*, surrounding the chimney *c*. Another steam-dome *j* is also exhibited, of the usual form, for which the former is to be substituted.

Fig. 2 is a vertical transverse section of the boiler, exhibiting the blow-off cocks E, the water-boxes *a* and *b*, the tubes in the fire-box *a'* and *b'*, the steam-boxes *a''* and *b''*, the mode of connecting the tubes to the boiler, the mode of discharging their contents into the steam-chamber, a drum *d*, into which the discharge is made, the chimney *c*, the outline of the steam-dome *l* surrounding the chimney, and a tube *m*, coiled around the chimney in the steam-chamber, through which the steam is taken to the cylinders.

Fig. 3 is a horizontal section or plan through the lowest portion of the tube, exhibiting the blow-off cocks *e*, the stop-cocks *g*, the tubes *f* for supplying water to the tubes, the water-boxes *a* and *b*, and the lower portions of the tubes *a'* and *b'*. The tubes to the number of about ten are connected at their extremities to the water-boxes *a* and *b* at the lower end and steam-boxes *a''* and *b''* at the upper end, as in Fig. 2. The boxes and tubes connecting with the water-jacket on the left are marked *a* and *a'*, those on the right *b* and *b'*.

Fig. 4 is a perspective view of a single system or section of the tubes connected by means of the boxes *a* and *a''*, detached from the boiler.

In external appearance the boiler bears resemblance to the portion of a locomotive-boiler which contains the fire-box, the cylindrical portion being removed and a chimney carried from the fire-box directly upward through the steam-chamber. The fire-box occupies the whole of the inner portion of the boiler, there being simply a water-space around it about two inches in thickness, and it should be about six feet high. The bottom is occupied by the grate, which is placed a few inches above the lower edge of the water-jacket, as it generally is in locomotive-boilers. The middle and upper portions of the fire-box are filled with long tubes about an inch in diameter connected at the lower end with the water-boxes *a* and *b* and rising by successive coils or folds to the steam-boxes *a* and *b* underneath the crown-sheet, in the manner represented in Fig. 2. For convenience in the construction of the boiler a convenient number of the tubes are connected together by means of the boxes *a* and *a''* and *b* and *b''*, and a whole section of tubes can thus be placed in the fire-box at once. By reference to Figs. 2 and 4 it will be seen that the long tubes are formed by several short straight tubes connected by curved joints into which they are screwed in the manner practiced in steam-heating apparatus. The tubes are connected with the water-boxes by means of short tubes, which are first screwed into the boxes and connected with the long tubes by means of a collar cut with right and left screws to fit corresponding screws on the ends of the tubes. By turning the collar the ends of the tubes can be drawn together and made perfectly tight. These short tubes should be an inch and a half in diameter or two inches. To place a section of tubes thus joined together in the fire-box three short tubes are screwed into the lower water-box on the side next the fire-box and three corresponding tubes are screwed into the boiler. These tubes are shown at *f* in Fig. 3. Two of them pass through the inner shell of the boiler and terminate in the water-space. The middle one passes through the outer shell of the boiler and forms a blow-off cock. These tubes are connected with the short tubes in the water-box by means of a collar containing a right and left screw, which fits corresponding screws on the tubes. At the upper end

the steam-box is connected to the crown-sheet in a similar manner by means of two tubes only.

In placing the tubes in their place the workmen stand in the fire-box and commencing at the end of the boiler opposite the opening *k*, the sections are fastened in their places consecutively till the last one is reached. The upper nuts for fastening this section in its place are reached through the opening *k*, the lower ones from below the boiler. If necessary, the tubes can be further secured to the sides of the fire-box by rests or stays.

The tubes which pass through the crown-sheet are terminated by the ends being bent downward and toward the chimney, so as to discharge the steam generated within them against the chimney and then on to the surface of the water within the drum *d*. This drum is to be perforated with holes, so as to allow the water above the fire-box to have free access to it, and it may be extended upward, as traced by the lines *d'*, to the roof of the boiler, so as to form a support or stay to resist the pressure of the steam. In such case it should be perforated with holes above the water-line as well as below, so that the steam as well as the water shall pass through it freely.

The length and diameter of the tubes in the fire-box may be considerably varied, but in general the diameter should be about one inch, and the length should be such that when the boiler is in operation the water entering the tubes should all be converted into steam before it has passed through more than two-thirds of the coil, so that the upper parts of the tubes shall be filled with steam only, which will be superheated before it is discharged into the steam-chamber. The stop-cocks *g* are fastened to the outer shell of the boiler and work through screws, so that they can be screwed up against the ends of the tubes *f* and stop the passage of the water into the water-boxes. These boxes are made of boiler-iron and are long enough for the immersion of the required number of tubes, and in the transverse section are about three inches square. The chimney *e* must be of boiler-iron capable of resisting the pressure in the boiler.

The drum *d* may be of thin iron; but when used as a support, as above described, it should be of sufficient thickness to give the required resistance. Any additional support which may be needed to sustain the crown-sheet may be obtained by means of stay-bolts connecting this sheet with the outer shell of the boiler. The steam-dome around the chimney has no peculiarity in its construction which requires particular description. The coil *m* around the chimney is made of thin iron, and is pierced with small holes for the entry of the steam, and is placed around the chimney in order that the steam may be taken from that part of the chamber which has the highest temperature.

The operation of my boiler is as follows: The stop-cocks *g* being opened and the cocks *e* closed, the water is pumped into the boiler, and passing through the tubes *f* into the boxes *a* and *b* fills the tubes, the upper boxes *a''* and *b''*, and the tubes in the steam-chamber up to the water-line. The fire being built, the heated air rises through the fire-box around the tubes and is discharged through the chimney. The space through the fire-box is so large that a comparatively slow draft serves to supply fresh air to the fuel, while the heating-surface with which it comes in contact is so large that ample opportunity is given to impart the heat to the water. The grate-surface, also, is so large that a large amount of fuel is brought into contact with the air, by which means a slow rate of combustion can be maintained. When the boiler is in full operation, the evaporation will take place so rapidly that the upper portion of the tubes will be filled with steam, and the water-line in the tubes carried down much lower than it is in the boiler, in consequence of which and of the tendency of the steam to rush upward the water in the water-jacket will be forced rapidly into the tubes to supply the loss by evaporation. The upper portion of the tubes, being filled only with steam, will acquire a higher temperature than the lower portions, which are filled with water, and the steam will thus acquire an excess of heat, which it will give out to the water with which it comes in contact on escaping from the bent tubes in the steam-chamber. Particles of water held in suspension by the steam in the chamber will also be converted into steam by this excess of heat and by the radiation from the chimney. From the combined effect of these two causes the temperature of the steam in the chamber will be higher than that of the water below. When the steam-dome is made to surround the chimney, the steam is there further heated by radiation. When it becomes necessary to blow off the pipes, the stop-cocks *g* are screwed up against the ends of the tubes *f*, and the entrance of the water into the boxes and tubes is thus prevented. The blow-off cock *e* is then opened and the contents of the tubes in that section are discharged.

If it is desired to blow off the water in the water-jacket and steam-chamber, the stop-cocks are allowed to remain open and the water will then be forced into the water-boxes and out through the blow-off cocks.

I have already stated that the length of the tubes may be greatly varied. In the drawings hereto annexed I have represented them as about one hundred and ten feet long and about one inch in diameter. This length should be increased or diminished, as the diameter varies very nearly in the ratio of the squares of the diameter.

I claim—

1. In a fire-box surrounded by a water-jacket, the combination of the tubes in the fire-box with the boxes or chambers, as herein described, so that a number of tubes shall

have the same connections through the said boxes or chambers with the water-jacket and steam-chamber, and shall also be capable of being put in and taken out of the boiler at the same time.

2. The use of tubes coiled or folded into the fire-box and connected with the water-jacket and steam-chamber through the boxes or chambers *a* and *b*, and *a''* and *b''*, as herein described, of such length in proportion to their diameter that all the water entering them at the lower end shall be converted into steam in the lower portion and the steam be superheated in the upper portion before it is discharged into the steam-chamber.

3. The use of tubes in the steam-chamber for discharging the steam generated in the tubes in the fire-box, so bent that the superheated steam issuing therefrom shall be discharged into a drum around the chimney and against the chimney in the first instance, and then against the surface of the water, as herein described.

4. The use of the drum around the chimney in the steam-chamber for securing the discharge from the tubes and checking the disturbance of the water through the whole extent of the steam-chamber, arranged and constructed as herein described.

5. The combination of the blow-off cocks *e*, with the stop-cocks *g*, for the purpose of blowing off each section of tubes separately, as herein described.

6. The use of the tube coiled around the chimney for the purpose of taking the steam from the steam-chamber at the point where it has the highest temperature.

EDWARD CRANE.

Attest:

JOHN S. HOLLINGSHEAD,
JOHN DOWLING.