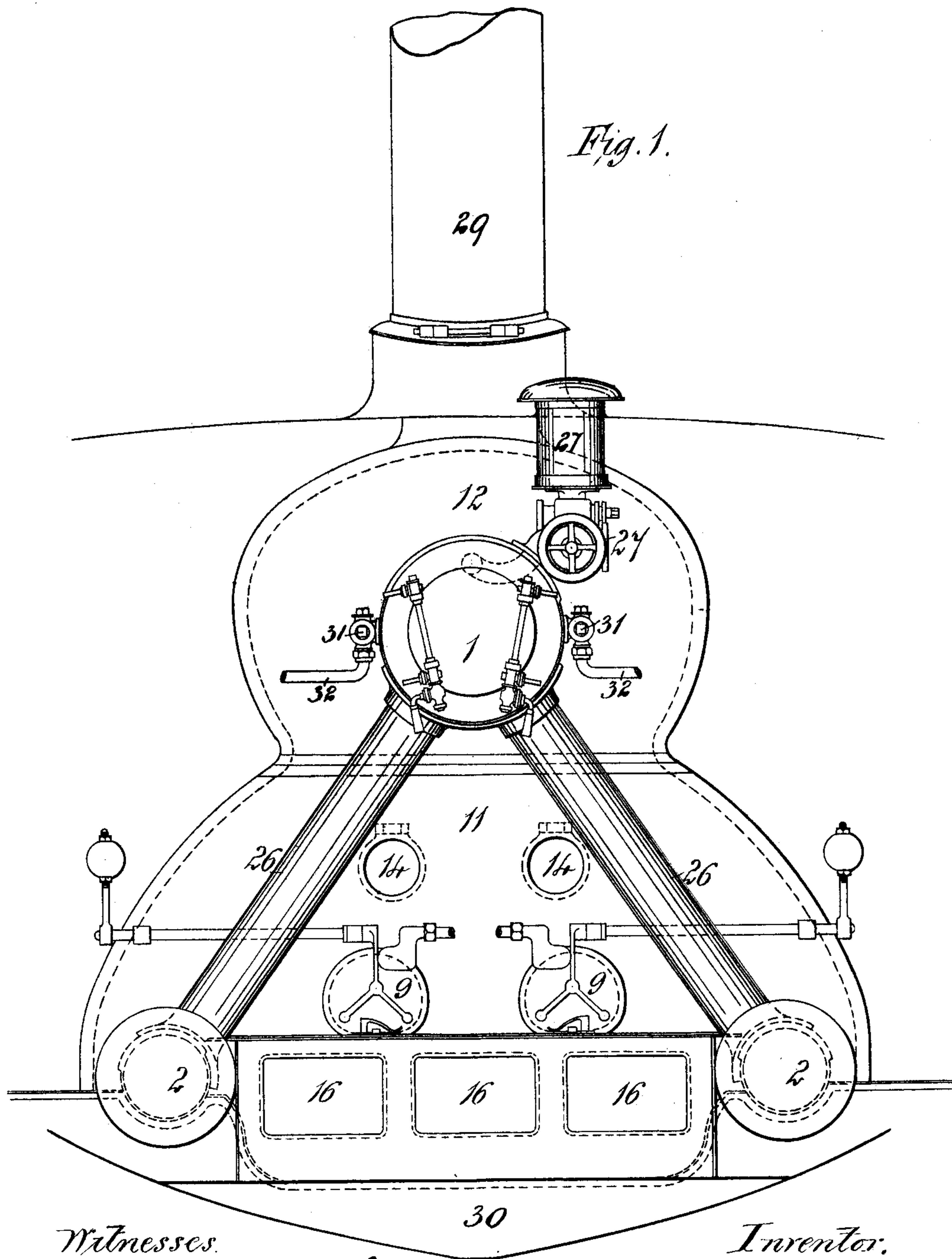


J. I. THORNYCROFT.

STEAM GENERATOR.

No. 387,547.

Patented Aug. 7, 1888.



Witnesses.

W. B. Ridgway.
F. J. Brongham.

Inventor.

John Isaac Thornycroft.

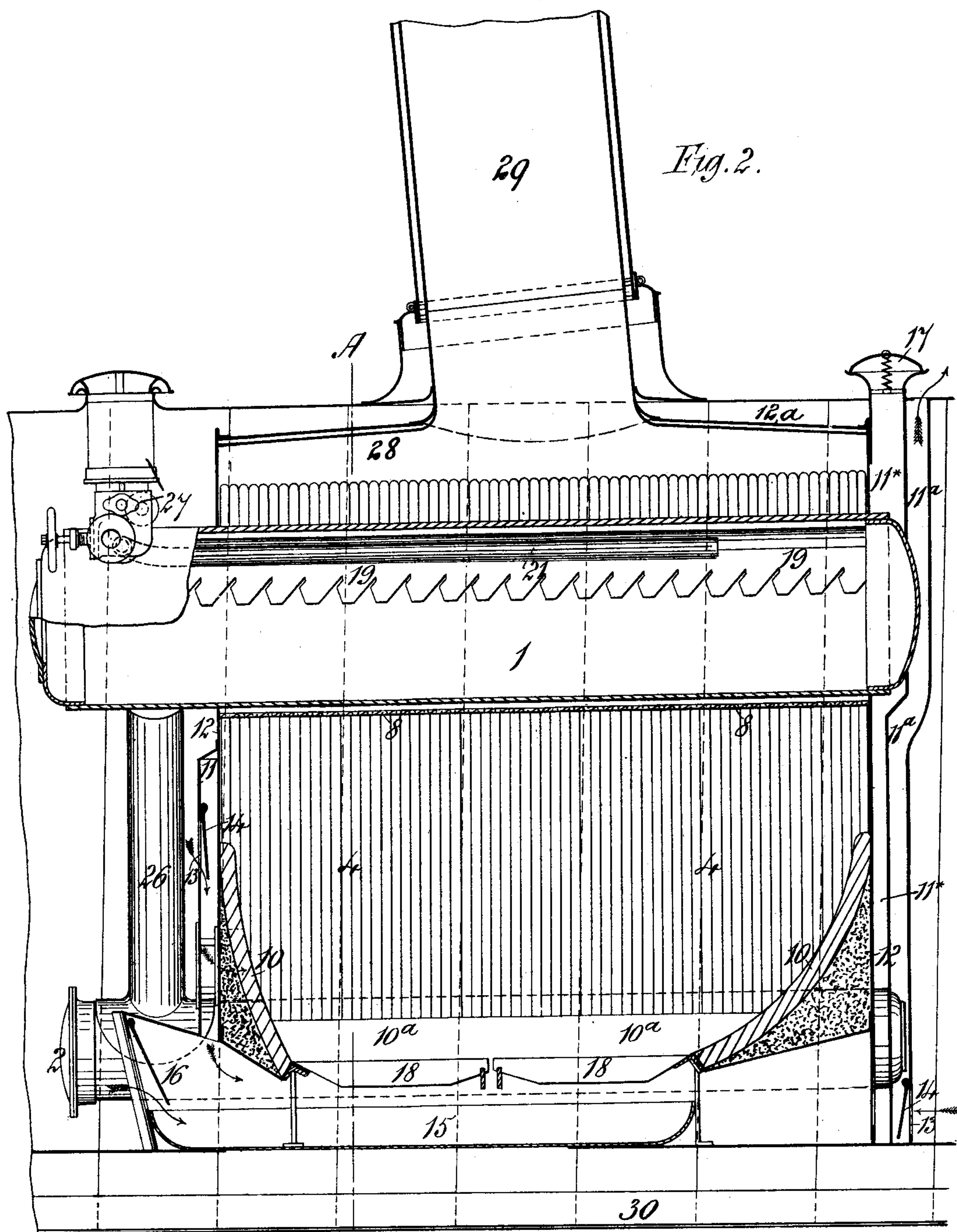
(No Model.)

4 Sheets—Sheet 2.

J. I. THORNYCROFT.
STEAM GENERATOR.

No. 387,547.

Patented Aug. 7, 1888.



Witnesses,
W. B. Ridgway,
J. J. Bingham.

Inventor
John Isaac Thornycroft.

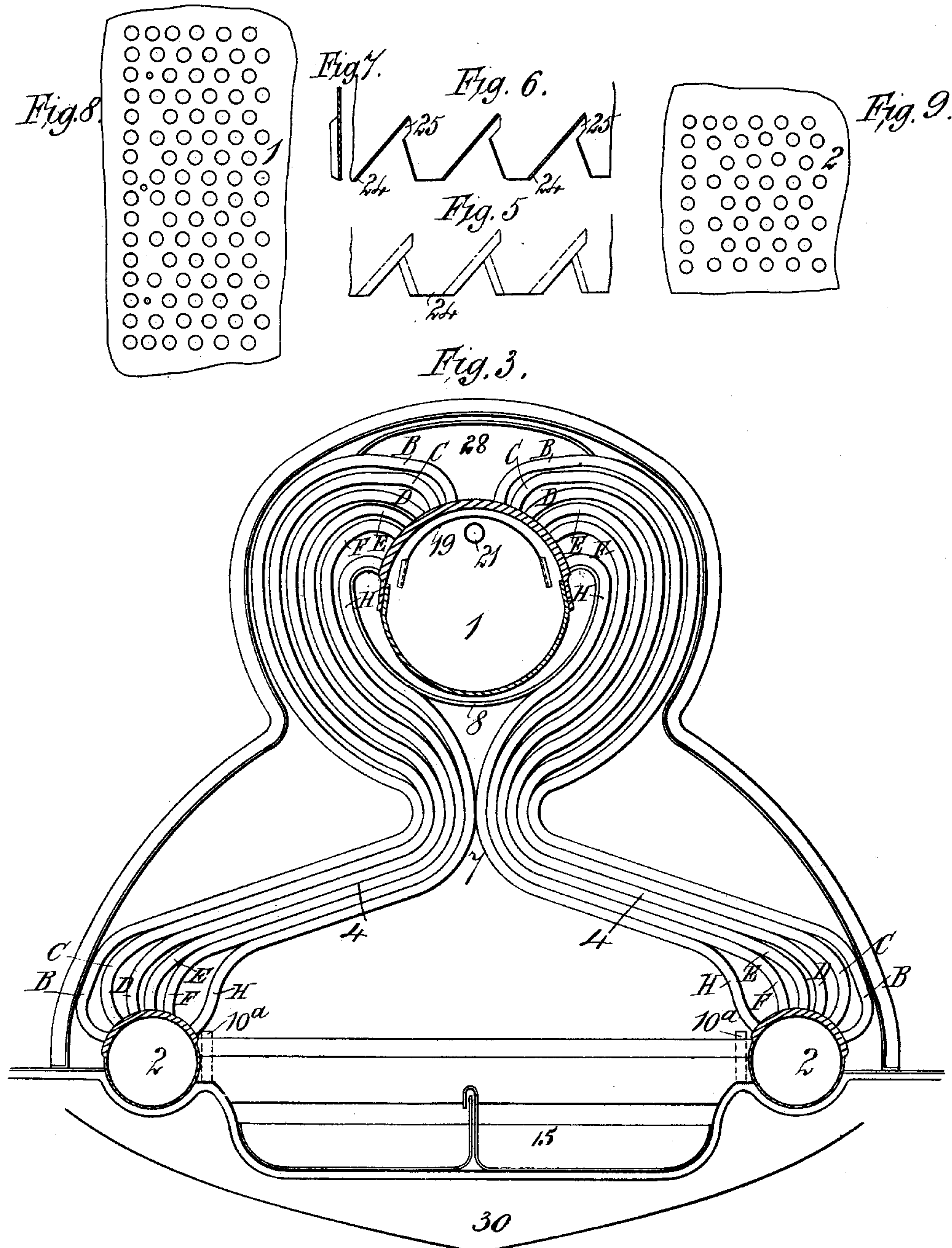
(No Model.)

4 Sheets—Sheet 3.

J. I. THORNYCROFT
STEAM GENERATOR.

No. 387,547.

Patented Aug. 7, 1888.



Witnesses
W. B. Ridgway.
J. J. Drougham.

Inventor,
John Isaac Thornycroft.

(No Model.)

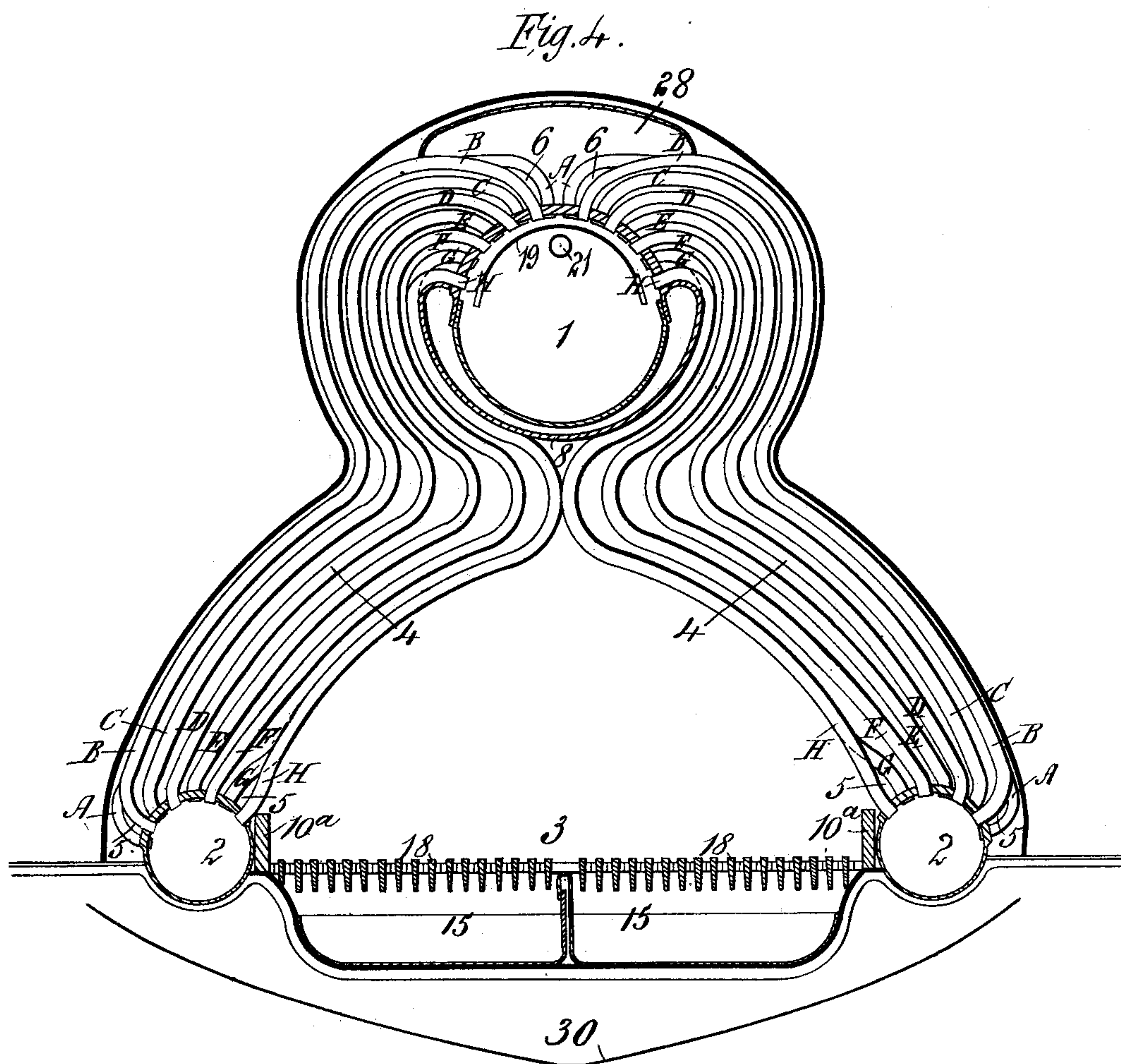
4 Sheets—Sheet 4.

J. I. THORNYCROFT.

STEAM GENERATOR.

No. 387,547.

Patented Aug. 7, 1888.



Witnesses
W. C. Ridgway.
J. B. Bingham.

Inventor.
J. I. Thornycroft.

UNITED STATES PATENT OFFICE.

JOHN ISAAC THORNYCROFT, OF CHISWICK, COUNTY OF MIDDLESEX,
ENGLAND.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 387,547, dated August 7, 1888.

Application filed July 5, 1887. Serial No. 243,372. (No model.) Patented in England January 31, 1885, No. 1,404; in France June 28, 1887, No. 184,504; in Italy June 30, 1887, XLIII, 275; in New South Wales August 2, 1887, No. 56; in Spain August 29, 1887, No. 11,387, and in Austria-Hungary December 2, 1887, No. 25,762.

To all whom it may concern:

Be it known that I, JOHN ISAAC THORNYCROFT, a subject of the Queen of Great Britain and Ireland, residing at Chiswick, in the county of Middlesex, Kingdom of Great Britain and Ireland, have invented Improvements in Steam-Generators, (for part of which I have obtained a patent in Great Britain, No. 1,404, bearing date of January 31, 1885; in Spain, No. 11,387, dated August 29, 1887; in France, No. 184,504, dated June 28, 1887; in Austria-Hungary, No. 25,762, dated December 2, 1887; in Italy, XLIII, 275, dated June 30, 1887; and in New South Wales, No. 56, dated August 2, 1887,) of which the following is a specification.

This invention has reference to improvements, hereinafter described, in steam-generators of the kind wherein the water is exposed to the action of heat while passing in tubes between two vessels, one of which acts as a steam collector and separator. A horizontal cylindrical steam collector and separator is connected by two series of tubes with two water vessels or chambers, or with two parts of the same water vessel or chamber, situated at either side of the grate or fire bars. These tubes are arranged in groups, and all the tubes of one group stand in the same vertical plane, or approximately so. Each tube is connected at its lower end to the water vessel or chamber and at its higher end to the upper side of the steam collector and separator. The groups of tubes stand side by side, and are so disposed that the double row formed by the two outer tubes of each group, and likewise the double row formed by the two inner tubes of each group, constitutes a wall or partition, except near the upper and lower extremities of the tubes. These two walls inclose between them, at each side of the grate, a space which acts as a flue for the ascent of the gases from the grate to the uptake. The first and last group of tubes at each side is of a different configuration from the others, so that a partial wall or partition is formed at each end of the grate to inclose the furnace. The lower side of the steam-separator is protected from the flame by a shield of non-conducting material—such as asbestos cloth—which connects the walls of tubes

at either side and constitutes the roof of the furnace. The furnace is provided with a fire door or doors at one end, and with fire-brick deflecting-plates at the ends and sides of the fire-grate. Chambers provided with valves for admission of air for cooling parts of the boiler and maintaining the stoke-hold cool are arranged at the ends of the boiler. One of such chambers is in communication with the ash-pan and the other with the atmosphere. An additional chamber is employed, that is in communication with the ash-pan, and is provided with an outlet that is normally closed by a loaded valve that will open to admit of the escape of steam in case a tube should burst. The steam collector and separator has a steam-pipe extending the greater part of its length. This pipe is protected by one or more baffle-plates, over which the mixed water and steam rising through the tubes is poured. The water falls into the lower parts of the separator and descends through one or more large return-tubes to the water chamber or vessel. The steam turns under the baffle-plate and enters the steam-pipe. The collector is provided with a safety-valve or with safety-valves, of which one is constructed in combination with a stop-valve or regulator.

Referring to the accompanying four sheets of illustrative drawings, Figure 1 is a front elevation, and Fig. 2 a longitudinal section, of a steam-generator according to this invention, shown as mounted in a boat or vessel represented in section. Fig. 3 is an elevation of the steam-generator with the front plate removed, showing more particularly the arrangement of the tubes in the first row. Fig. 4 is a transverse section in the line A B, Fig. 2. Figs. 5, 6, and 7 are detail views, drawn to an enlarged scale, of a portion of a baffle-plate, hereinafter described. Figs. 8 and 9 are developed surfaces, drawn to an enlarged scale, of the upper portions of a steam collector and separator and a water vessel or chamber, respectively.

1 is a horizontal cylindrical steam collector and separator.

2 and 2 are water vessels or chambers, situate one at each side of the fire-grate 3; and

4 4 are two series of tubes connecting the steam collector and separator 1 with the water vessels or chambers 2, the whole forming a steam-generator. The tubes of each series are arranged in groups of eight tubes each, A B C D E F G H, as shown in Figs. 3 and 4, their lower ends being secured to the upper part of the water vessels or chambers 2, and their other ends to the upper part of the steam collector and separator 1. The two inner rows of tubes, G H, and the two outer rows of tubes, A B, of each series, excepting those of the first and last groups, are so disposed and arranged by bending that they constitute inner and outer walls or partitions, except near the upper and lower extremities of the tubes, where openings 5 and 6, respectively, are left, as shown in Fig. 4, for the entrance and exit of products of combustion.

It will be understood that the arrangement is such as to prevent entry of flame and products of combustion between the tubes to the flue or space between the inner and outer tubular walls except at the openings 5 at the lower part of the inner tubular walls, the upper parts of the innermost tubes (except at 6) being arranged so closely together as to form a complete wall. Within the flue or space thus formed at each side of the fire-grate by the tubular walls or partitions the remainder of the tubes, excepting the first and last groups, are situated, as shown. The tubes constituting the first and last groups A B C D E F G H of each series are so bent and arranged, as shown in Fig. 3, that they form a partial wall or partition, 7, at each end of the fire-grate 3, to inclose the furnace. The wall or partition 7 at the rear of the furnace is not shown in Fig. 4, for the sake of clearness. 8 is a shield of non-conducting material—such as asbestos cloth—for preventing the direct impact of the furnace-flame upon the lower side of the steam separator and collector. This shield extends the whole length of the furnace, so as to form the roof thereof, and connects the inner walls of tubes, as shown.

9 9 are balanced fire-doors at one end of the furnace.

10 10 are curved deflecting plates or blocks of refractory material—such as fire-brick—one being arranged at each end. The space behind each plate or block 10 is shown as being filled with pumice-stone or analogous substance. Openings corresponding in position with the fire-door openings are formed through the front plate or block 10 for admission of fuel.

10^a 10^a are two plates of refractory material, one at each side of the fire-grate, to protect the water-vessels 2 from excessive heat.

11 11^a are chambers formed by casings at the ends of the generator.

13 13 are openings (controlled by flap-valves 14) through which air can be admitted to prevent overheating of those portions of the ends 12 of the boiler-casing 12^a that are not protected by the partial walls or partitions 7, and

for maintaining the stoke hold cool. The air so admitted through the chamber 11 at the fire-door end of the boiler passes to the furnace mainly through the ash-pan 15; but part may pass to the furnace above the fuel through openings in the baffle-plates carried by the fire-doors. The air that passes through the chamber 11^a cools the adjacent parts of the boiler and boat with which it comes in contact, and passes to the atmosphere, external to the boat, by any suitable course. In the example shown it passes upward through the deck of the boat or vessel.

16 16 16 are hinged flap-valves or doors that control the main admission of air to the furnace through the ash-pan.

11* is a chamber situate between the rear of the steam-generator and the chamber 11^a. It is in communication with the ash-pan, and is continued upward so as to extend above the top of the deck of the vessel, where it is provided with a valve, 17, which, by the action of a spring, as shown, or by a weight or load, normally closes the outlet to prevent escape of air, but will nevertheless lift to allow of the escape of steam in the event of a tube bursting.

18 18 are the fire-bars of the furnace.

19 is a baffle plate of curved form in transverse section, secured within the steam separator and collector 1.

21 is a perforated steam-pipe arranged beneath the baffle-plate. In lieu of a perforated pipe, a pipe open only at its ends may be employed. Over the baffle-plate jets of mixed water and steam are poured from the upper ends of the tubes when the steam-generator is at work, the water falling to the lower part of the separator and collector 1, while the steam turns under the baffle-plate and enters the steam-pipe 21.

To enable the steam to readily separate from the water, the lower ends or edges of the baffle-plate are notched and cut, as shown more clearly in Fig. 5, the edges or portions 22 and 23 being afterward so bent as to project at right angles to the remainder of the plate, as shown in side and transverse sectional views in Figs. 6 and 7. By this construction water projected against the baffle-plate will run off at its lower edges, 24, only, while steam similarly projected will readily pass through the notched openings 25.

26 26 are return-pipes, in communication at their upper ends with the separator and collector 1 and at their lower ends with the water vessels or chambers 2, as shown. Through these tubes the water separated from steam in the separator 1 passes to the water vessels or chambers 2, from which it is again caused to rise through the series of tubes by the heat of the furnace.

27 is a combined safety-valve and stop-valve or regulator. A second safety-valve may be fitted to the separator and collector. Flame and heated products of combustion from the furnace pass through the openings 5 to the flue or space between the inner and outer tubular

walls or partitions and impart heat to the tubes in their course. The products of combustion finally escape through the openings 6 to the flue 28, which is in communication with an uptake or chimney, 29. 30 is the boat or vessel in which the steam-generator is shown mounted.

31 31 are valves for controlling the passage of water through the feed-pipes 32.

10 In some cases the outer casing, 12^a, may be dispensed with, the outermost tubes being arranged to serve as a casing. In this case the spaces between these tubes at their upper and lower ends may be filled up with some suitable material, such as metal.

15 What I claim is—

1. In a steam-generator, a combined collector and separator comprising a vessel, 1, baffle-plate 19, and perforated steam-pipe 21, said baffle-plate being arranged above said steam-pipe and partially inclosing the same, substantially as herein described.

2. In a steam-generator, a combined collector and separator comprising a cylindrical vessel, 1, with curved baffle-plate 19, extending lengthwise thereof and formed with notched or serrated edges, substantially as herein described, for the purpose specified.

3. In a steam-generator, a combined collector and separator comprising a vessel, 1, baffle-plate 19, having notched or serrated edges, and perforated steam-pipe 21, substantially as described.

4. In a steam-generator, the combination of a combined collector and separator comprising a cylindrical vessel, a curved baffle-plate with notched or serrated edges, and a perforated steam-pipe arranged lengthwise and below said baffle-plate, water vessels or chambers 2, and pipes connecting said combined collector and separator with said water vessels or chambers, substantially as described.

5. In a steam-generator, the combination of a combined collector and separator, water vessels or chambers 2, pipes 4, connecting said collector and separator with said water vessels or chambers, and a return-pipe, some of said pipes 4 being arranged close together for the greater part of their length to form inner and tubulous close walls of flues, within which other pipes 4 are separately placed, the pipes forming said inner walls being bent near their lower ends to form inlet-passages 5, and the pipes forming said outer walls being bent near their upper ends to form outlet-passages 6, substantially as described, for the purposes specified.

6. In a steam-generator, the combination of a combined collector and separator, water vessels or chambers 2, pipes 4, connecting said collector and separator with said water vessels or chambers, and a return-pipe, some of said pipes 4 being arranged close together for the greater part of their length to form inner and outer longitudinal tubulous close walls of flues, within which other of said pipes are separately arranged and bent at other parts to form inlet

and outlet passages 5 and 6 to and from said flues, and others of said pipes 4 being arranged to form a partial wall or division, 7, at each end of the combustion-chamber, substantially as herein described, for the purposes specified.

7. In a steam-generator, the combination of a combined collector and separator comprising a cylindrical vessel, 1, curved baffle-plate 19, having notched or serrated edges, and a perforated steam pipe, 21, arranged below said baffle plate, water vessels or chambers 2, pipes 4, connecting said collector and separator with said water vessels or chambers, and return-pipes 26, some of said pipes 4 being arranged to form the inner and outer close tubulous walls of flues with inlet and outlet passages 5 and 6, and within which flues other pipes 4 are arranged, while other pipes 4 are arranged to form partial walls or divisions 7 at the ends of the combustion-chamber, substantially as described, for the purposes set forth.

8. In a steam-generator, the combination of a combined collector and separator comprising a vessel, a baffle plate, and a steam-pipe, water vessels or chambers 2, pipes 4, return-pipes 26, a combustion-chamber, an ash-pit with air-inlet, valve 16, and an air-chamber provided with inlet-valve 14, for admission of air, said air-chamber being situate at and adapted to cool one end of the combustion-chamber, substantially as described, for the purposes specified.

9. In a steam-generator, a combined collector and separator comprising a vessel, a baffle-plate, and a steam-pipe, water vessels or chambers 2, pipes 4, return-pipes 26, a combustion-chamber, an ash-pit with valve 16, and chambers 11 11^a, with valves or doors 14 for admission of air, all substantially as described, for the purposes set forth.

10. In a steam-generator, a combined collector and separator comprising a vessel, a baffle-plate, and a steam-pipe, water vessels or chambers 2, pipes 4, return-pipes 26, a combustion-chamber, an ash-pit with valve 16, and chamber 11* in communication with the ash-pan and having an outlet closed by a loaded valve, 17, substantially as herein described, for the purposes specified.

11. In a steam-generator, a combined collector and separator, water vessels or chambers 2, pipes 4, return-pipes 26, a combustion-chamber, an ash-pit with valve 16, chamber 11 in communication with said ash-pit, chamber 11^a in communication with the external atmosphere, valves 14 for admission of air to said chambers, and chamber 11*, with loaded valve 17, all substantially as herein described, for the purposes set forth.

12. In a steam-generator, a combined collector and separator comprising a vessel, 1, a baffle-plate, and a steam-pipe, water vessels or chambers 2, pipes 4, return-pipes 26, blocks or plates 10 and 10^a, of refractory material, fire grate 3, ash-pan 15, with valve 16, chambers 11 11^a, with valves 14 for admission of air, and chamber 11*, with loaded valve 17

for exit of steam, all substantially as herein described, for the purposes set forth.

13. In a steam-boiler, a combined collector and separator comprising a vessel, 1, a baffle-
5 plate, and a steam-pipe, water vessels or chambers 2, pipes 4, return-pipes 26, fire-grate 3, blocks or plates 10 and 10^a, of refractory material, shield 8, of non-conducting material, ash-
pan 15, with valves 16, chambers 11 and 11^a, with
10 valves 14 for admission of air, chamber 11*, with loaded valve 17 for exit of steam, flue

28, and uptake or chimney 29, all substantially as herein described, for the purposes specified.

In testimony whereof I have signed my name to this specification in the presence of two sub- 15
scribing witnesses.

JOHN ISAAC THORNYCROFT.

Witnesses:

TOB. G. RIDGWAY,
Not. Pub., 19 Change Alley, London, E. C.

F. J. BROUGHAM,
46 Lincoln's Inn Fields, London.