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J. & W. ROWBOTHAM.

SECTIONAL STEAM BOILER.

No. 407,744. Patented July 23, 1889.

Fig. 1.

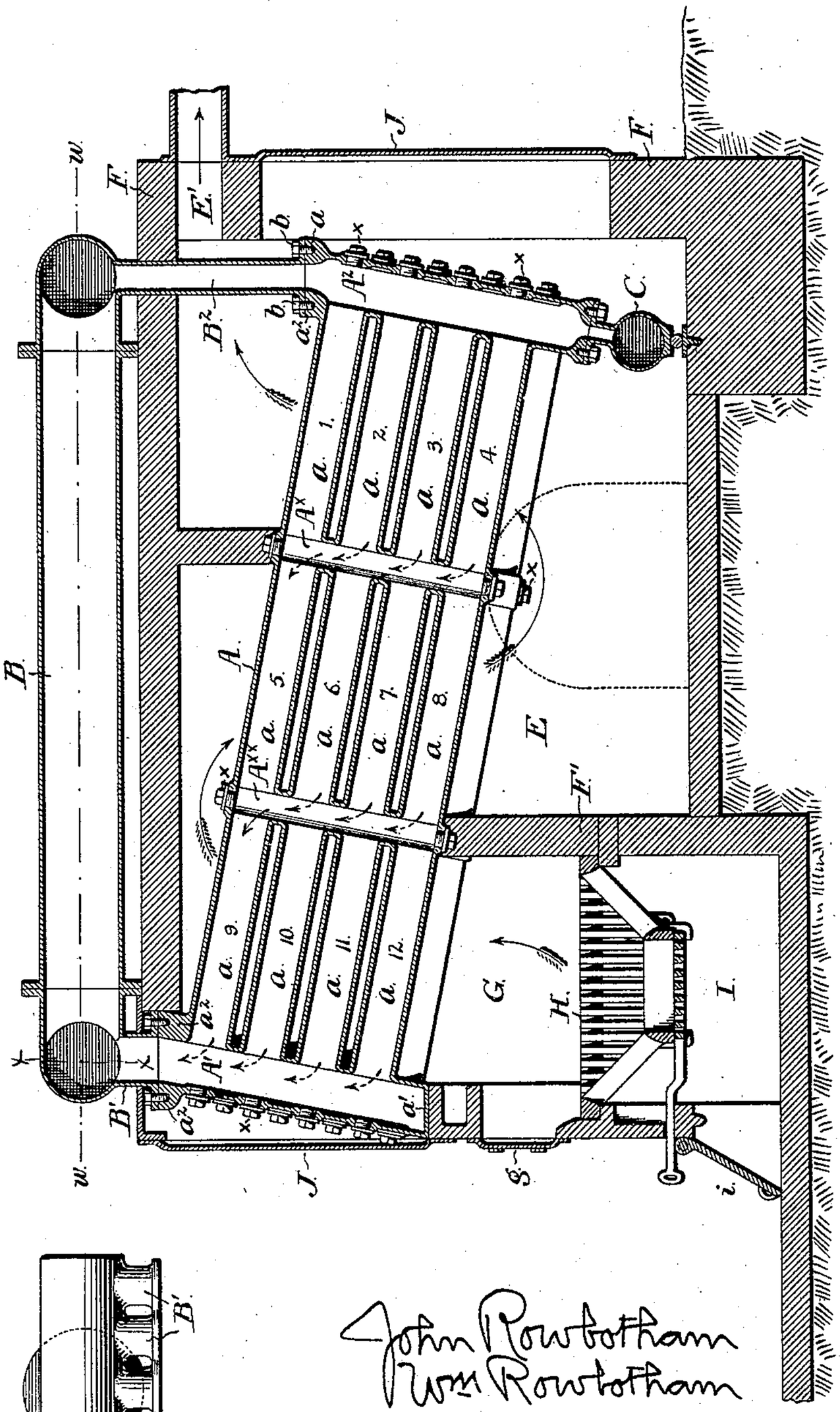

Fig. 2.

Witnesses:

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F. D. Goodwin

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Wm Rowbotham
Inventors
By Their Attorney
John Dalleyder

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J. & W. ROWBOTHAM.

SECTIONAL STEAM BOILER.

No. 407,744. Patented July 23, 1889.

Fig. 3.

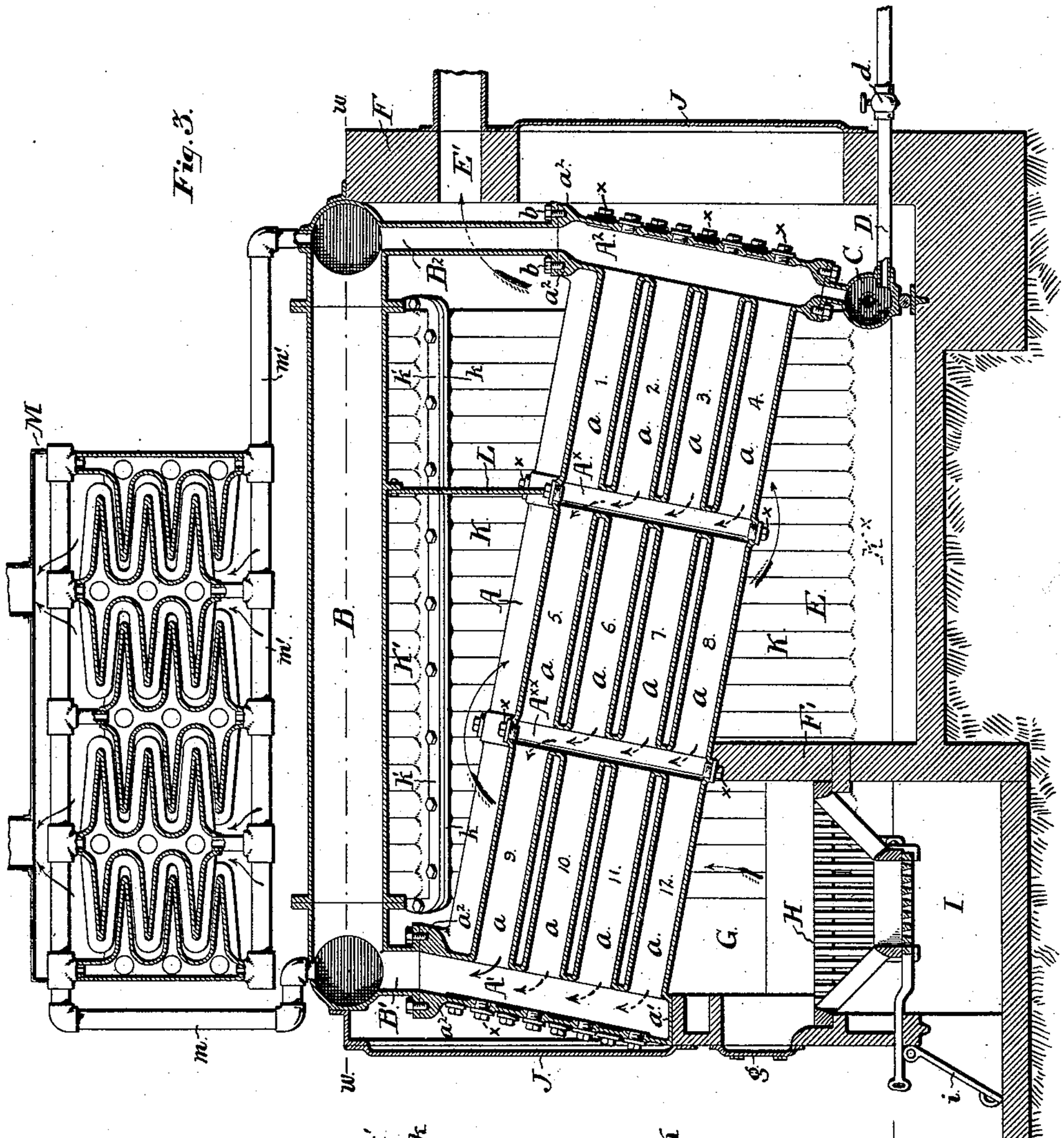

Fig. 4.

Witnesses:
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J. & W. ROWBOTHAM.

SECTIONAL STEAM BOILER.

No. 407,744. Patented July 23, 1889.

Fig. 5.

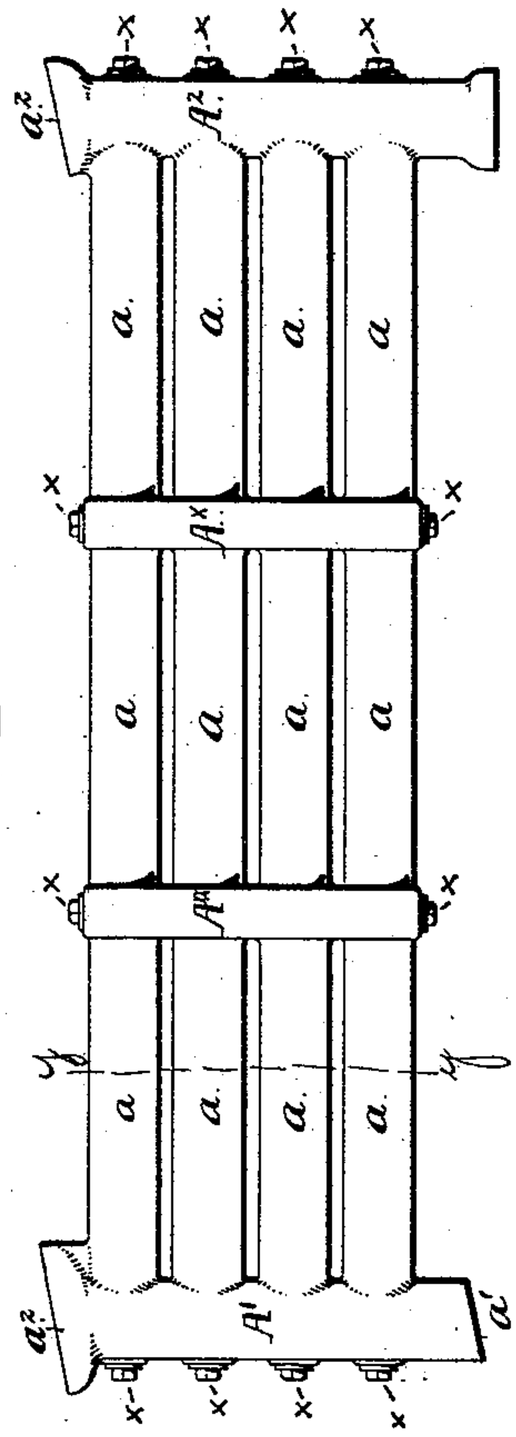


Fig. 9.

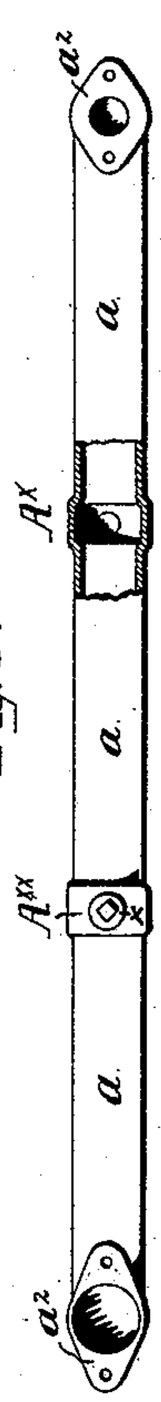


Fig. 8.

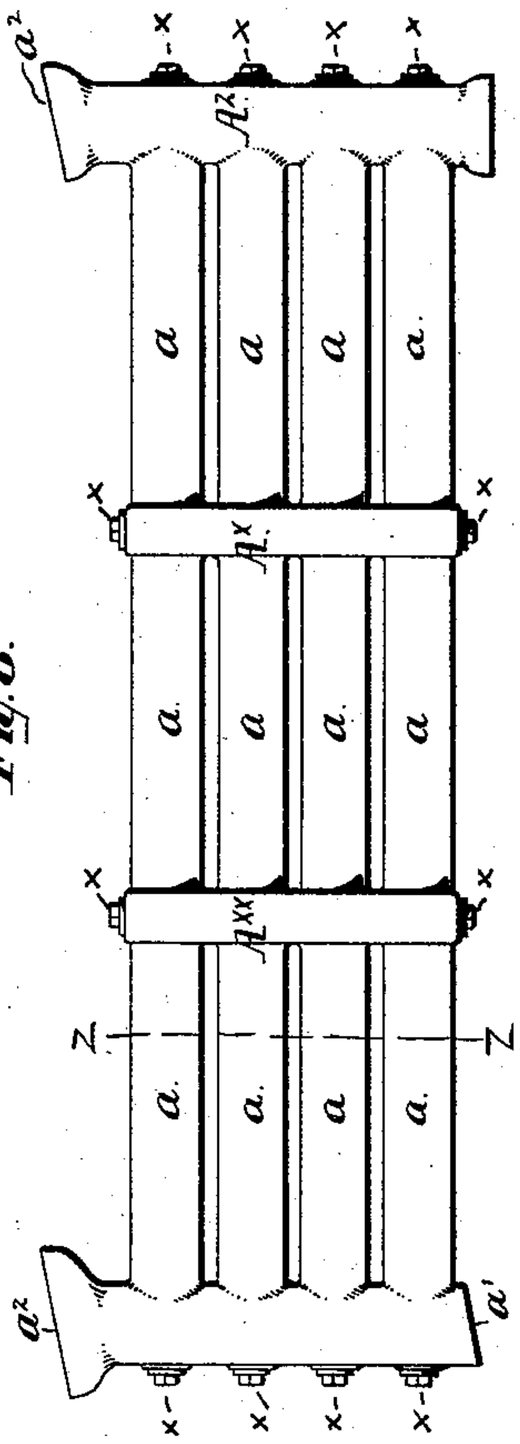


Fig. 6.

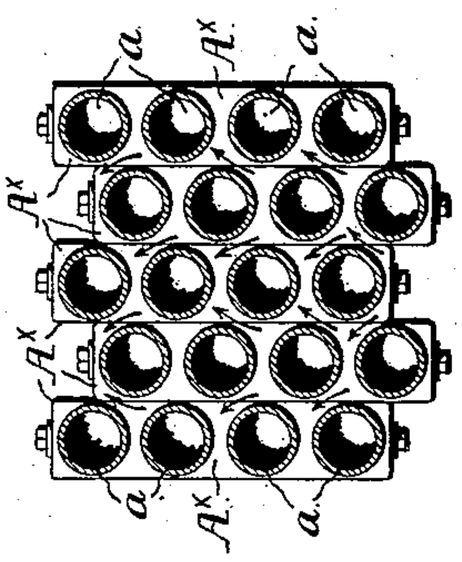


Fig. 7.

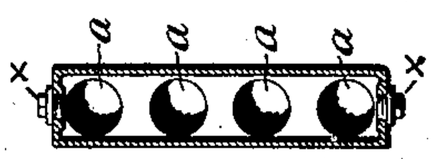


Fig. 10.

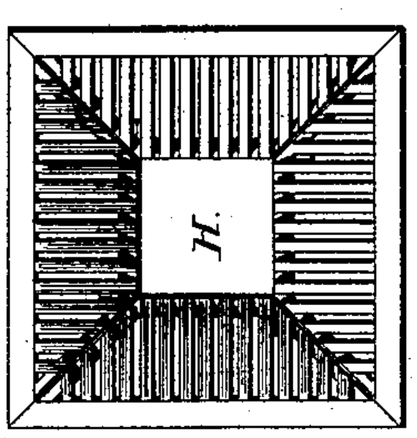
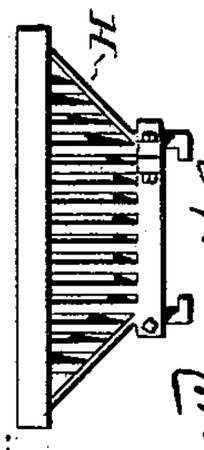


Fig. 11.



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(No Model.)

4 Sheets—Sheet 4.

J. & W. ROWBOTHAM.

SECTIONAL STEAM BOILER.

No. 407,744. Patented July 23, 1889.

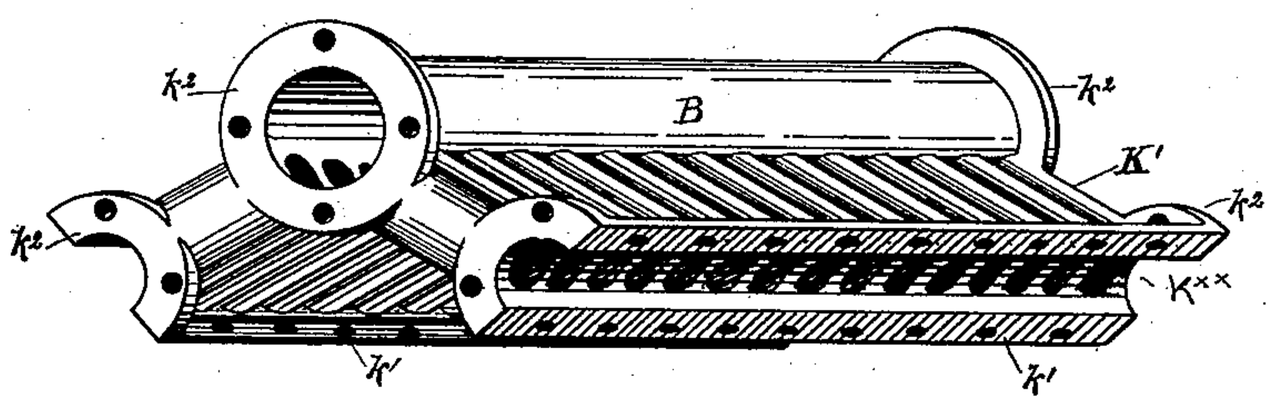

Fig. 12.

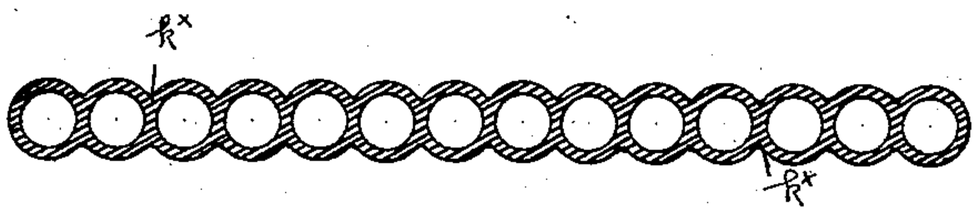

Fig. 14.

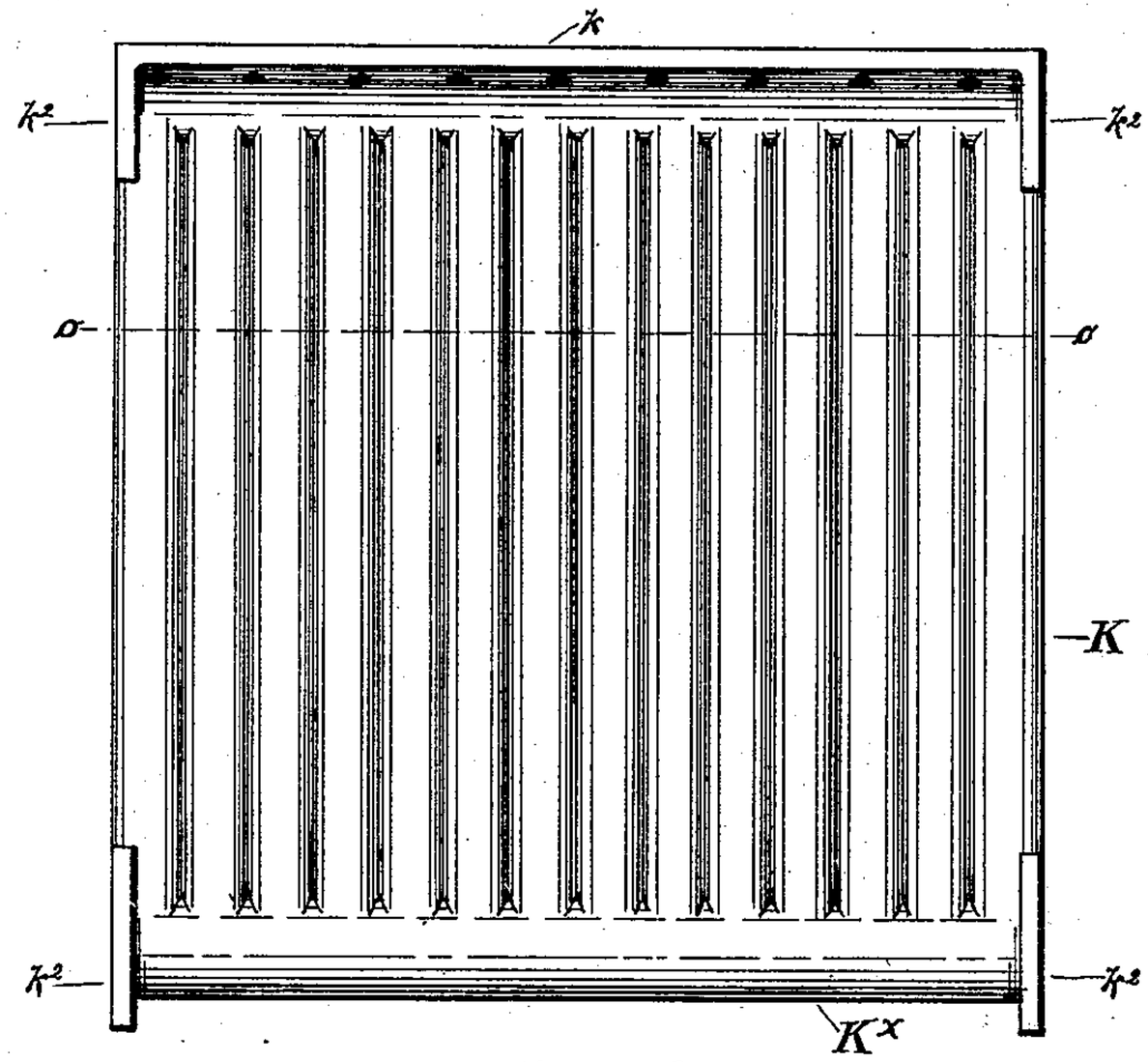

Fig. 13.

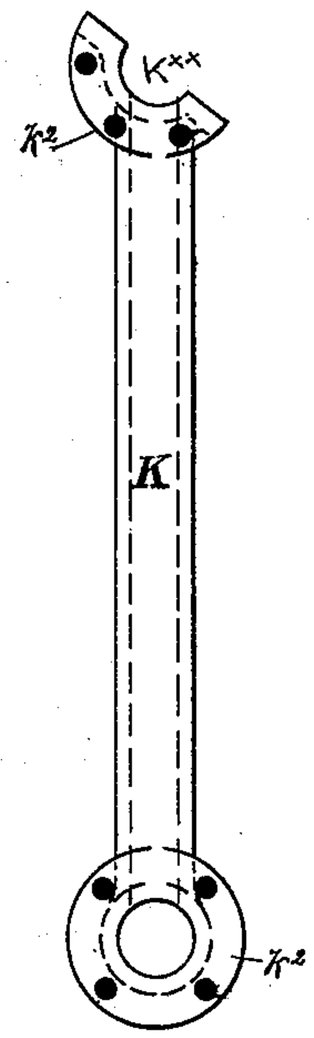

Fig. 15.

Witnesses.
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Inventors.
John Rowbotham
William Rowbotham
By their Attorney, John Tolley Jr.

UNITED STATES PATENT OFFICE.

JOHN ROWBOTHAM AND WILLIAM ROWBOTHAM, OF MERCHANTVILLE, NEW JERSEY; SAID WILLIAM ROWBOTHAM ASSIGNOR TO SAID JOHN ROWBOTHAM.

SECTIONAL STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 407,744, dated July 23, 1889.

Application filed March 14, 1889. Serial No. 303,230. (No model.)

To all whom it may concern:

Be it known that we, JOHN ROWBOTHAM and WILLIAM ROWBOTHAM, citizens of the United States, residing at Merchantville, in the county of Camden and State of New Jersey, have jointly invented certain new and useful Improvements in Sectional Steam-Boilers and Furnaces, of which the following is a specification, reference being had to the accompanying drawings, forming part hereof.

Our invention relates, generally, to the class of boilers and furnaces employed for generating steam for heating, propelling vessels, and other purposes, and specifically to a novel construction of a sectional boiler and furnace, hereinafter described and claimed, and to the several novel features of construction and combinations of parts herein described in detail, and set forth in the claims, to the end that a rapid generation and supply of steam and more perfect circulation of water are obtained and a less moist steam resultant than in any of the other well-known forms of boilers and furnaces used for like purposes.

In the drawings, Figure 1 is a vertical sectional view of a boiler and furnace embodying our invention, showing the staggered sections of the boiler and supported at an incline within a furnace. Fig. 2 is a front view of the water-drum, taken on the line *x x* of Fig. 1, and represents a form of construction of the vertically-extending arm thereof for a boiler embodying our invention, consisting of a series of five sections of sets of tubes. Fig. 3 is a vertical sectional view of a boiler and furnace embodying our invention, the furnace walls and top represented as formed partially of tubes, for a purpose hereinafter more fully set forth, and mounted on and above said furnace and in open communication with the boiler is a steam-radiator. Fig. 4 is a vertical sectional view of the tube furnace-walls represented in Fig. 3, showing their form of construction and communication with each other and with the water-drum forming part of the furnace-top wall. Figs. 5 and 8 are side views of a boiler-section consisting of a series of four tubes and a header or stand-pipe at each end and provided with two hollow diaphragms intermediate of its length, the respective tubes of the boiler being in open communication with the diaphragms, Fig. 5 representing the uppermost tube entering the headers or stand-pipes immediately beneath the lug or flanged ends, and Fig. 8 representing the uppermost tube entering the headers or stand-pipes at a point below the lug or flanged ends a distance equal to one-half the diameter of one of said tubes, as by these constructions we obtain a staggered position of the tubes when the sections are arranged side by side, and for a purpose hereinafter more fully set forth. Fig. 6 is an end sectional view taken on the line *y y* of Fig. 5, representing a boiler consisting of a series of five sections of four tubes each, showing the tubes staggered and the respective diaphragms of each section in contact with each other to form a single diaphragm. Fig. 7 is an end sectional view taken on the line *z z* of Fig. 8, representing a single boiler-section consisting of a series of four tubes. Fig. 9 is a top plan view of a boiler-section, showing the form of header-flanges and boiler-diaphragms with the tubes of the section in open communication therewith. Fig. 10 is a plan view of the furnace-grate, and Fig. 11 a side view of the same. Fig. 12 is a view in perspective of the furnace-top, showing the series of tubes arranged at an incline and cast integral with the steam-drum at one end and with a flange at the opposite end, and with suitable end flanges for connecting with like sections. Fig. 13 represents a side or vertical wall of the furnace, showing the series of tubes cast integral with a base or laterally-extending tube at one end, and with a continuous flange at its opposite end, and with suitable end flanges for connecting with like sections. Fig. 14 is a top plan view of the construction of the tubes of the furnace-walls, taken on the line *o o* of Fig. 13, and showing the series of tubes so cast together that the thickness of two contiguous tubes together at the line of contact is equal only to the thickness of one tube as to its part out of contact; and Fig. 15 is an end view of the vertical wall as shown in Fig. 13.

In the drawings we have shown each boiler-section to consist of four tubes vertically placed and connecting with and opening into a header or stand-pipe at each end and each

section provided with two hollow diaphragms intermediate of its length, with which the respective tubes are in open communication, and the boiler proper to consist of a series of five of said sections, in three of said sections the uppermost tube entering the headers or stand-pipes immediately below the lugs or head-flanges thereon, and in the other two sections entering at a point below said lugs or head-flanges a distance equal to one-half the diameter of one of said pipes, in order to obtain a staggered position for the tubes in the respective sections when alternately arranged together; but we do not wish to be understood as restricting ourselves to such exact construction, as it will of course be obvious that each section may be cast as a whole to a desired length and height with its accompanying end headers or stand-pipes, and the number of tubes and diaphragms, or either, increased or decreased, as may be desired, and the number of sections limited only to the size of boiler required; but for the purpose of clearer illustration and description we show in the drawings a boiler containing five sections of four tubes each, and each section provided with end headers or stand-pipes and two hollow diaphragms intermediate of its length.

Each section, consisting of four tubes and two end headers or stand-pipes with two intermediate hollow diaphragms and the tubes of each section in open communication with said diaphragms, is preferably made in one casting to the form shown in the drawings, the parts marked *x* being simply sand-core plugs.

Referring to the drawings, A is the boiler, and, as described, constructed in sections, each section being in itself a series of tubes *a*, as shown in Figs. 6 and 7, and provided with two hollow diaphragms $A^{\times}$ $A^{\times\times}$ intermediate of its length and with which the respective tubes are in open communication, and end headers or stand-pipes A′ A^2 in open communication with said tubes, as clearly shown in the drawings.

The header or stand-pipe A′ is closed at its base end and preferably formed with a slight incline, as shown at *a′*, in order to present a horizontal bearing-surface to insure its better support when the section is arranged at an incline in the furnace, and at its opposite end is open and formed with a lug or head-flange a^2.

The respective lug or flanged ends of the headers or stand-pipes A′ A^2 are also preferably formed at a slight incline, in order to present a horizontal bearing-surface when the section is arranged at an angle within the furnace. The lower end of the header or stand-pipe A^2 is mounted on, connected to, and in open communication with a mud-drum C, located in the rear of the furnace, and the upper end of each header or stand-pipe A′ A^2 is connected to and in open communication with the vertical arms B′ B^2 of a water and steam drum located above the boiler, and of a construction hereinafter more fully described.

$A^{\times}$ $A^{\times\times}$ are the diaphragms of the boiler-sections. (Best shown in Fig. 9 of the drawings.) These diaphragms are hollow, closed at sides and ends, and in open communication with the tubes of the sections, affording increased water-space, radiating-surface, and means for facilitating the exit of steam from the boiler—that is to say, the boiler being arranged at an incline steam generated in the three lower rows of tubes of the section will pass to and ascend in the diaphragm at its next highest level. Thus the steam generated in tubes 2, 3, and 4 will pass to and ascend in the diaphragm $A^{\times}$ to tube 5, where it combines with the steam from tube 1, and in tubes 6, 7, and 8 will pass to and ascend in the diaphragm $A^{\times\times}$ to tube 9, where it combines with the steam from tube 5, and in turn enters the header or stand-pipe A′ to find its common outlet, the steam generated in the tubes 10, 11, and 12 entering the stand-pipe A′ separately, all as indicated by the arrows in the several views. The greatest heat being at the front end of the boiler and the greatest amount of steam being generated in the center and rear portions of the boiler and supplied to the front portion at its highest level, the amount of water lifted with the steam is consequently lessened to a considerable extent and a more dry steam resultant.

B is a water and steam drum, and, as shown in Fig. 1, is located above the furnace, and in the construction of furnace shown in Fig. 3 forms part of the top wall thereof.

B′ B^2 are the respective end sections of the water and steam drum B, and, as shown in Figs. 1 and 3, are preferably made in one casting of an elbow form with flanged ends, and when in position are directly above and in line with the headers or stand-pipes A′ A^2 of the boiler, and are mounted on and connected thereto by screw-bolts *b* or the like, and in open communication therewith. The arms of these respective drum-sections are at right angles to each other and of different diameter and length, as a reference to the drawings will clearly show, the vertical arms thereof being formed with as many outlets or ports as will correspond in number to the outlets or ports of the headers or stand-pipes A′ A^2 of the several sections comprising the boiler proper, (see Fig. 2,) and the lateral arms being connected by a tube-section to form the drum proper.

C is a mud-drum suitably located and supported within the furnace at the base and to the rear thereof, and provided with as many restricted port-openings having flanged ends as will correspond in number to the outlets or ports of the lower end of the headers or stand-pipes A^2 of the various sections comprising the boiler proper, and is connected to the flanged ends of said header or stand-pipe sections by screw-bolts *b* or the like.

D is a water-supply pipe extending through the furnace-wall and connecting with and opening into the mud-drum C, provided with a suitable stop cock or valve *d* beyond the wall, and connected at its opposite end to a water-supply.

The number of boiler-sections comprising the boiler proper is limited only to the size of boiler desired, and in order to derive the greatest advantage from the heated gases of the furnace we prefer to stagger the various series of sections of boiler-tubes, and to this end we so alternately arrange the sections, when constructed as stated, that each tube in each section shall be on a line with the intervening space between the tubes in its neighboring or contiguous section, as clearly shown in Fig. 6. It follows that the heated gases in passing to the stack or flue are divided and caused to travel their greatest distance, and consequently retained a longer time about the tubes. To obtain this staggered position of the boiler-tubes, we have shown in Fig. 5 the uppermost tube of the series of tubes in the boiler-section connecting with and opening into its end headers or stand-pipes immediately beneath the head-flanges thereon, and in Fig. 8 connecting with and opening into its end headers or stand-pipes at a distance below the head-flanges thereon equal to one-half the diameter of one of the tubes, and, as will at once be understood, by alternately arranging sections so formed the staggered position of the tubes results, as clearly shown in Fig. 6.

It will of course be apparent that the tubes of the sections may be arranged in line with the tubes in its neighboring or contiguous section, but not with so advantageous a result as when staggered, as above explained. The boiler, when in the furnace, is arranged at an incline, and, as shown in Figs. 1 and 3, its elevated or front end is suitably supported on the front wall of the furnace, the rear or lower end of the boiler being mounted on and in open communication with a mud-drum to the rear of the furnace, at the base thereto, as stated.

E is the furnace, E′ the escape-port therefrom, F the outer walls thereof, and F′ the partition or bridge wall therein.

G is the fire-chamber, *g* the door thereof, H the grate, I the ash-pit, and *i* the door to the ash-pit.

J J are doors, respectively hinged to the front and rear walls of the furnace to provide openings to the furnace to permit of the removal or insertion of any one or all the boiler-sections for their repair or cleansing or the placing of new sections. To remove any one of said sections from the boiler, it is only necessary to take out the screw-bolts *b b* at three corners of the sections, thus disconnecting the section from the drum at the top and the drum at the base of the furnace, when the section so disconnected may easily be withdrawn from the furnace. All the sections may likewise be disconnected and withdrawn and subsequently reinserted or replaced by new sections and attached to the respective drums by screw-bolts or in any suitable manner.

In Figs. 3, 4, 12, 13, 14, and 15 we have shown a construction of furnace walls or casing formed of castings in section, each section consisting of a series of vertical tubes K, so cast together that the thickness of metal of two contiguous tubes together, as at $k^{\times}$, and extending the length thereof, shall be equal to but the thickness of the metal of one tube—that is to say, that at the line of contact of two tubes the metal in each tube is equal only to one-half the thickness of the metal of the tube in its parts out of contact. These tubes at one end are cast integral and in open communication with a base or laterally-extending tube $K^{\times}$ and at their opposite end formed with a laterally-extending continuous inclined flange *k*. This flange *k* is suitably coupled or joined by bolts, rivets, or the like to a similar inclined flange end *k′* of inclined corresponding tube-sections K′, which said tube-sections are cast integral in open communication and at an incline with the steam-drum B, and together form the roof or top wall of the furnace-casing. The flanged ends *k k′* of these tube-sections K and K′ are so formed as to be semicircular in outline, so that when joined together they form a laterally-extending water-tube $K^{\times\times}$, as well as a continuation of the vertical tubes K, with the tubes K′ connecting with the steam-drum B. When two or more of these cojoint wall-sections are employed in line in a single furnace, suitable flanged ends k^2 are cast with the laterally-extending tubes at their ends and with the steam-drum for uniting the various sections. These flanges are cast flush with the end of the section, so that in joining sections no open space is left between them. These tubes are adapted to be filled with water, and are acted upon by the heat of the furnace and afford a greatly-increased radiating-surface and means of generating steam in connection with the boiler. Further, tubular furnace-walls when constructed in accordance with our invention have no open spaces between the tubes, as is the case when independent tubes are used to form the walls, and require no additional outer wall, as is generally employed. The outer faces of our furnace walls or casing may be coated with hair, felt, or in any of the well-known ways without danger of subsequently taking fire, and, further, for the purpose of preventing radiation. This construction of furnace-walls is especially valuable when forming a part of a marine boiler and furnace. As will be obvious, in casting these sections both sides thereof may present a smooth or even surface in contradistinction to corrugated or scalloped sides, as shown in the drawings, the latter construction, however, being preferable for sav-

ing of metal without weakening the structure, expense, and for presenting greater heating-surface.

l l l are lugs, ribs, flanges, or the like, cast with or attached to the inner surface of the top wall of the furnace as a means of attaching or suspending a diaphragm L within the furnace, for a purpose more fully set forth.

L is a diaphragm of asbestus, fire-brick, or their equivalent, which extends the width of the furnace and from the top of the boiler at a point about two-thirds of its length from its front or elevated end to the inner surface of the top wall of the furnace to form a barrier to the further straight passage of the heated gases to the escape-port E′, leading from the rear of the furnace to a stack or flue, (not shown,) and at the same time forms a continuation of a diaphragm of the boiler. This diaphragm may, as shown in Fig. 1, be built from the boiler-top to the under side of the furnace-top of fire-brick or its equivalent that will stand a high heat, or, as shown in Fig. 3, may be a sheet of asbestus or its equivalent, and suspended from the top of the furnace and attached to the boiler in any suitable manner.

M is the radiator. It is proper here to state that we prefer to mount and suitably support a radiator over and above the furnace and in open communication therewith. When the radiator is placed as shown in Fig. 3, a good construction is to provide the drum-section B′ with a restricted outlet-port at its top having a flanged end, whereby suitable connection and steam communication may be made with the radiator for the supply of steam thereto. This form of construction we instance only as a good form of close connection with the radiator, although it will be obvious that suitable pipe-connection may be made with the radiator for the supply of steam thereto.

In Figs. 10 and 11 we have shown a novel construction of grate intended for use in the furnace, but not specifically described or claimed in detail here. Suffice it to say that the radial grate-bars, walls, and rim are so formed and combined that an increased means of combustion is obtained without waste of fuel.

To furnish the boiler with water, the stop-cock *d* on the pipe D is opened, and said pipe being in connection with a suitable water-supply, the water first enters the mud-drum and in turn the headers or stand-pipes A^2, boiler-tubes *a*, and diaphragm $A^{\times}$ $A^{\times\times}$, headers or stand-pipe A′, and finds its level at the water-line *w w* about the center of the water and steam drum B, and when the furnace-walls are formed of tubes, as above stated, they in turn are filled with the water before it finds its level in the drum.

In operation the heated gases passing from the fire-chamber ascend between, around, and above the boiler-tube sections directly over said fire-chamber, and then encounter the furnace-diaphragm L and boiler-diaphragm $A^{\times}$, and are caused to descend between, around, and below the boiler-tubes, forming the second section of the boiler, so to speak, and then ascend between, around, and over the third section of the boiler, so to speak, and find their outlet from the furnace through the escape port E′ to the stack or flue, all as indicated by the arrows in Figs. 1 and 3, whereby the heated gases are caused to pass several times over the boiler prior to their escape from the furnace and a rapid generation of steam ensues. The steam so generated is fed from the steam-drum by suitable pipe-connections *m* to one or a series of radiators located over the furnace or at distant points, the condensed steam returning by suitable pipe-connections *m′* to the drum-section B^2, or other desired point, as instanced in Fig. 3.

A sectional steam-boiler constructed and arranged in accordance with our invention and within a furnace of the character described possesses the advantages of increased means for fully utilizing the heated gases of the furnace, of rapid generation of steam, since the heated gases are compelled to pass several times over and about the boiler prior to its escape from the furnace, of increased means for the rapid supply of steam to its main outlet-port, of the admission of water to the boiler at its lowest level, a perfect circulation of water obtained, and a less moist steam resultant.

As stated, we do not wish to restrict ourselves to the exact construction shown and described—as, for instance, the boiler proper may consist of any desired number of sections and the number of tubes in each section varied, the number of diaphragms on each section and within the furnace changed, and suitable means, other than shown, for feeding the steam from the boiler for the return of condensed steam to the boiler and for the supply of water to the boiler be substituted, and other minor features of construction in detail and in combination be adopted without departing from the spirit of our invention.

Having thus described our invention, we claim—

1. A sectional steam-boiler constructed and arranged as described, each section being a single casting and consisting of a series of tubes formed with and opening into a header or stand-pipe at its ends, and formed with one or more hollow diaphragms intermediate of its length, with which the series of tubes are in open communication, whereby the steam generated in the section to the immediate rear of each hollow diaphragm is caused to flow therein, as set forth.

2. In combination with a steam-boiler, a furnace the vertical walls of which are formed in whole or part of one or more castings, each casting consisting of a series of vertical tubes in such juxtaposition that the thickness of metal of two contiguous tubes at the line of contact is equal only to the thickness of the metal of one tube as to its portion out of con-

tact, said tubes at one end cast integral and in open communication with a laterally-extending base-tube and at its opposite end formed with a flange adapted to be suitably united to a corresponding flanged end of a similarly-cast section of a series of tubes, the latter cast integral, in open communication and preferably at an incline with a steam-drum and together forming the furnace-top, the flanged ends of said sections so formed as, when joined together, to form a laterally-extending tube, and when two or more such cojoint sections are employed in a single furnace the ends of the respective laterally-extending tubes and the steam-drum section formed with a flange as a means of coupling the sections together, all of said tubes adapted to contain water and form radiating-surface for generating steam in connection with a boiler, as set forth.

In testimony whereof we have hereunto signed our names this 4th day of March, A. D. 1889.

JOHN ROWBOTHAM.
W. ROWBOTHAM.

In presence of—
W. ALEX. ROBINSON,
JOHN JOLLEY, Jr.