(No Model.) 4 Sheets—Sheet 1.

J. F. ALLEN.

SECTIONAL SAFETY BOILER.

No. 590,292. Patented Sept. 21, 1897.

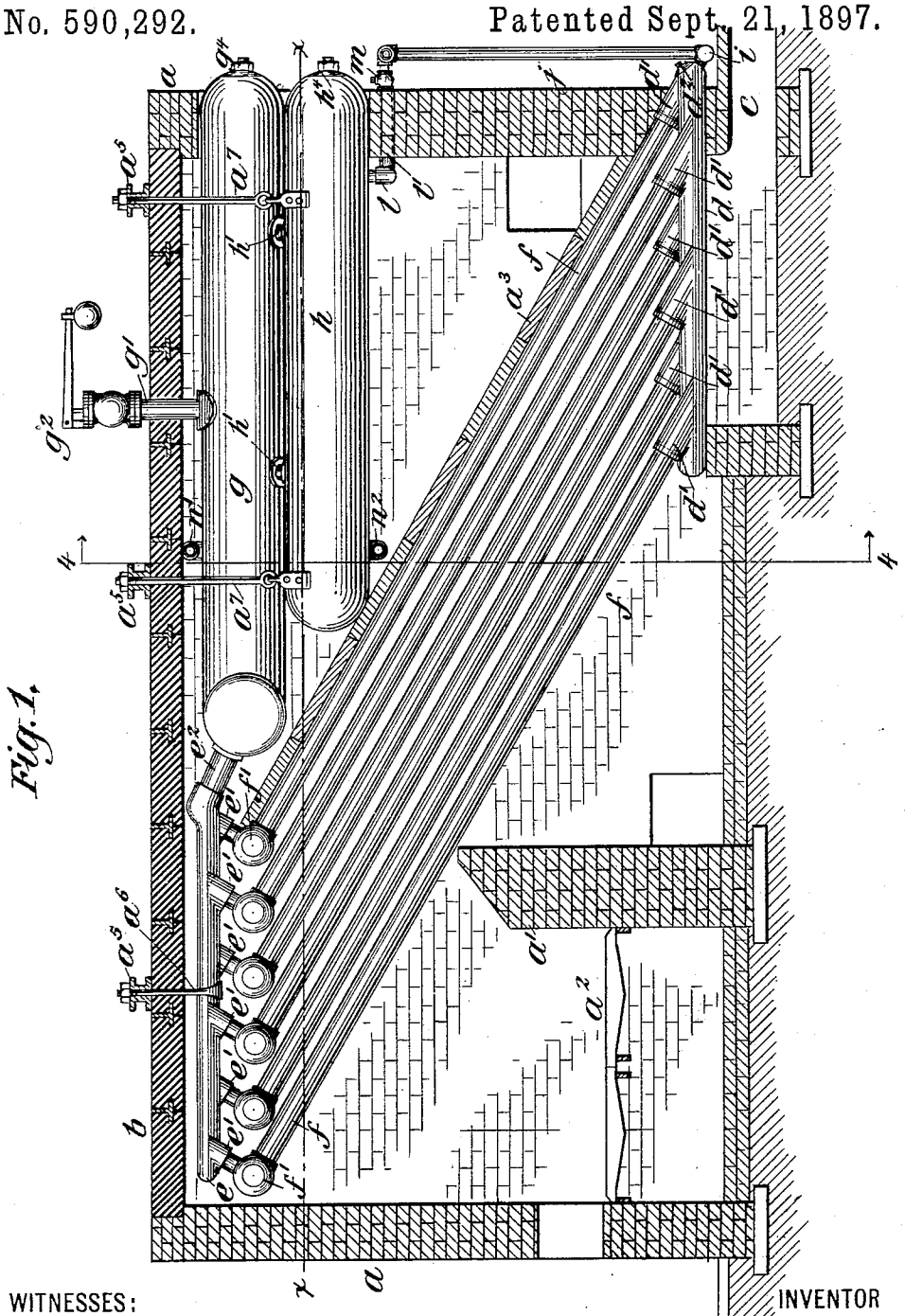

Fig. 1.

WITNESSES:

D. K. Raymond

Ambrose D. Merrill

INVENTOR

John F. Allen

BY

Henry D. Williams

ATTORNEY

(No Model.) 4 Sheets—Sheet 2.

J. F. ALLEN.

SECTIONAL SAFETY BOILER.

No. 590,292. Patented Sept. 21, 1897.

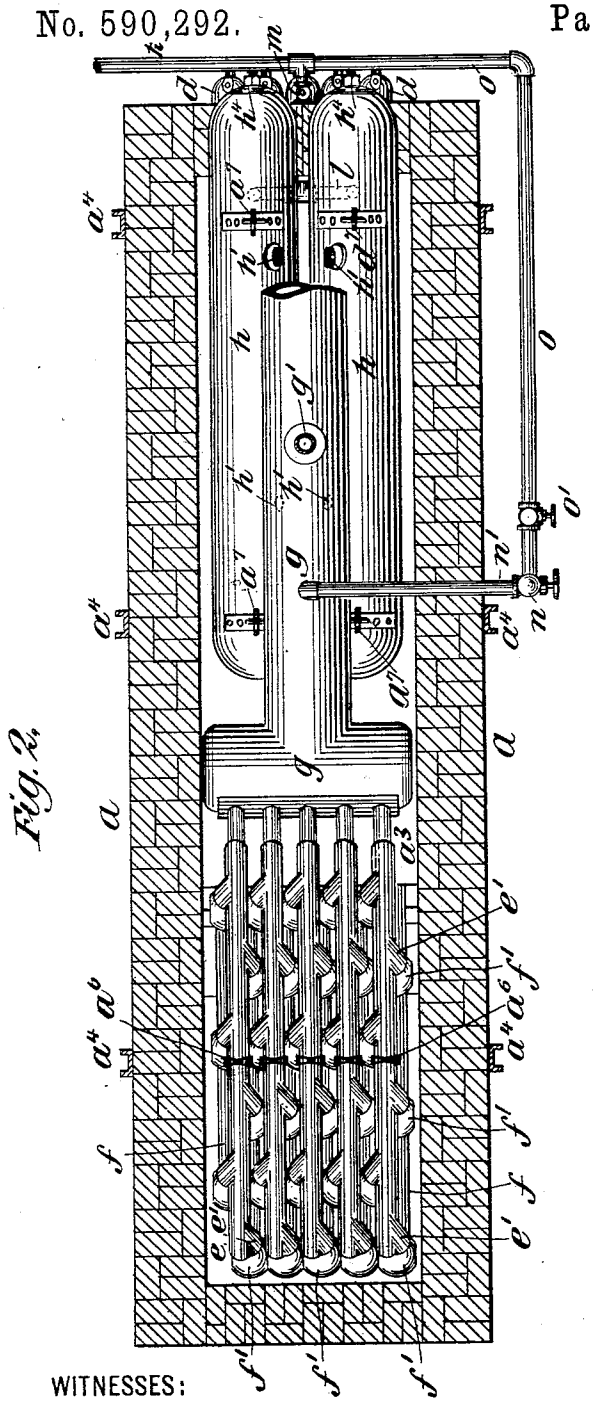

Fig. 2.

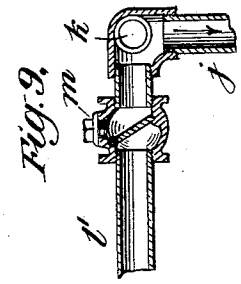

Fig. 9.

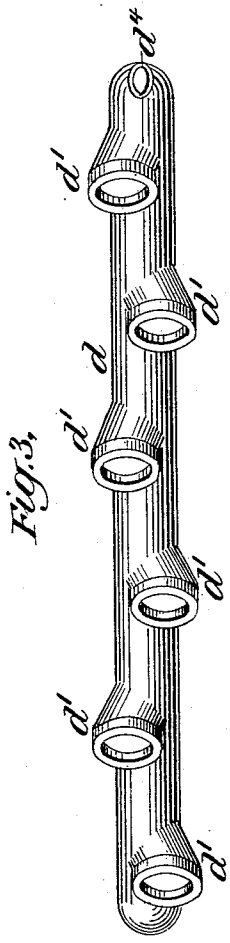

Fig. 3.

WITNESSES:

D. K. Hayward

Ambrose D. Merrill

INVENTOR

John F. Allen

BY

Henry D. Williams

ATTORNEY

(No Model.) 4 Sheets—Sheet 3.

J. F. ALLEN.

SECTIONAL SAFETY BOILER.

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Fig. 5,

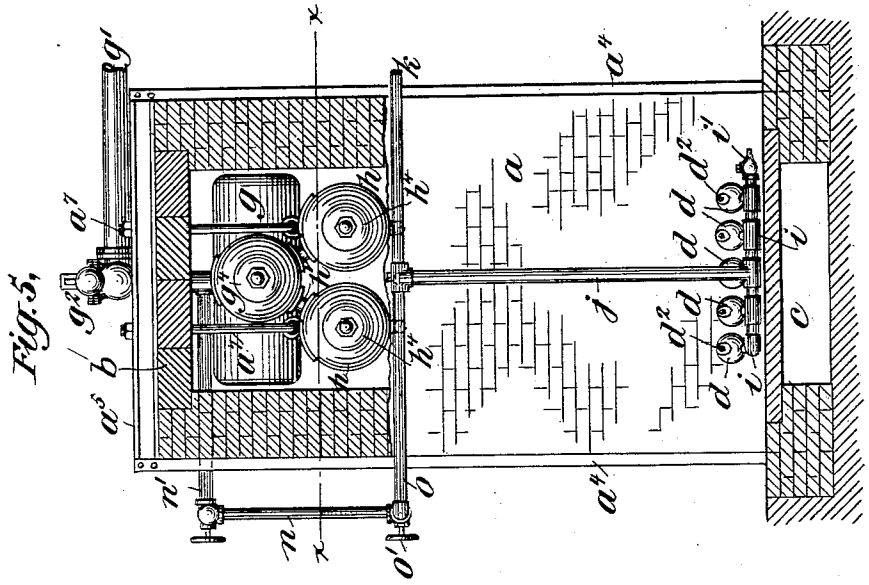
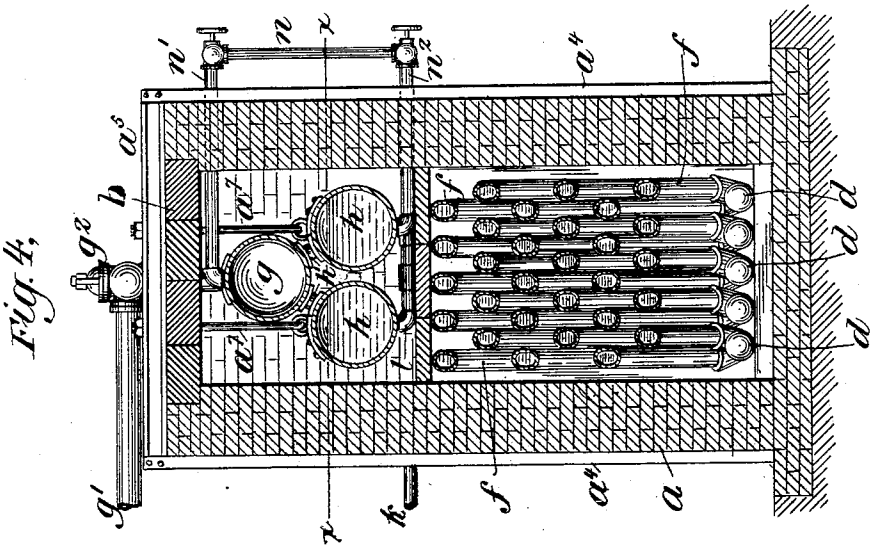


Fig. 4,



WITNESSES:

D. N. Haywood

Ambrose B. Merrill

INVENTOR

John F. Allen

BY

Henry D. Williams

ATTORNEY

(No Model.) 4 Sheets—Sheet 4.

J. F. ALLEN.

SECTIONAL SAFETY BOILER.

No. 590,292. Patented Sept. 21, 1897.

Fig. 7.

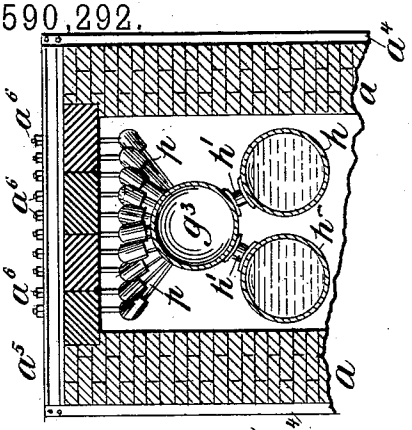


Fig. 6.

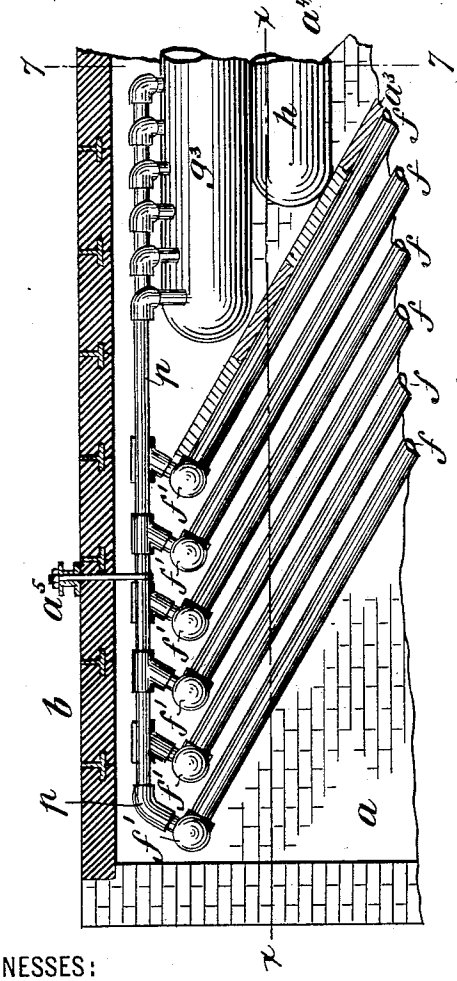
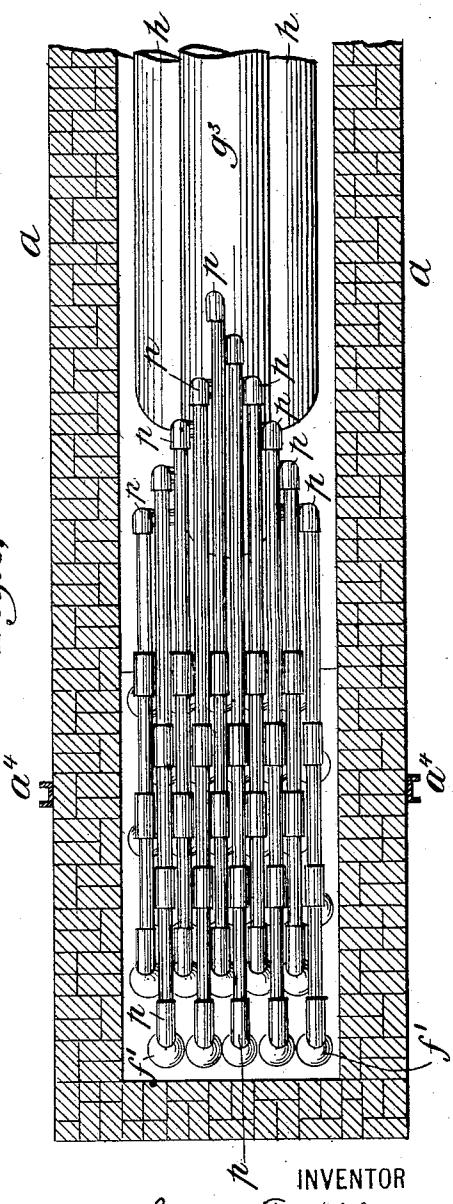


Fig. 8.



WITNESSES:

D. H. Maynard

Ambrose B. Merrill

INVENTOR

John F. Allen

BY

Henry D. Williams

ATTORNEY

UNITED STATES PATENT OFFICE.

JOHN F. ALLEN, OF NEW YORK, N. Y.

SECTIONAL SAFETY-BOILER.

SPECIFICATION forming part of Letters Patent No. 590,292, dated September 21, 1897.

Application filed February 8, 1897. Serial No. 622,585. (No model.)

To all whom it may concern:

Be it known that I, JOHN F. ALLEN, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Sectional Safety-Boilers, of which the following is a specification, reference being had to the accompanying drawings, forming part hereof.

This invention relates to sectional safety-boilers, and has for its objects to provide a boiler which will deliver superheated steam at a temperature far above that at which the products of combustion leave the boiler to enter the chimney, and in which a reversal of the circulation of water or the driving of water out of the water-tubes or the checking of the feed to the water-tubes is prevented, and in which a minimum number of joints is used and a simple construction attained and the parts are readily accessible for cleaning.

Other objects of my invention will appear from the particular description hereinafter given of a boiler embodying my invention.

One feature of my invention is the employment of horizontal or substantially horizontal and longitudinally-arranged lower headers which will receive the dirt and scale from the tubes, and from which the dirt and scale may be removed through suitable hand-holes provided at the ends of the headers.

Another feature is the employment of tubes extending upward and forward from these horizontal lower headers at an easy angle, whereby a flexible scaling-bar may be caused to enter any tube from a hand-hole in the rear of the header for the purpose of cleaning the tube.

Another feature of my invention is the employment of horizontal or substantially horizontal upper headers in connection with inclined tubes, and with a water-chamber arranged below the tops of the tubes, and with flues for deflecting the heated gases toward the lower ends of the tubes, whereby the upper portions of the tubes and the upper headers are used as superheaters, the products of combustion being so conducted that the moderately-heated gases come in contact with this superheating portion of the boiler.

Another feature of my invention is a parallel arrangement of upper and lower headers and the employment of right-angled connection whereby the tubes and connections are all of the same length, a desideratum in manufacturing the boilers, and individual tubes may be taken out and renewed without breaking the connections of the other tubes.

Another feature of my invention is the employment of means for checking a reverse circulation, located between the steam-collecting chamber and the feed-water inlet, whereby the feed-water is compelled to enter the lower ends of the tubes and circulate upward therethrough, while at the same time any water which reaches the steam-collecting chamber is permitted to return to the lower ends of the tubes in the direction of circulation.

One of the greatest dangers in safety-boilers as heretofore constructed is that when overdriven, as they frequently are in marine boilers, a geyser-like action takes place which drives the water with the steam into the steam-chamber, or the generation of steam is sufficiently rapid to drive the water out of the tubes at both ends, leaving nothing but steam in the tubes, and to prevent the entrance of the feed-water into the tubes, reversing the circulation. Many accidents have resulted from these causes. Should my improved boiler be fired so hard that water is driven out of the upper ends of the tubes the water can flow back into the tubes through the return-pipe and the inflowing feed-water compelled to flow always in the direction of circulation will be reinforced by this overflow, and under all circumstances the supply of feed-water can be so regulated as to maintain the proper amount of water in the tubes, and under no circumstances can the steam generated in the tubes force the water backward out of the tubes or check the feed or reverse the circulation.

To describe my invention more particularly, I will now refer to the accompanying drawings, illustrating a boiler embodying my invention.

Figure 1 is a side elevation of such a boiler with the casing in section. Fig. 2 is a plan view of the same also with the casing in section. Fig. 3 is an enlarged plan detail view

of one of the horizontal headers. Fig. 4 is a vertical section of the boiler on the line 4 4, Fig. 1, looking toward the rear. Fig. 5 is a rear end elevation of the boiler with the upper part of the casing in section. Fig. 6 is a side elevation, with the casing in section, of the front and top portions of a modified construction of boiler. Fig. 7 is a vertical section of the same on the line 7 7, Fig. 6, looking toward the front. Fig. 8 is a plan view of the same with the casing in section. Fig. 9 is an enlarged longitudinal section of the check-valve detached.

The boilers shown in the drawings are of a construction that I propose to frequently employ in stationary boilers, having brick side and end walls *a a*, provided with suitable openings therein, a bridge-wall *a'*, furnace grate-bars a^2, a roof *b* of fire-brick and T-irons, and a flue *c* at the lower rear portion of the boiler for the escape of the products of combustion. It is, of course, evident that for marine boilers a metallic shell or casing would replace the mason-work casing shown in the drawings, and that the casing may be made up of any suitable material and the details of construction may be as desired so long as the general arrangement shown is followed and the products of combustion are led downward and away from contact with the water-holding portions of the boiler at the lower portion thereof.

Referring to Figs. 1 to 5, inclusive, of the drawings, the water and steam-containing portions of the boiler comprise, mainly, the horizontal lower headers *d d*, the inclined tubes *f f*, the horizontal upper headers *e e*, the steam-drum *g*, connected to the upper headers, and the two water-drums *h h*, arranged below and connected to the steam-drum *g*. The lower headers *d*, inclined tubes *f*, and upper headers *e* are in the direct draft and in direct contact with the products of combustion, but a partition a^3, which is shown as of fire-brick and resting upon the upper layer of tubes *f*, deflects the heated gases downward and away from the steam-drum *g* and water-drums *h h*.

The lower horizontal headers *d d*, of which five are shown, are arranged side by side and are not directly connected one with another, but each lower header is independently connected at its rear end, as by the short nipple shown, to the cross conduit or pipe *i*, shown as made up of couplings and nipples, the rear ends of the horizontal headers being shown as projecting through the walls of the casing and the cross-pipe *i* being outside of the casing. A vertical conduit or pipe *j* is joined at its lower end to the cross-conduit *i*, and the feed-pipe *k* for supplying water to the boiler is connected to the top of this vertical pipe *j*, and, as will be seen, the feed-water entering at the inlet *k* will flow downward through the vertical conduit *j* and into the cross-conduit *i*, and from there will be distributed to the several lower headers *d*, flowing in separate streams into the lower headers and flowing in a forward direction through each lower header.

The inclined tubes *f* are shown as arranged in six layers, each layer composed of five separate tubes. The tubes of each layer are staggered or arranged alternately with the tubes of the adjacent layers, so that one tube is over the space between two lower tubes, as clearly shown in Fig. 4, and to this end the lugs *d' d'*, projecting upwardly from the lower headers *d* and receiving the lower ends of the tubes *f*, are staggered or arranged alternately on opposite sides of the lower headers, as clearly shown in Fig. 3. By this arrangement an effective action of the heated gases is obtained, as all of the gases are compelled to circulate around the tubes.

The upper ends of the tubes *f* are secured in globes *f' f'*, a separate globe *f'* being provided for each tube, and each globe *f'* is separately connected to one of the upper headers *e*, as by a short nipple extending at right angles to the tubes *f* and entering a lug *e'*, projecting downwardly from an upper header *e*. The number of upper headers corresponds to that of the lower headers in the construction shown in Figs. 1 to 5, inclusive, and the lugs *e'* on the upper headers are staggered or arranged alternately in correspondence with the lower headers, so that the tubes *f* are arranged in parallel directions. The right-angled connections, as just described, at the upper ends of the tubes *f* permit a variable expansion of the tubes without undue strain to the parts of the boiler, and as a result of these connections the work of assembling the parts of the boiler is simple and a tube may be readily removed and replaced, as the unscrewing of a short nipple disconnects the upper part of any tube. By reason of the right-angle connections the unscrewing of a nipple and the consequent springing of the end of the tube downward causes no substantial departure from alinement of the engaging parts, the nipple being in a line tangential to the arc of this downward movement. The nipple should, of course, have the usual right and left threads. It will also be observed that according to this construction the tubes *f* are all of equal length.

The upper headers *e* are independent and unconnected, but each upper header is connected at its rear end, as by a short pipe or nipple e^2, to the steam-drum *g*, the steam-drum being shown as of T shape, with the head of the T at its front end receiving the connections e^2 from the upper headers *e*.

The circulation of water from the horizontal lower headers *d* is upwardly into the several tubes *f f* from their lower ends. Each tube acts as a separate boiler, and the steam generated therein rises to the upper inclined surface of the tube and passes upwardly through the connected globe *f'* and short connection into the corresponding upper header *e*. Here the steam from the several tubes

connected to each upper header is commingled and passes through the connection e^2 into the steam-drum g. The water-level is maintained below the upper ends of the tubes at about the line $x\,x$. As will be seen, the fire is applied below the water-level and the gases are drawn downward and along the lower portions of the tubes. The upper ends of the tubes f, the globes f', connections, and horizontal upper headers e are therefore in contact with moderately-heated gases, and, being above the water-level, act to superheat the steam, and the steam is delivered into the steam-drum g in superheated condition. The steam-outlet is from some suitable part of the steam-drum g, as through the steam-pipe g', having the usual safety-valve g^2 therein and extending out from the top of the steam-drum.

The condensed water, if any, or any water which may be carried over with the steam, will be collected in the water-drums $h\,h$, of which two are shown, these water-drums being arranged below the steam-drum $g\,g$ and connected with the steam-drum, as by short nipples $h'\,h'$, of which four are shown, and the water-level comes within these water-drums near the tops thereof, as shown. From these water-drums a connection is made to the vertical pipe j, this connection being shown as formed by a cross-pipe l, connected at its ends to the lower parts of the two water-drums $h\,h$ and medially connected by a pipe l' to the upper end of the vertical pipe j. The cross-pipe l connects the two water-drums $h\,h$ together at a considerable distance below the water-level, thus insuring the same water-level in both water-drums. The pipes l and l' constitute the return-conduit, and means are provided therein for checking a reverse circulation or preventing the feed-water from flowing directly into the water-drums $h\,h$ and steam-drum g, instead of flowing downward through the vertical conduit j and entering the lower ends of the tubes f, the means shown for such purpose being a balanced check-valve m, located in the pipe l' and arranged to close against the movement of the water toward the water-drums, while it freely permits water to flow through it away from the water-drums. (See Fig. 9.) Thus in the event of any increase of water in the water-drums, such as would raise the water-level therein above that in the tubes f, the check-valve m will open and permit water to flow out of the water-drums and into the tubes until a uniform water-level is attained, and in the event of the boiler being so overdriven that the water would be carried with the steam into the steam-drum this water would drain into the water-drums, and by raising the water-level in the water-drums above that in the tubes f would cause water from the water-drums to flow through the pipes $l\,l'$ and j into the lower ends of the tubes f in the direction of the feed, and would thus act to reinforce the feed. If the boiler should be so overdriven as to develop pressures within the tubes, such as would destroy the equilibrium of the water-levels and tend to force the water downward out of the tubes, the check-valve m would be immediately closed against any tendency toward backflow of the water, and the water could not escape backwardly from the tubes, nor could the feed be checked or direction of feed be reversed. It will therefore be evident that with my improved boiler the tubes will be abundantly supplied with water and it will be impossible to drive the water out of the tubes, and it will be impossible to prevent the forcing of water into the tubes by the feeding means so long as a proper feed is maintained. Thus one of the greatest sources of danger in boilers of this type as heretofore constructed is obviated and an effective and safe action at high pressures is attained.

In operating the boiler the water-drums $h\,h$ should be supplied with water up to the desired water-level, and thus these water-drums $h\,h$ act as a water-reservoir and provide a considerable reserve supply of water, which would flow freely into the tubes f in the event of diminution of the feed or the lowering of the water-level in the tubes from any cause, as the check-valve m offers no obstruction to the flow of water from the water-drums into the tubes.

The means shown for indicating the water-level comprise the water-gage n, located outside of the casing and connected at its upper end to the top of the steam-drum g and at its lower end by the pipe n^2 to the bottom of the right-hand water-drum h. To provide means for connecting at will the water drums and tubes, a pipe o connects the pipe n^2 or lower end of the water-gage to the vertical pipe j, and a valve, such as the globe-valve o', is located in this pipe, capable of being operated by hand. When it is desired to test the water-level, this valve o' may be opened for a few minutes and will establish a communication between the water-drums and the lower ends of the tubes, permitting water to flow backward from the tubes to the water-drums. If it should happen that too much water was being fed into the boiler, the water-level might be raised in the tubes without causing a corresponding rise in the water-drums, as the check-valve m prevents backflow, and in this event the momentary opening of the valve o' would give an immediate indication of this difference in water-levels by the sudden rising of the water in the gage. The difference in the water-levels that would exist with a too abundant feed would be in the direction of the greater safety, but would be undesirable and could be at once detected by the manipulation of the globe-valve o'. If for any reason the water-level in the tubes should be above that in the water-drums, the opening of the globe-valve o' would restore the equilibrium of levels; but in the ordinary working of the boiler the globe-valve o' would be closed and the only return communication

from the drums to the tubes would be through the check-valve *m*.

The cleaning of the boiler may be readily effected through the hand-holes d^2, one at the rear end of each lower header *d*. The dirt and scale, if any, will mainly collect in the lower headers *d*, the inclined surface of the tubes *f* tending to discharge all such matter downward into the headers and the inflowing feed tending to keep the cross-conduit *i* clean. Nevertheless, the interiors of the tubes may be readily cleaned by a flexible scaling-bar entered at the hand-holes d^2, as the inclination of the tubes (shown as about thirty degrees) forms an easy angle with the horizontal headers. The cross-conduit *i* may also be readily reached through the hand-holes d^2 for cleaning purposes, and a blow-off cock i' is shown as provided at the left-hand end of this cross-conduit for use in cleaning the boiler. Hand-holes are also provided for cleaning each of the drums, the hand-hole g^4 being located at the rear end of the steam-drum *g* and the hand-holes h^4 being located at the rear ends of the water-drums *h h* and the rear ends of these drums projecting out through the casing for convenience of access.

I prefer to construct the boiler so that the upper parts are supported independently of the casing, and to that end, as shown, three sets of channel-bars a^4 a^4 are set into the foundation and extend vertically upward outside of the casing, and the opposite channel-bars of each set are joined above the casing by two reversed horizontal channel-bars a^5, spaced apart a slight distance. The upper horizontal headers are supported by hangers a^6, having bolts which pass upward between the front reversed horizontal channel-bars a^5 and having suitable nuts bearing upon said bars, and the water-drums *h h* are supported at their front and rear ends by hangers a^7 a^7, also having bolts with nuts and engaging the middle and rear sets of channel-bars a^5.

It is evident that various modifications may be made in the construction above particularly described within the purview of my invention. Such a modification is illustrated in Figs. 6, 7, and 8, in which the upper horizontal headers are formed by small conduits *p p*, made up of ordinary pipes and couplings, each conduit *p* being connected to all of the tubes in a longitudinal line, or, as shown, twice as many of these conduits being provided as of the upper headers shown in the main views of the drawings and each conduit being connected to three of the tubes *f*. The connections of these conduits *p* with the tubes *f* are substantially the same as heretofore described; but the connections with the steam-drum are different, and in this modified construction the steam-drum *g* is not of the T shape shown in the main views, but is a plain cylinder with rounded ends, and it is not necessary to reinforce the steam-drum at the point of connection as the conduits *p* enter the steam-drum at points sufficiently distant from each other to prevent any substantial weakening of the steam-drum, their entering points being distributed over a considerable portion of the length of the steam-drum, as shown.

While I have described the boiler as adapted for the generation of steam from water and use the terms "steam" and "water" for greater convenience in the claims, it is of course evident that the boiler may be used for the vaporization of other fluids than water.

It is evident that some of the features of my invention may be embodied in structures not embodying other features thereof or may be otherwise combined or used together or separately than as above particularly described.

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

1. A boiler having water-tubes, a feed-inlet leading to the lower portions of the water-tubes, a steam-outlet, a return-conduit between the steam-outlet and the water-inlet, and means for checking a reverse circulation located in said return-conduit, substantially as set forth.

2. A boiler having water-tubes, a feed-inlet leading to the lower portions of the water-tubes, a steam-chamber and a steam-outlet, a return-conduit between the steam-chamber and water-inlet, and a check-valve located in said return-conduit for preventing a reverse circulation through said return-conduit, substantially as set forth.

3. A boiler having inclined water-tubes and longitudinally-arranged substantially horizontal lower headers receiving the lower ends of said water-tubes, said water-tubes being inclined at an oblique angle to said headers, substantially as set forth.

4. A boiler having inclined water-tubes, longitudinally-arranged substantially horizontal lower headers receiving the lower ends of such water-tubes, said water-tubes being inclined at an oblique angle to said lower headers, and substantially horizontal upper headers connected to the upper ends of said water-tubes, substantially as set forth.

5. A boiler having inclined water-tubes, lower headers receiving the lower ends of such water-tubes, substantially horizontal upper headers and connections substantially at right angles to said tubes joining the tubes to the upper headers, substantially as set forth.

6. A boiler having lower headers, inclined water-tubes extending upward from said lower headers, substantially horizontal upper headers for said tubes, flues for directing the heated gases downward toward the lower ends of said tubes, a water-reservoir located below the upper ends of said tubes, a connection from the upper headers to the water-reservoir having a steam-outlet therein, and a connection from the water-reservoir to the lower headers, substantially as set forth.

7. A boiler having lower headers, water-

tubes extending upward from said lower headers, upper headers for said tubes, flues for directing the heated gases downward toward the lower ends of the tubes, a water-reservoir below the upper ends of said tubes, and a connection from said water-reservoir to the lower headers having a check-valve therein, said check-valve being arranged to close against the flow of water toward said reservoir, and a water-inlet connected to the lower headers in advance of said check-valve, substantially as set forth.

8. A boiler having lower headers, water-tubes extending upward from said lower headers, upper headers for said tubes, flues for directing the heated gases downward toward the lower ends of said tubes, a steam-chamber connected to said upper headers, a water-reservoir below the upper ends of the tubes and connected to said chamber, and a connection from said water-reservoir to the lower headers having a check-valve therein, said check-valve being arranged to close against the flow of water toward said reservoir, and a water-inlet connected to the lower headers in advance of said check-valve, substantially as set forth.

9. A boiler having lower headers arranged in a substantially horizontal plane, inclined water-tubes extending upward from said lower headers, upper headers for said tubes, said upper headers being also arranged in a substantially horizontal plane, a steam-chamber connected to said upper headers, a water-reservoir connected to said steam-chamber, and a connection from said water-reservoir to the lower headers, substantially as set forth.

10. A boiler having substantially horizontal lower headers, inclined water-tubes extending upward from said lower headers, upper headers for said tubes, a steam-chamber connected to said upper headers, a water-reservoir below the upper ends of the tubes and connected to said steam-chamber, and a connection from said water-reservoir to the lower headers having a check-valve therein, said check-valve being arranged to close against the flow of water toward said reservoir, and a water-inlet connected to the lower headers in advance of said check-valve, substantially as set forth.

11. A boiler having longitudinally-arranged substantially horizontal lower headers, a feed-inlet and connections from said feed-inlet to the rear ends of the lower headers, water-tubes extending upward from said lower headers, and connections from the upper ends of said water-tubes to the feed-inlet, substantially as set forth.

12. A boiler having longitudinally-arranged substantially horizontal lower headers, a feed-inlet and connections from said feed-inlet to the rear ends of the lower headers, inclined water-tubes extending upwardly from said lower headers, longitudinally-arranged substantially horizontal upper headers connected to the upper ends of said tubes, a steam-chamber connected to the rear ends of said upper headers, a water-reservoir below the upper ends of said tubes and connected to the steam-chamber, and a connection from said water-reservoir to the feed-inlet, substantially as set forth.

13. A boiler having inclined water-tubes, upper headers arranged in a substantially horizontal plane for the upper ends of said tubes, a steam-chamber connected to the upper headers, a water-reservoir below the upper ends of the tubes and connected to the steam-chamber, and connections from said water-reservoir to the lower ends of the tubes, substantially as set forth.

14. A boiler having longitudinally-arranged substantially horizontal lower headers, a feed-inlet and connections from said feed-inlet to the rear ends of the lower headers, inclined water-tubes extending upwardly from said lower headers, longitudinally-arranged substantially horizontal upper headers, connections substantially at right angles to said tubes joining the tubes to the upper headers, a steam-chamber connected to the rear ends of said upper headers, a water-reservoir below the upper ends of said tubes and connected to the steam-chamber, a connection from said water-reservoir to the feed-inlet, and flues for directing the heated gases downwardly toward the lower ends of the tubes, substantially as set forth.

15. A boiler having longitudinally-arranged horizontal lower headers, a feed-inlet and connections from the feed-inlet to the rear ends of the lower headers, inclined water-tubes extending upwardly from said lower headers, longitudinally-arranged substantially horizontal upper headers, connections substantially at right angles to said tubes joining the tubes to the upper headers, a steam-chamber connected to the rear ends of said upper headers, a water-reservoir connected to the steam-chamber, and a connection from said water-reservoir to the feed-inlet, substantially as set forth.

16. A boiler having lower headers arranged in a substantially horizontal plane, with inclined lugs alternately arranged, inclined tubes extending upwardly from the inclined lugs, and upper headers connected to the inclined tubes, substantially as set forth.

17. A boiler having lower headers d, with lugs d' alternately arranged, the inclined tubes f extending upwardly from said lugs d', the globes f' at the upper ends of said tubes, the upper headers e having lugs e' alternately arranged, connections arranged substantially at right angles to the tubes from the globes to the lugs e', and the steam-drum g, connected to the upper headers, substantially as set forth.

18. A boiler having lower headers d, a cross-conduit connected to the rear ends of said lower headers and a conduit leading to said cross-conduit and having the feed-inlet, the inclined tubes f, said lower headers having lugs d' alternately arranged receiving the

lower ends of said tubes, the globes f' at the upper ends of said tubes, the upper headers e having lugs e' alternately arranged, connections arranged substantially at right angles to the tubes from the globes to the lugs e', the steam-drum g connected to the upper headers, the water-drums h, h, connected to the steam-drum, and the conduit l, l, having a check-valve therein, and joined to the conduit leading to the cross-conduit and lower headers, said check-valve being arranged to close against the flow of water toward the water-reservoir, substantially as set forth.

Signed at New York, in the county of New York and State of New York, this 4th day of February, A. D. 1897.

JOHN F. ALLEN.

Witnesses:
HENRY D. WILLIAMS,
HERBERT H. GIBBS.