

No. 711,546.

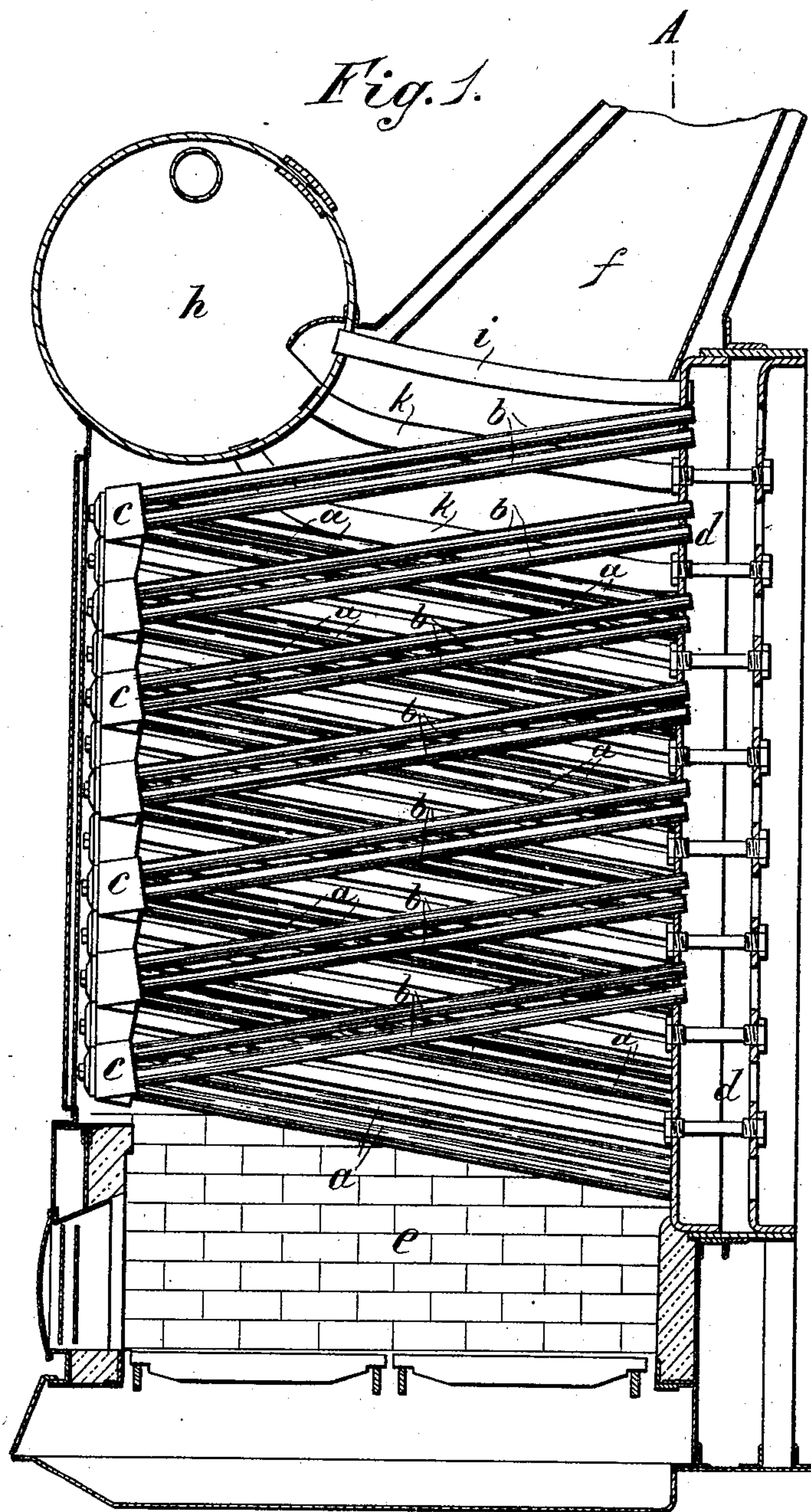
Patented Oct. 21, 1902.

J. E. THORNYCROFT.  
WATER TUBE BOILER.

(Application filed June 18, 1901.)

(No Model.)

3 Sheets—Sheet 1.



Attest:  
W. D. Rafter  
Contractor

by

A Inventor:  
John E. Thornycroft.  
Phillip. J. Sawyer. Rees & Kennedy  
Attys

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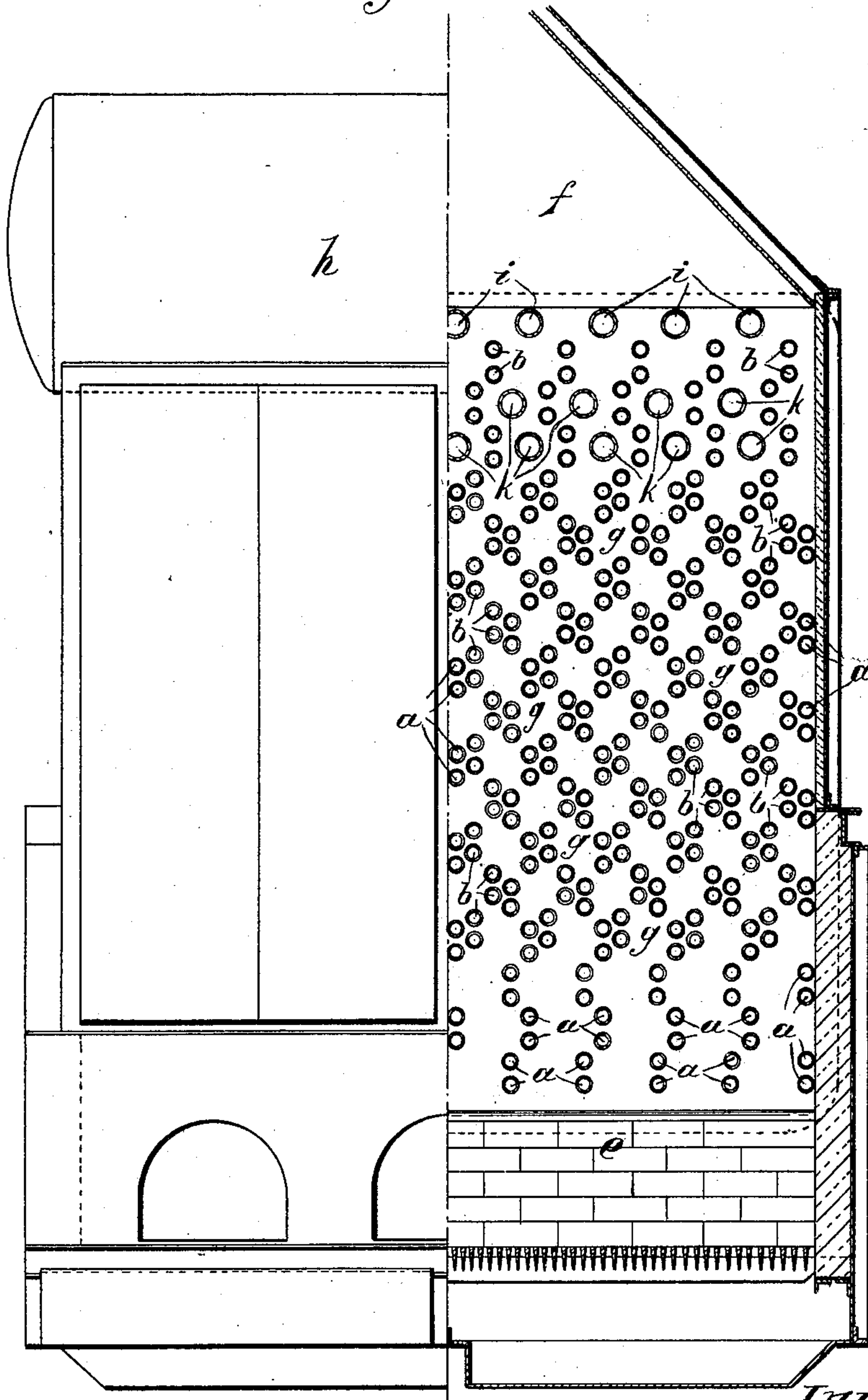
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*Fig. 2.*



Attest:  
G. D. Raper  
Inspector

Inventor  
John E. Thornycroft  
by Philipp. Sawyer, Recd. & Sundry  
Attys



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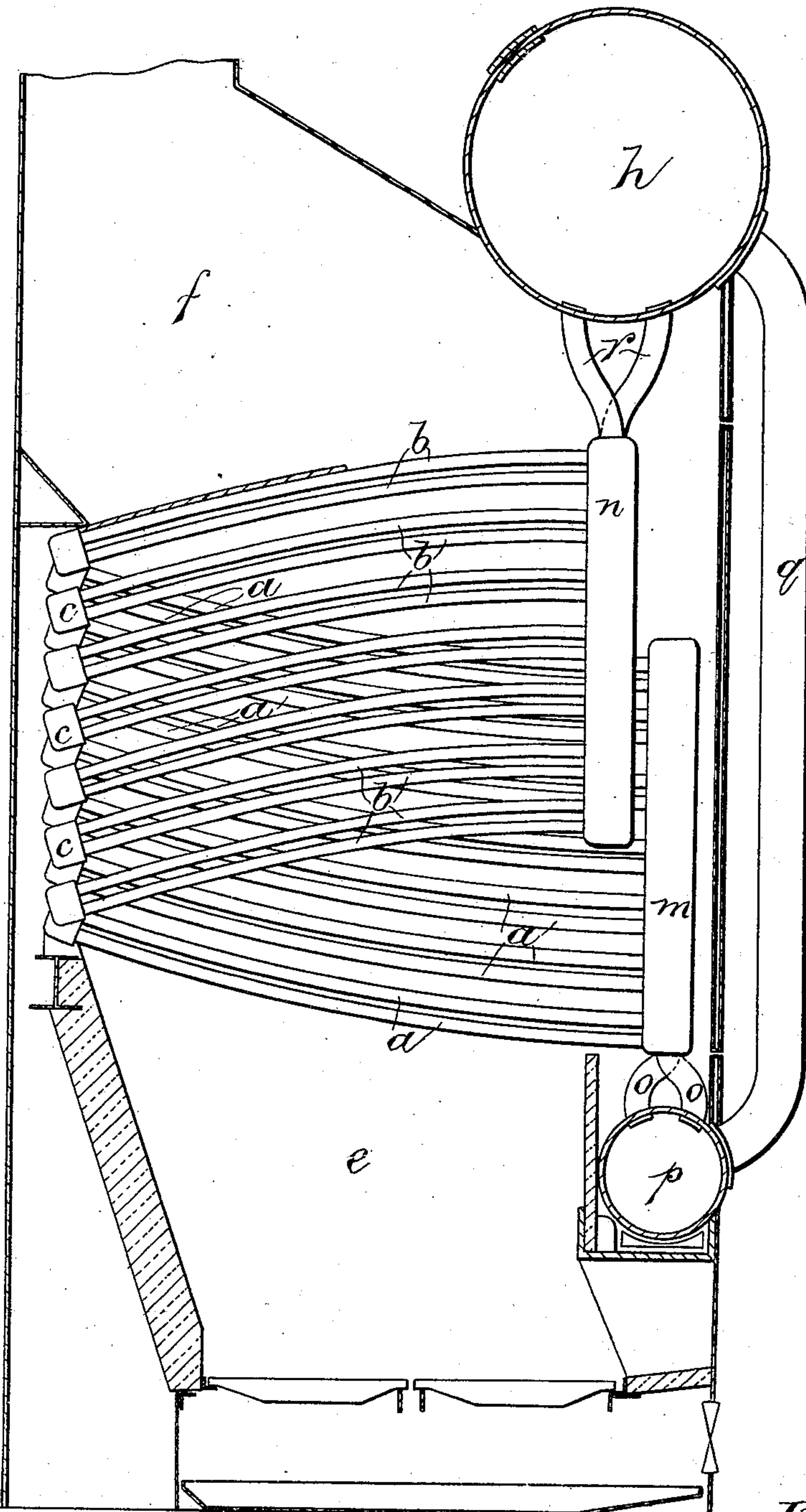
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*Fig. 3.*



Attest:  
H. S. Rafter  
Assistant

Inventor  
John E. Thornycroft  
by Philipps. J. W. Rice & Company  
Attys



# UNITED STATES PATENT OFFICE.

JOHN EDWARD THORNYCROFT, OF CHISWICK, ENGLAND.

## WATER-TUBE BOILER.

SPECIFICATION forming part of Letters Patent No. 711,546, dated October 21, 1902.

Application filed June 18, 1901. Serial No. 64,983. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN EDWARD THORNYCROFT, a subject of the King of Great Britain and Ireland, residing at Chiswick, in the county of Middlesex, England, have invented Improvements in Water-Tube Boilers, of which the following is a specification.

In the specifications of former Letters Patents granted to me—viz., No. 669,562, No. 670,975, and No. 670,976—and in the specification of my application for Letters Patent, Serial No. 729,299, I have described various constructions of water-tube boilers of the kind wherein water is caused to pass through a number of steam-generating elements arranged in parallel and each comprising a pair of water-tubes of large size that are arranged to extend from front to back of the boiler over a fire grate or grates and are inclined toward one another, the converging ends of each pair of tubes being connected together through a junction-box common to them and their diverging ends being connected at different levels to a pair of headers or to a water-box, to which a number of other similar steam-generating elements are connected. With such construction, owing to the comparatively large cross-section of the water-tubes, the heating-surface of each steam-generating element is small compared with the volume of the water in such element, so that a given volume of water has to pass many times through the element before it is wholly converted into steam.

The present invention relates to boilers of the type referred to, and has for its object to obviate the above-mentioned disadvantage and also to enable the heat of the hot gases to be transferred to the water in a more advantageous and effective manner than heretofore, so that the water will be converted into steam more quickly than usual and the efficiency of the boiler increased.

With this and other objects in view the invention consists in certain constructions and in certain parts, improvements, and combinations, as will be hereinafter fully described and then specifically pointed out in the claims hereunto appended.

In the boiler which has been selected to illustrate the invention the steam-generating elements each comprise two sets or groups of

inclined water-tubes that are of comparatively small size and are connected at their converging ends to a common water-box having a removable cover or closure, so that access can be gained to all the tubes in the two sets or groups and any one or more of such tubes can be withdrawn or replaced through the junction-box, the diverging ends of the two sets or groups of water-tubes being connected to a pair of headers or to a water-box. There may be two or more water-tubes in each set or group thereof, so that each junction-box would be common to, say, four or more tubes of smaller size than when only a single pair of tubes is connected to the common junction-box, as in earlier constructions of water-tube boilers of the kind referred to. By the construction described there will be formed, as seen in a vertical section of the boiler taken across the tubes, a number of clusters of water-tubes of small cross-section with comparatively large supplementary combustion-spaces between them, through which the hot gases will flow in succession in such a way as to heat the clusters of tubes in an advantageous manner, the streams of water, on account of the comparatively small size of the tubes, being brought into effective contact with the walls of the tubes, and thereby rapidly heated.

Referring to the accompanying illustrative drawings, Figure 1 is a longitudinal section, and Fig. 2 a part cross-section, on the line A A of Fig. 1 and a part front elevation showing one construction of water-tube boiler of the kind referred to according to the present invention. Fig. 3 is a similar view to Fig. 1, showing the invention applied to a modified construction of boiler of the kind referred to.

In the construction shown in Figs. 1 and 2 each steam-generating element comprises two lower water-tubes *a a*, that are inclined upwardly and forwardly, and two upper water-tubes *b b*, that are inclined upwardly and backwardly, the converging ends of the four tubes being secured to a common junction-box *c* and the diverging ends to a common water-box *d*. Fig. 2 shows how the space above the main combustion-chamber *e* and the chimney *f* is filled with clusters of water-tubes *a b* of small cross-section, between which are a number of comparatively large supplement-



tary combustion-spaces *g*, through which the hot gas will flow in a zigzag manner and be brought into intimate and effective contact with the water-tubes. In the example shown in Figs. 1 and 2 the water-tubes *a b* are straight; but they may be slightly curved in the direction of their length, as shown in Fig. 3, in order to facilitate their expansion when heated and prevent their connections with the junction and water boxes *c* and *d* being injured by such expansion and also to admit of their diverging ends being secured in the inner wall of the water-box or headers *d'* in a position nearly at right angles thereto. As will be seen, the junction-boxes *c* are inclined to the sides of the boiler, so that in conjunction with the zigzag arrangement of the tubes in the water-box *d* the vertical sets or groups of inclined tubes *a a* and *b b* of the superimposed steam-generating elements will come so close to the vertical sets or groups of the oppositely-inclined tubes *b b* and *a a*, respectively, of the adjacent superimposed steam-generating elements as to practically prevent hot gases taking a short upward course between the vertical sets or groups of tubes to the chimney *f* above, but will, on the contrary, be caused to move in a zigzag course between the tubes from one supplementary combustion-space *g* to another. *h* is a combined steam and water drum located at the front of the boiler and connected to the upper part of the water-box *d* by steam-tubes *i* and water-return tubes *k*, these tubes *i* and *k* extending across the space above the water-tubes and below the chimney.

Instead of connecting the diverging ends of the water-tubes *a* and *b* to a common water-box *d*, which may or may not be divided internally into vertical downtake and uptake chambers, they may be connected, as shown in Fig. 3, to a pair of lower and upper headers *m* and *n*, that are in the example shown arranged one in front of the other, the lower end of each header *m* being connected through tubes *o*, a horizontal water vessel *p*, and a downtake-tube *q* to the steam-drum *h* and the upper end of each header *n* being connected by tubes *r* to the said steam-drum.

In each example the tubes *a a* or *b b* in each set or group are shown arranged one above the other, with their axes in the same vertical plane; but they may be otherwise arranged, and more than two tubes may be used in each set or group.

What I claim is—

1. In a steam-boiler, the combination with a steam and water vessel, of a plurality of steam-generating elements each comprising two sets or groups of tubes inclined to one another and a junction-box common to both sets or groups of tubes and connected to the converging ends thereof, and means connecting the diverging ends of the tubes of each element to said steam and water vessel.

2. In a steam-boiler, the combination with a steam and water vessel, of a plurality of

steam-generating elements each comprising a cluster or group of tubes the tubes forming each group or cluster being connected to a common junction-box and the junction-box of each element being disconnected from the junction-boxes of adjacent elements, and means connecting the ends of the tubes opposite to those which are connected to the junction-boxes to the steam and water vessel, whereby water enters a junction-box through part of the tubes of a cluster and leaves it through the remainder of the tubes of the cluster, substantially as described.

3. In a steam-boiler, the combination with a lower main combustion-chamber, and an upper steam and water vessel, of clusters of water-tubes extending across the space above the main combustion-chamber, the tubes in each cluster being near together and arranged to form with adjacent clusters of tubes comparatively large supplementary combustion-chambers through which hot gas will flow in a zigzag direction, and means connecting said tubes to said steam and water vessel.

4. In a steam-boiler, the combination with a lower main combustion-chamber, and an upper steam and water vessel, of a plurality of steam-generating elements each comprising two sets or groups of tubes inclined to one another and a junction-box common to both sets or groups of tubes and connected to the converging ends thereof, and means connecting the diverging ends of the tubes of each element to said steam and water vessel, said elements being arranged to extend across the space above the combustion-chamber and to form therein clusters of water-tubes of small section with comparatively large supplementary combustion-chambers between such clusters.

5. In a steam-boiler, the combination with a lower main combustion-chamber, and an upper steam and water vessel, of a plurality of steam-generating elements each comprising two sets or groups of tubes inclined to one another with the tubes in each set or group arranged one above the other and a junction-box common to both sets or groups of tubes and connected to the converging ends thereof, and means connecting the diverging ends of the tubes of each element to said steam and water vessel, said elements being arranged to extend across the space above the combustion-chamber and to form therein clusters of water-tubes composed of two vertical rows of tubes of small section with comparatively large supplementary combustion-chambers between such clusters, substantially as described.

6. In a steam-boiler, the combination with an upper steam and water vessel, a lower combustion-chamber, and a water-box connected to said vessel, of a plurality of steam-generating elements extending over said combustion-chamber and each comprising two sets or groups of tubes inclined to one another and connected at their diverging ends to said



water-box and a junction-box connected to the converging ends of said tubes and having a removable cover, substantially as described.

7. A steam-boiler comprising a combustion-  
5 chamber, an upper steam and water vessel located at the front of the boiler, a water-box closed at the bottom and arranged at the back of the boiler, a plurality of steam-generating elements each comprising two sets or groups  
10 of water-tubes inclined to one another and having their diverging ends connected to the inner side of said water-box and a junction-box inclined to the sides of the boiler and

connected to the converging ends of the two sets or groups of tubes, the tubes in each set 15 or group being arranged one above the other, and tubes connecting the upper part of said water-box to said steam and water vessel and arranged at different levels, substantially as described. 20

Signed at 77 Cornhill, London, E. C., England, this 29th day of May, 1901.

JOHN EDWARD THORNYCROFT.

Witnesses:

WM. O. BROWN,  
EDMUND S. SNEWIN.