No. 745,616. PATENTED DEC. 1, 1903.

J. F. HOTTMAN, JR.

# WATER TUBE BOILER.

APPLICATION FILED JULY 25, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

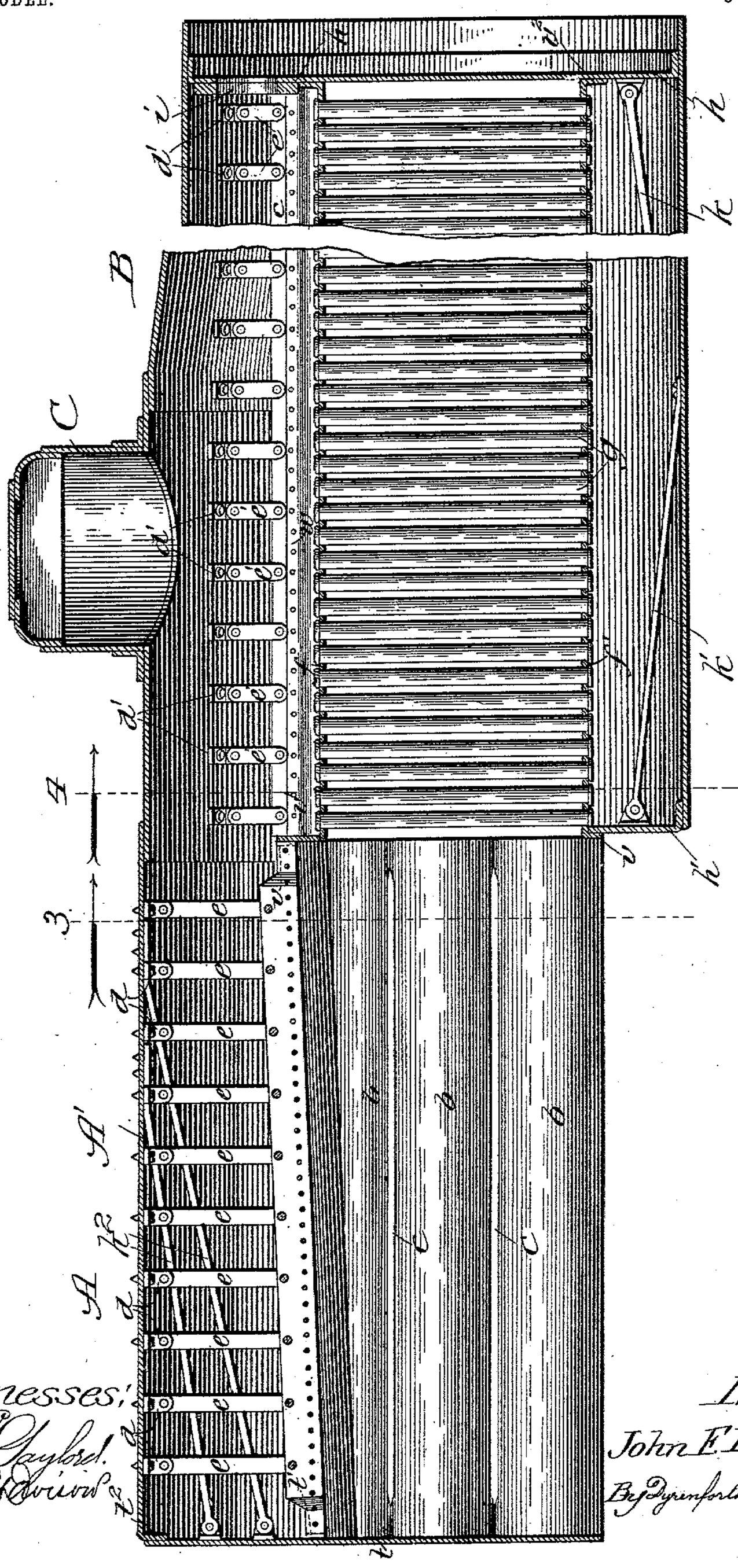


Fig. 1.

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NO MODEL. 3 SHEETS—SHEET 2.

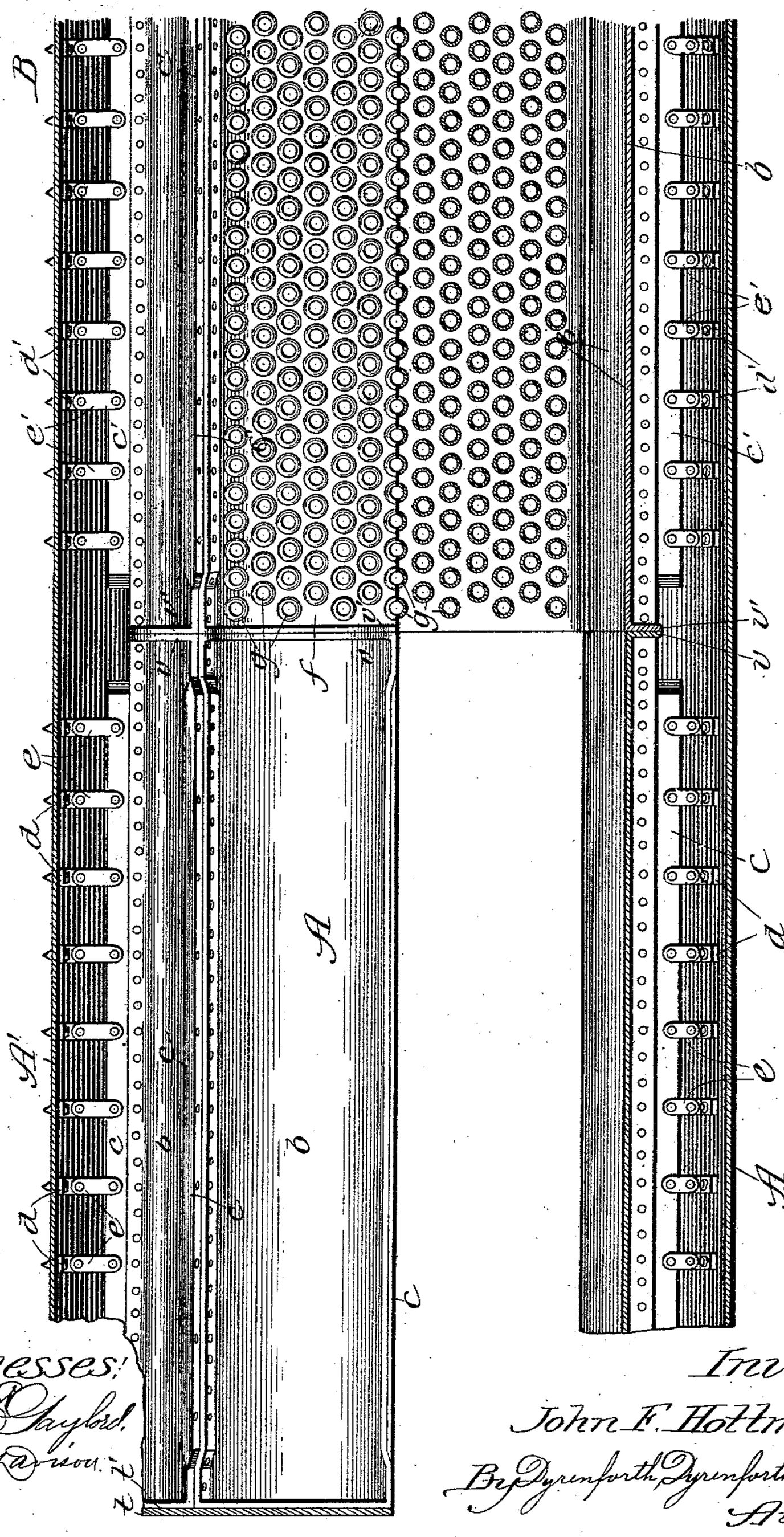


Fig. 2.

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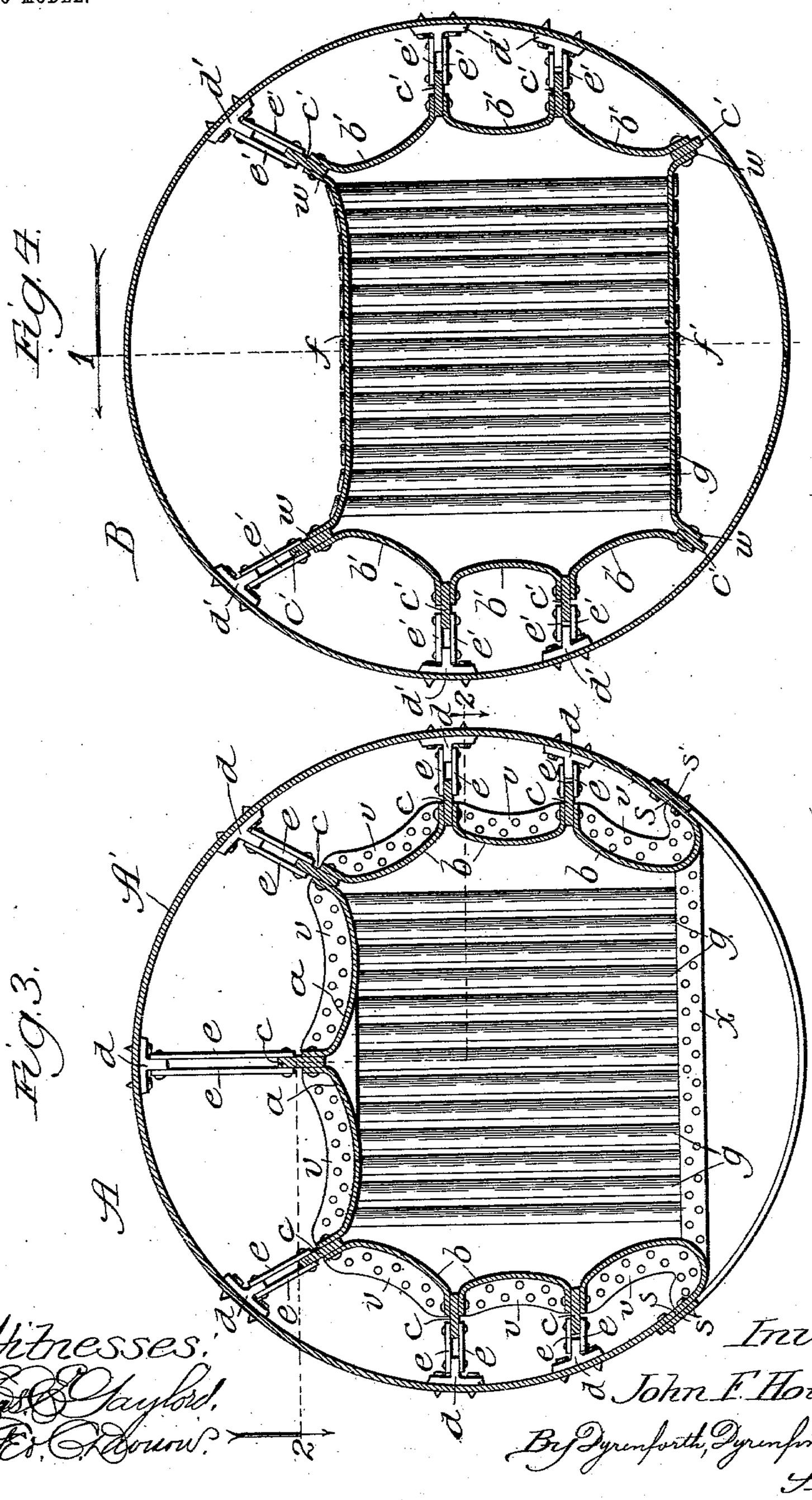
NO MODEL. 3 SHEETS—SHEET 3.

Fig. 3.

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No. 745,616. Patented December 1, 1903.

# UNITED STATES PATENT OFFICE.

JOHN F. HOTTMAN, JR., OF DUBUQUE, IOWA.

## WATER-TUBE BOILER.

SPECIFICATION forming part of Letters Patent No. 745,616, dated December 1, 1903.

Application filed July 25, 1903. Serial No. 166,928. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN F. HOTTMAN, Jr., a citizen of the United States, residing at Dubuque, in the county of Dubuque and State of Iowa, have invented a new and useful Improvement in Water-Tube Boilers, of which the following is a specification.

In all locomotives in practical use the fire-box construction is such as to require the use of a very large number of stay-bolts, involving enormous expense in making and putting them in place.

The primary object of my invention is to provide a construction of fire-box in a water-tube boiler for locomotive service, as also for stationary or marine service, whereby the use of stay-bolts may be dispensed with in any part of the boiler, with the advantage of great saving in the expense which the making and placing of stay-bolts involve and the further advantage of avoiding danger to safety of the boiler from the breaking of stay-bolts, to which large numbers of them are subject from no apparent cause in a locomotive-boiler after it has been in service a short time.

A further object of my invention is so to dispose the water-tubes in the forward fire-box as to induce rapid generation of steam and its free liberation in large volume from the water, and my improved construction affords still further advantages, which are hereinafter stated.

I have more particularly devised my improvements for use in a locomotive-boiler, though they are not limited to such particular use, and that character of boiler is therefore employed for illustrating my invention in the accompanying drawings, in which—

Figure 1 is a broken longitudinal vertical section of my improved locomotive water-tube boiler, taken at the line 1 on Fig. 4 and viewed in the direction of the arrow; Fig. 2, a cross-section taken on the irregular line 2 2, Fig. 3, and viewed in the direction of the arrows; Fig. 3, a section taken at the line 3 on Fig. 1 and viewed in the direction of the arrow, and Fig. 4 a section taken at the line 4 on Fig. 1 and viewed in the direction of the arrow.

A is the rear section of the fire-box, and B is the forward section thereof. The rear fire-box section has the "wagon-top" A′, (or rear portion of the shell with its lower longitudinal section omitted,) containing the grates (not shown) on the plane at *x*, Fig. 3, the crown-sheet *a*, shown to be formed in two sections, and the two opposite sets of side sheets *b b*, each of which may be formed of three sections, as shown. The crown-sheets and side sheets are curved to a certain radius of a circle, with the concave surfaces of the sections against the pressure in the boiler and their convex surfaces exposed to the flame and gases of combustion.

Between the flanged longitudinal edges of the sections of the crown-sheet and those of the side sheets are interposed stiffening-bars *c* of iron, to which such edges are securely riveted, thereby forming a self-sustaining surface without the aid of stay-bolts. To equalize the strains present in a high-pressure boiler on the crown-sheet and the side sheets, the ribs *c* are connected to crow-feet *d*, riveted to the wagon-top A′ by means of link-braces *e*. The bars *c* extend within a short distance of each end of the sheets *a b*, where they are scarfed or tapered, so that where the ends of the sheets are flanged smooth continuous joints are formed at *v* and *v′*, Figs. 1 and 2, the flange *v* of the rear fire-box section being riveted to the flange *v′* of the forward fire-box section, and the back head *t* is riveted to the flange *t′* of the rear fire-box and to the flange $t^2$ at the rear end of the wagon-top A′. The two lower sections of each side sheet *b* are formed to produce at *s* butt-joints with the edges of the wagon-top, (or rear portion of the boiler-shell,) and the butts are covered in a usual way with suitable straps *s′*.

The forward fire-box section is formed in the boiler-shell with side sheets *b′ b′*, like and forming continuations of the side sheets *b* in the rear fire-box section, a top tube-sheet *f*, and a bottom tube-sheet *f′*, both numerously perforated coincidently and connected at coincident perforations by vertical water-tubes *g* of suitable diameter—say about two and one-half inches—and spaced apart—say about one-half an inch. These water-tubes are best disposed, as represented, in longitudinal parallel rows, with the members in each row arranged in staggered relation to those in the row adjacent to it. Along their lateral edges

the tube-sheets are flanged, as represented at *w*, and connected with the respectively adjacent concavo-convex side sheets *b'*, preferably as shown. Thus between the flanged edges of each tube-sheet and the side sheet to which it is connected is interposed longitudinally an iron bar *c'*, along which the sheets are riveted, as in the construction of the rear section of the fire-box. The sheets thus connected, except at the base of the forward fire-box section, are supported at suitable intervals lengthwise of the boiler-shell by link-braces *e'*, connecting the bars *c'* with crow-feet *d'*, riveted to the boiler-shell. In this way the structure of the forward section of the fire-box is suspended in a manner to render it self-sustaining. In Fig. 4 the upper tube-sheet is shown to be suspended from the boiler-shell at crow-feet *d'*, connected by brace-links *e'* with bars *c'*, interposed between the lateral edges of the tube-sheet and the respectively adjacent side sheets *b'*; but such suspension is not essential to my improved construction.

The forward fire-box section is connected to the rear section of the fire-box at the flanges *v v'* and to the front head *h* at the flange $v^2$. The front head contains the opening *i* for the dry-pipe, (not shown,) which delivers the steam to the engine-cylinders from the steam-dome C, containing the throttle-valve, (not shown,) all in the usual manner.

At *k* and *k'* in Fig. 1 are shown brace-rods for supporting the head *h*, which is covered by the smoke-box, (not shown,) and the head *h'* at the rear end of the forward fire-box section; and the back head *l* is also shown to be braced by similar rods $k^2$.

By the construction thus described, involving the employment of the curved plates *a*, *b*, and *b'* in the formation of the fire-box, the use of stay-bolts is entirely dispensed with, since the arrangement of the plates with their concave surfaces presented to the boiler-pressure utilizes the tensile strength of the metal in each plate for fortifying the structure. Moreover, no joints or rivets are exposed to the fire and the large extent of water-space afforded eliminates all danger of the plates or sheets becoming cracked or burned and renders practicable the employment of heavier plate than it is customary to employ in the construction of fire-boxes, thus materially adding to the strength and durability of the structure. It will furthermore be observed that the construction of the fire-box affords to it an open bottom, thus rendering easier the matter of firing it and facilitating the matter of maintaining the fire without requiring it to be cleaned so frequently as is necessary in locomotives having the corrugated type of fire-box, also that the large body of cold water commonly contained below the grate-line in the corrugated type referred to is entirely dispensed with, since my grates by being situated at the lowest point in the fire-box subject the water at all points to the heat of the products of combustion, thereby producing free generation of steam, perfect circulation of the water surrounding the fire-box, and equal expansion of all parts.

An important advantage of my improved construction is due to the large number of water-tubes *g* which it enables to be used, thereby to divide the water in the boiler into a large number of small units. Extending vertically across the path of the hot products of combustion, they absorb a greater amount of heat than if they lay horizontally in that path, and, besides, they form thoroughly-effective stays for the tube-sheets. By disposing the water-tubes in the staggered relation in which they are represented they present to the flame and gases a tortuous course past the tubes, causing rapid ebullition of the water passing through them, and the steam-bubbles thereby formed gain ready, direct, and natural access to the surface of the water in the boiler, to which they are liberated as steam through the vertical tubes. In this way a large volume of steam may at all times be maintained and perfect circulation of water kept up in the boiler, and because of the rapid circulation of the water no scale lodges in the tubes to impair their original high efficiency in steam generation and their durability.

A still further advantage due to my improved fire-box construction relates to the prevention of leakage of the flues, which is a serious difficulty in the ordinary construction of boilers. My improvement entirely avoids this difficulty, since the junctions of the tubes with the two tube-sheets being entirely covered with and surrounded by water are not subjected to varying ranges of temperature and are entirely out of the fire, so that they are thoroughly protected from causes tending to produce leakage in them.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a water-tube boiler, the combination with the boiler-shell, of a fire-box comprising a plurality of connected plates attached to said shell to extend lengthwise within it, and each formed to a certain radius of a circle with the concave surface presented to the pressure in the boiler and the convex surface presented to the products of combustion.

2. In a water-tube boiler, the combination with the boiler-shell, of a fire-box comprising a plurality of plates flanged along their lateral edges, each formed to a certain radius of a circle, and bars interposed between the flanges which are riveted thereto, said bars being connected at intervals to the boiler-shell to support said plates lengthwise therein with their concave and convex surfaces presented, respectively, to the pressure in the boiler and the products of combustion.

3. In a water-tube boiler, the combination with the boiler-shell, of a fire-box comprising a plurality of plates flanged along their lateral edges, each formed to a certain radius of a circle, bars interposed between the flanges,

which are riveted thereto, and crow-feet fastened at intervals to the shell and having brace-link connections with said bars to support said plates lengthwise within the shell with their concave and convex surfaces presented, respectively, to the pressure in the boiler and the products of combustion.

4. In a water-tube boiler, the combination with the boiler-shell, of a fire-box comprising a plurality of plates flanged along their lateral edges, each formed to a certain radius of a circle, bars interposed between the flanges, which are riveted thereto, crow-feet fastened at intervals to the shell and having brace-link connections with said bars to support said plates lengthwise within the shell with their concave and convex surfaces presented, respectively, to the pressure in the boiler and the products of combustion, and butt-joint connections between the shell and the lowermost said plates in the rear section of the fire-box.

5. In a water-tube boiler, the combination with the boiler-shell, of a fire-box comprising a plurality of plates each formed to a certain radius of a circle with flanges along their lateral edges and bars interposed between the flanges which are riveted thereto, said bars having scarfed ends and being shorter than the plates and connected at said ends to the fire-box ends, the whole presenting a smooth continuous surface, and connections at intervals between said bars and shell supporting said plates to extend lengthwise in the boiler-shell with their concave and convex surfaces presented, respectively, to the pressure in the boiler and the products of combustion.

6. In a water-tube boiler, the combination with the boiler-shell, of a fire-box formed of two sections, one beyond the other and comprising a plurality of plates flanged along their lateral edges, each formed to a certain radius of a circle, bars interposed between the flanges, which are riveted thereto, and connected at intervals to the boiler-shell to support said plates lengthwise thereof with their concave and convex surfaces presented, respectively, to the pressure in the boiler and the products of combustion, a pair of perforated tube-sheets between and connected at their lateral edges with said plates in one section of said fire-box, and water-tubes extending between and connecting said tube-sheets across the fire-box at right angles to the path through it of the products of combustion.

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In presence of—
LOUIS C. KOLFENBACH,
CHRIS. A. VOELKER.