(No Model.) 2 Sheets—Sheet 1.

J. I. THORNYCROFT.

STEAM GENERATOR.

No. 452,401. Patented May 19, 1891.

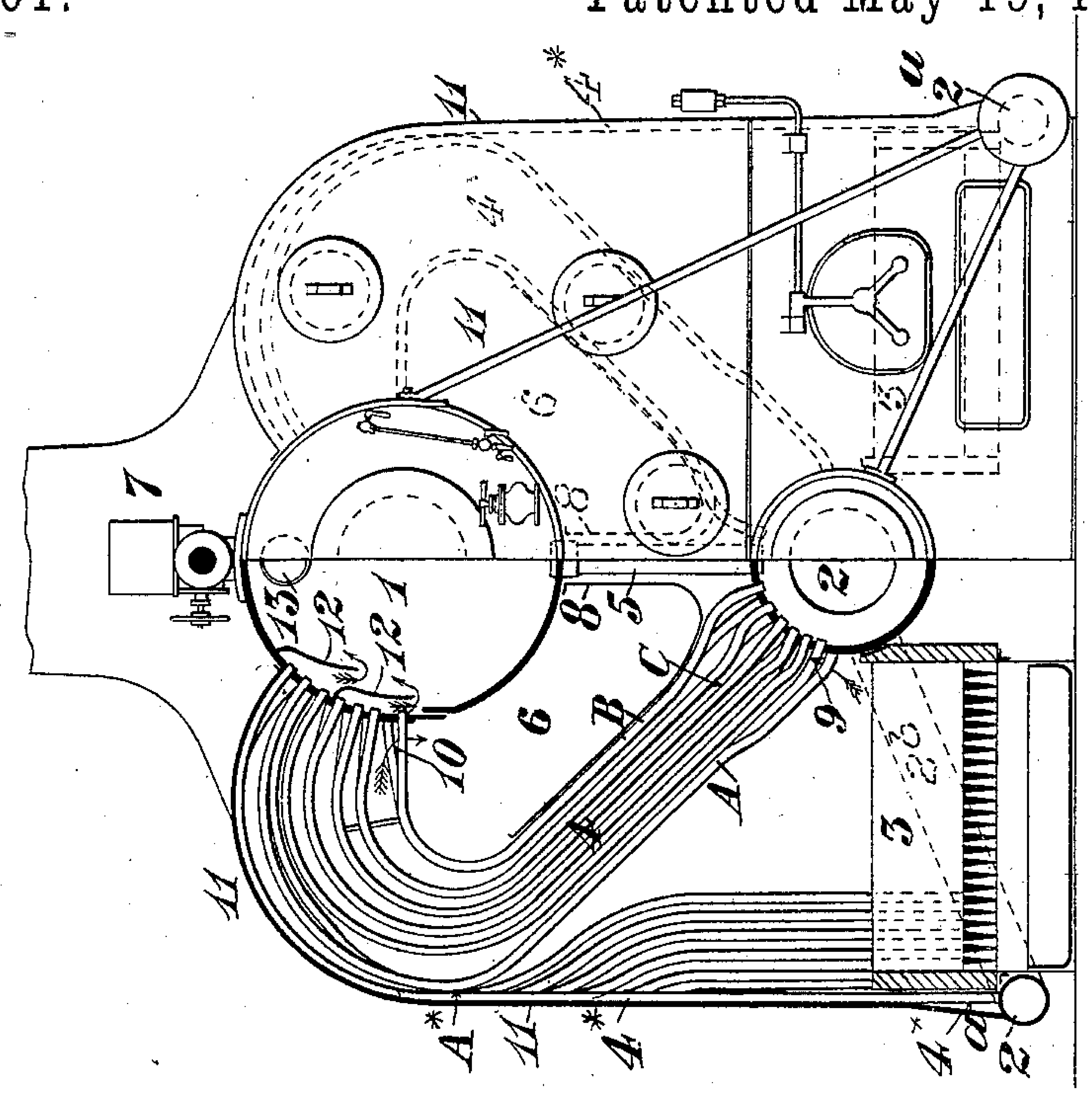

Fig. 1.

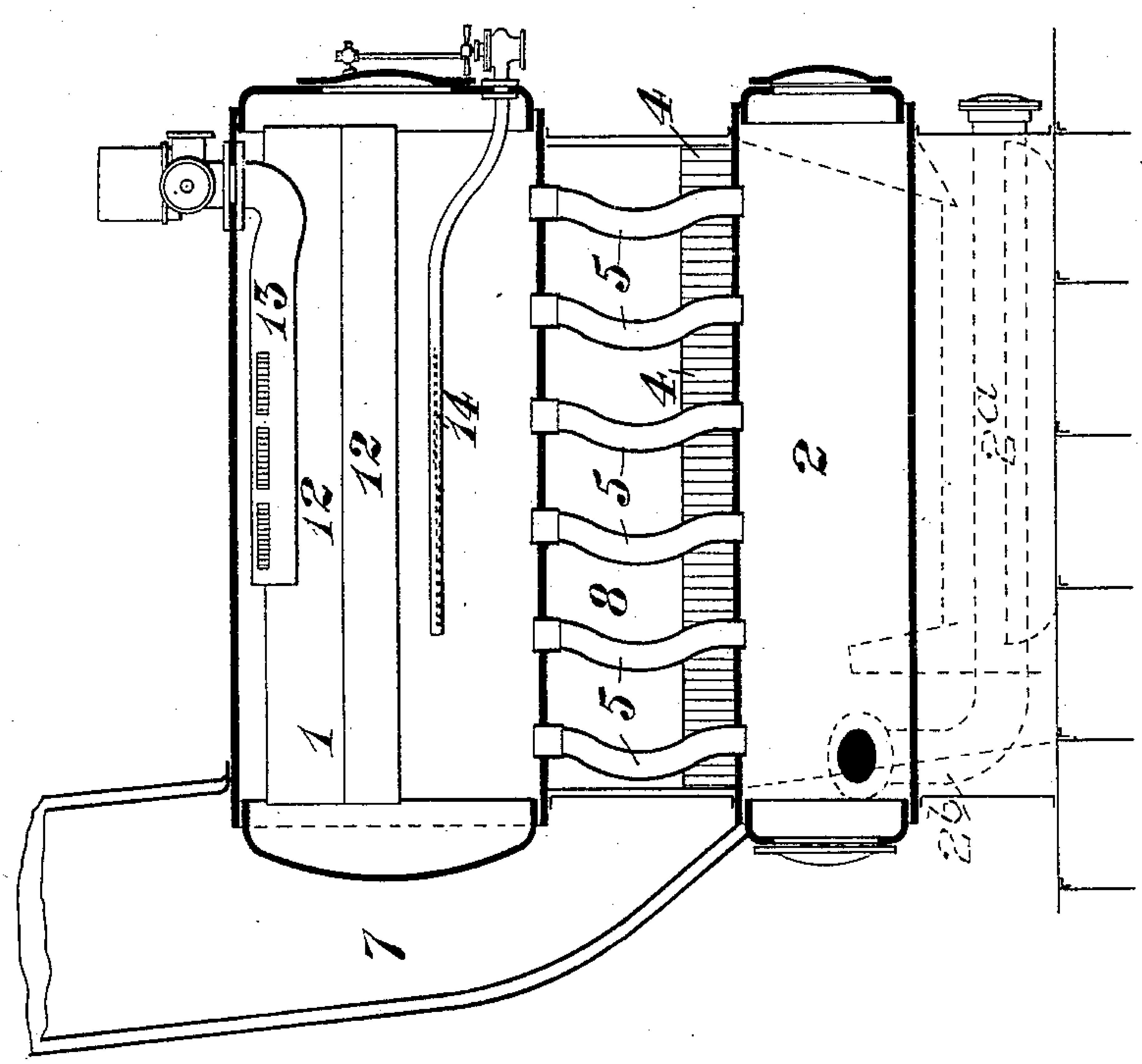

Fig. 2.

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(No Model.)

2 Sheets—Sheet 2.

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STEAM GENERATOR.

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Fig. 4.

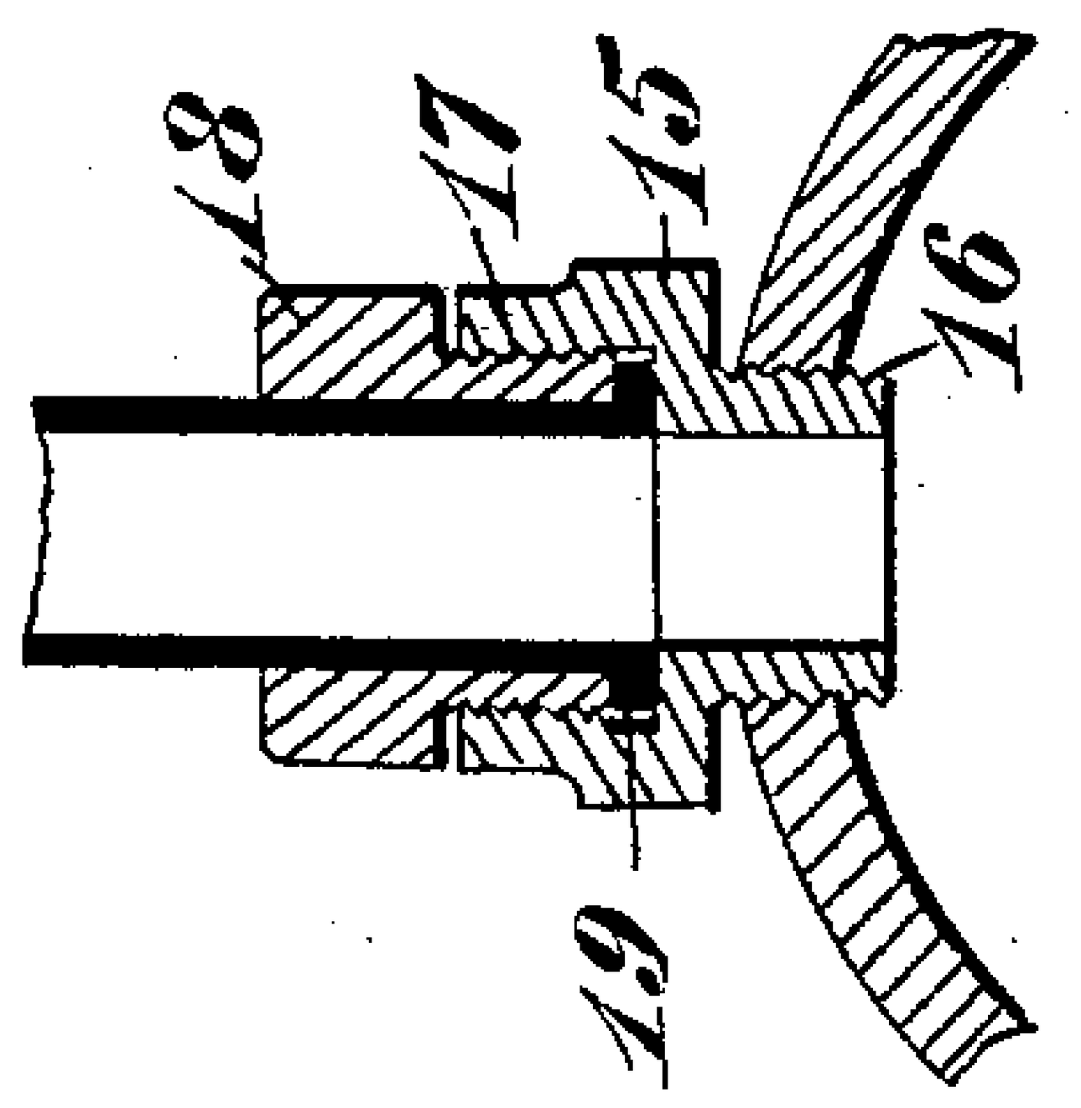


Fig. 5.

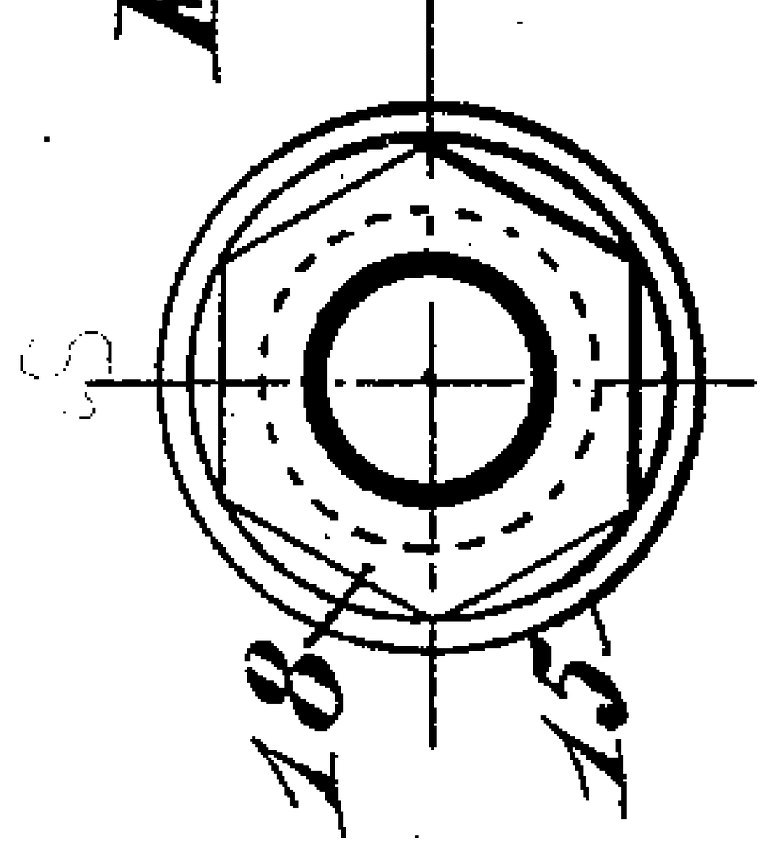
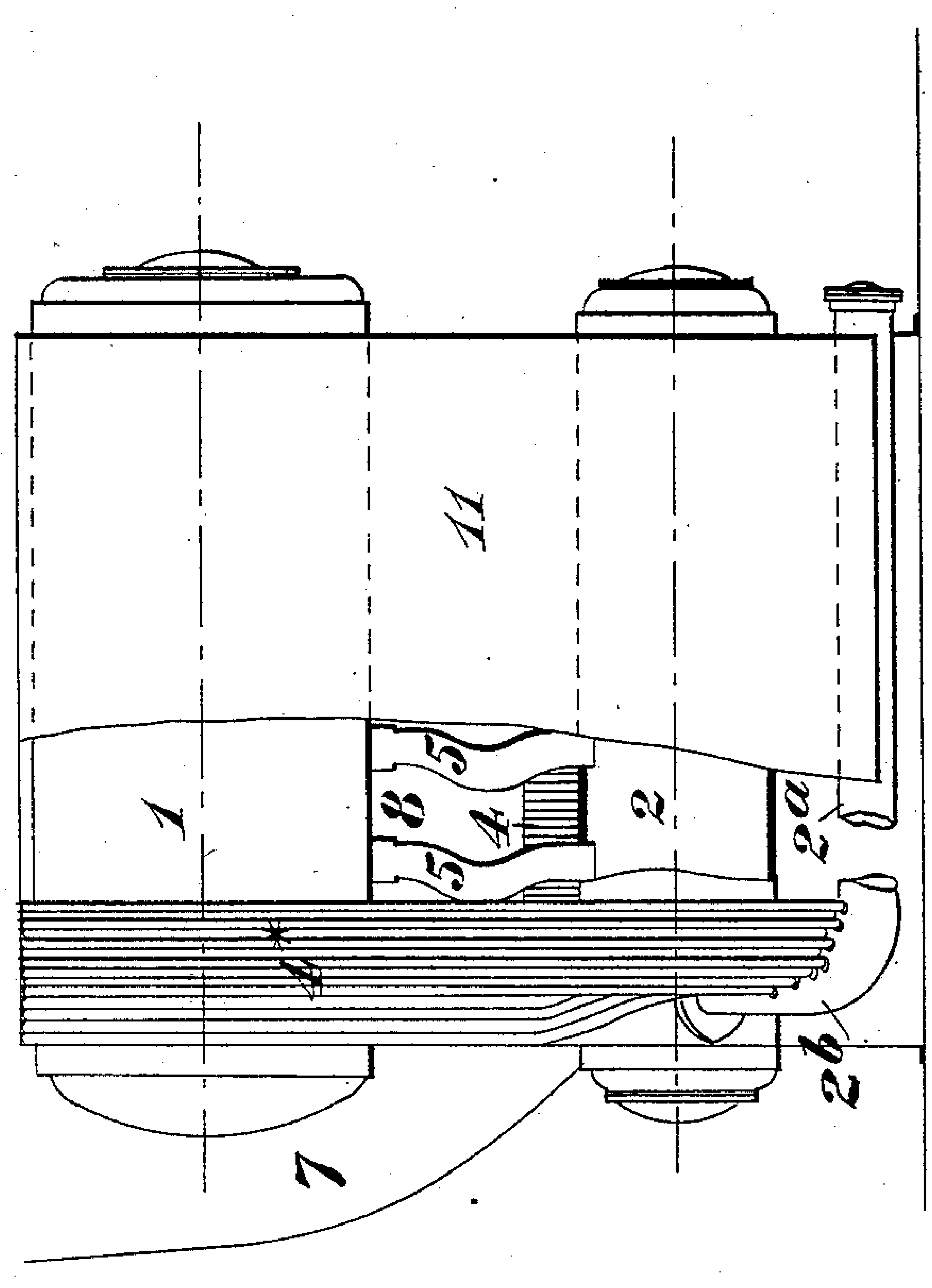


Fig. 3.



Witnesses

Edmund S. Snewin

Inventor

John I. Thornycroft

UNITED STATES PATENT OFFICE.

JOHN ISAAC THORNYCROFT, OF CHISWICK, ENGLAND.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 452,401, dated May 19, 1891.

Application filed February 2, 1891. Serial No. 379,910. (No model.)

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, England, have invented certain new and useful Improvements in Steam-Generators, of which the following is a specification.

My invention relates to steam-generators of the kind wherein 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—as, for example, in the generator described in the specification of a former patent granted to me, dated August 7, 1888, No. 387,547.

In order that my present improvements may be clearly understood, reference is had to the accompanying illustrative drawings, in which—

Figure 1 shows partly in transverse section and partly in front elevation, and Fig. 2 in central longitudinal vertical section, a steam-generator constructed according to this invention. Fig. 3 is a side elevation of the generator with a portion of the casing removed and with a part of the main water-vessel in section. Figs. 4 and 5 show in vertical section and plan, respectively, a convenient mode of connecting the lower ends of the tubes 4* to the supplementary water-vessels, which will usually be too small to permit of the tubes being fixed therein by a mandrel in the usual manner.

1 is a horizontal steam collector and separator.

2 is a horizontal cylindrical water-vessel, herein called, for distinction, the "main" water-vessel.

3 3 are fire-grates arranged one at each side of the main water-vessel 2.

2^a 2^a are supplementary water-vessels arranged at the outer sides of the fire-grates and each in communication with the main water-vessel.

4 4 are two series of bent tubes connecting the main water-vessel 2 with the upper part of the steam collector and separator.

4* 4* are two series of bent tubes connecting the supplementary water-vessels 2^a with the upper part of the steam collector and separator, and 5 5 are return-tubes connecting the main water-vessel 2 with the lower side of the steam collector and separator 1. The two series of bent tubes 4 are arranged, as shown, so as to form a passage or smoke-box 6 between them, that extends the whole length of the generator and communicates at one end with a chimney 7. The smoke-box is bounded by the tubes 4, the under side of the steam collector and separator 1, and the top of the main water-vessel 2, and through it the return-tubes 5 pass, as shown.

8 8 are bent plates extending longitudinally through the smoke-box, so as to divide the same into three parts—viz., two outer ones that serve for the passage of the hot gases to the chimney and an intermediate one in which are located the return-tubes 5. By this construction the return-tubes are protected from direct contact with the hot gases, and the downward flow of water through them is thereby facilitated.

The two series of tubes marked, collectively, 4, Fig. 1, are so bent and arranged that some of the tubes of each series are arranged close together for the greater part of their length to form inner and outer longitudinal tubulous close walls A and B, respectively, of a flue C and are bent at other parts to form inlet and outlet spaces 9 and 10, as described in my said former specification, and within each flue thus formed the remaining pipes of the series are arranged either separately, as described in the said former specification, or so that the pipes of every two rows are made to form a single longitudinal row of pipes except near their ends, as shown in Fig. 1.

The plates 8 serve, in addition to protecting the return-tubes 5, to prevent the direct escape of hot gases from the flues C into the smoke-box 6 through the spaces between the lower ends of the tubes 4, forming the inner walls B of the flues. Each series of bent tubes 4* consists at the extremities, where connected to the steam collector and separator 1 and supplementary water-vessel 2^a, of two rows, whose intermediate portions merge into one row that constitutes a wall of closely-arranged tubes.

In the example shown each supplementary water-vessel 2^a is formed with a bend 2^b and is in connection therethrough with the main water-vessel 2, as indicated in Figs. 1, 2, and

3. The wall of tubes 4* extends along the bent portion of the supplementary water-vessel, as represented. Each series of tubes 4* is arranged to touch the tubular wall A of the adjacent series of tubes 4 at A*, so as to practically close the top of the fire-box. Flame and hot gases pass from each fire-box through the spaces 9 at the bottom of the wall A of tubes into the corresponding flue C, and thence escape through the spaces 10 at the top of the inner wall B of tubes into the smoke-box 6 and chimney 7. The front ends of the fire-boxes and those parts of the rear ends not closed by the tubes 4* are closed, except opposite the fire-doors, by fire-brick.

11 11 are metal casings inclosing the tubes 4 and 4* and the front of the generator.

With the above-described arrangement the principal groups of tubes—viz., the groups 4 4—are located between two fires, there being only one wall of tubes—viz., 4*—at each outer side, so that there shall not be liability to any of the rows of tubes being cooled and the circulation therein being thus stopped or impaired. Furthermore, by causing the hot gases to escape from the flues C into the smoke-box 6 through the spaces 10 at the upper end of the inner wall B of tubes, instead of through the outer wall, as heretofore, they are made to pass between the tubes near to the water-level in the steam collector and separator, and thus the upper parts of the tubes will not be liable to overheating. The arrangement, moreover, by utilizing the space inclosed by the tubes 4 at each side of the lower part of the steam collector and separator as a smoke box or boxes for collecting the gases on their way to the chimney, improves the evaporative efficiency and at the same time enables a generator of a given power to be placed under coal-bunkers or in other situations where the height available is limited and would not accommodate a generator of the same power and similar class as heretofore usually constructed.

In the above-described construction of steam-generator it is advantageous to make the tubes 4 of a simple curved form, consisting, to a large extent, of one bend of constant radius, and with straight ends simply, but slightly bent at the extremities to adapt them to fit the varying angles of the holes in the steam collector and separator and the main water-vessel, thus tending to reduce cost. It will usually be advantageous to impart a bended form to the return-tubes 5, as shown in Figs. 2 and 3, to allow for change of form of the steam collector and separator and the main water-vessel, due to local heating of these parts, and then in some cases they may be simply secured by a mandrel or tube-expander. The chimney 7 may be attached to the fire-door end of the boiler or to the opposite end, as in the example shown. Large boilers might be adapted to be fired at both ends in a manner that will be readily understood without drawings.

The steam collector and separator is provided with any suitable arrangement of baffle plate or plates—for example, the plates 12—against which jets of mixed water and steam are poured from the upper ends of the tubes 4 and 4* when the generator is at work, the water falling to the lower part of the steam collector and separator, and thence through the return-tubes 5 and water-vessels 2 and 2ª to the tubes 4 4*, wherein it is further heated. The steam passes under the lower edges of the baffle plate or plates and enters a perforated steam-pipe 13, whence it can be conducted away for use.

Suitable constructions of baffle-plates are described and shown in my said former specification and in an application for patent filed by me, dated October 27, 1890, Serial No. 369,526.

14 is a pipe for supplying feed-water, which it is advantageous to admit to the steam collector and separator in order to aid the descent of water through the return-tubes 5. To this end, also, the feed-pipe is perforated at its under side and arranged to extend longitudinally within the steam collector and separator, so as to cause the feed-water to be distributed as uniformly as practicable to the several tubes.

The lower ends of the tubes 4* may advantageously be secured to the small supplementary water-vessels 2ª by a union of the construction shown in Figs. 4 and 5, and comprising a socket 15, formed with internal screw-thread 17 and with an externally-screw-threaded tubular part 16, screwed into the wall of the steam collector and separator and water-vessel, as the case may be.

18 is a gland screwed into the socket 15, between which and the inner end of the gland the flange 19 of the tube 4 or 4* is firmly held steam-tight.

What I claim is—

1. In a steam-generator, the combination of a steam collector and separator, a main water-vessel in communication therewith, a supplementary water-vessel in communication with said main water-vessel, and bent tubes connecting each of said water-vessels with the top of said steam collector and separator and arranged to form the top and sides of a fire-box, the tubes forming one side of said fire-box being arranged to form a tubulous wall, and some of the other tubes being arranged close together for the greater portion of their length to form inner and outer longitudinal tubulous close walls of a flue, within which the remainder of said tubes are arranged, and bent at other parts to form inlet and outlet passages for hot gases to and from said flue, substantially as herein described.

2. In a steam-generator, the combination of an upper steam collector and separator, lower main and supplementary water-vessels in communication therewith, and bent tubes connecting the said water-vessels with the top of said steam collector and separator, said

tubes being arranged in four series, so as to form two fire-boxes, between which the principal groups of tubes are located, substantially as herein described.

3. In a steam-generator, the combination of a steam collector and separator, a main water-vessel in communication therewith, supplementary water-vessels in communication with said main water-vessel, and bent tubes connecting each of said water-vessels with the upper part of said steam collector and separator and arranged to form two fire-boxes and an intermediate smoke-box.

4. In a steam-generator, the combination of a steam collector and separator, a water-vessel in communication therewith, and two series of bent tubes arranged to connect said water-vessel to the upper part of said steam collector and separator and to form in conjunction with said steam collector and separator and water-vessel a smoke-box, some of said tubes of each series being arranged close together for the greater part of their length to form inner and outer longitudinal close tubulous walls of flues, within which the other tubes of the series are placed, and the tubes forming said outer wall being bent at their lower ends to form inlets to the bottom of said flue, and the tubes forming said inner wall being bent at their upper ends to form outlets from the top of said flue into said smoke-box, substantially as herein described.

5. In a steam-generator, the combination of a steam collector and separator, a main water-vessel in communication therewith, supplementary water-vessels in communication with said main water-vessel, two fire-grates, one at each side of the main water-vessel, two series of bent tubes connecting the main water-vessel with the upper part of said steam collector and separator and arranged to form between them a smoke box or boxes, and two series of bent tubes connecting the supplementary water-vessels to the upper part of the said steam collector and separator, the tubes in each of these latter series being arranged to form a tubulous outer wall for one of said fire-boxes, substantially as herein described.

6. In a steam-generator, the combination of a steam collector and separator, a main water-vessel, supplementary water-vessels in communication with said main water-vessel, bent tubes connecting each of said water-vessels with the top of said steam collector and separator and arranged to form the sides and top of two fire-boxes and an intermediate smoke-box, and return-tubes connecting said steam collector and separator with said main water-vessel and extending downward through said smoke-box, substantially as herein described.

7. In a steam-generator, the combination of a steam collector and separator, a main water-vessel, supplementary water-vessels in communication with said main water-vessel, bent tubes connecting each of said water-vessels with the top of said steam collector and separator and arranged to form the sides and top of two fire-boxes and an intermediate smoke-box, plates arranged longitudinally within said smoke-box, so as to divide the same into a central chamber and two outer passages, and return-tubes connecting said steam collector and separator with said main water-vessel and extending downward through the central portion of said smoke-box, substantially as herein described, for the purposes specified.

8. In a steam-generator, the combination of a steam collector and separator 1, a main water-vessel 2, bent return-tubes 5, connecting the two, fire-grates 3, supplementary water-vessels 2^a, located at the outer sides of said fire-grates and connected to said main water-vessel, tubes 4 and 4*, connecting the said water-vessels 2 and 2^a with the top of said steam collector and separator, some of said tubes 4 being arranged to form flues within which other of said tubes are located and having inlets 9 at the bottom and outlets 10 at the top, and said tubes 4* being arranged to form a single tubulous wall at the outer side of each fire-box, a smoke-box formed by and between said tubes 4, steam collector and separator 1, and main water-vessel, and bent plates arranged longitudinally within said smoke-box, so as to divide the same into three parts, within the inner of which said tubes 5 are located, substantially as herein described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN ISAAC THORNYCROFT.

Witnesses:
WM. THOS. MARSHALL,
H. CHARLIER,
Both of 2 Pope's Head Alley, Cornhill, London, Gentlemen.