

No. 695,641.

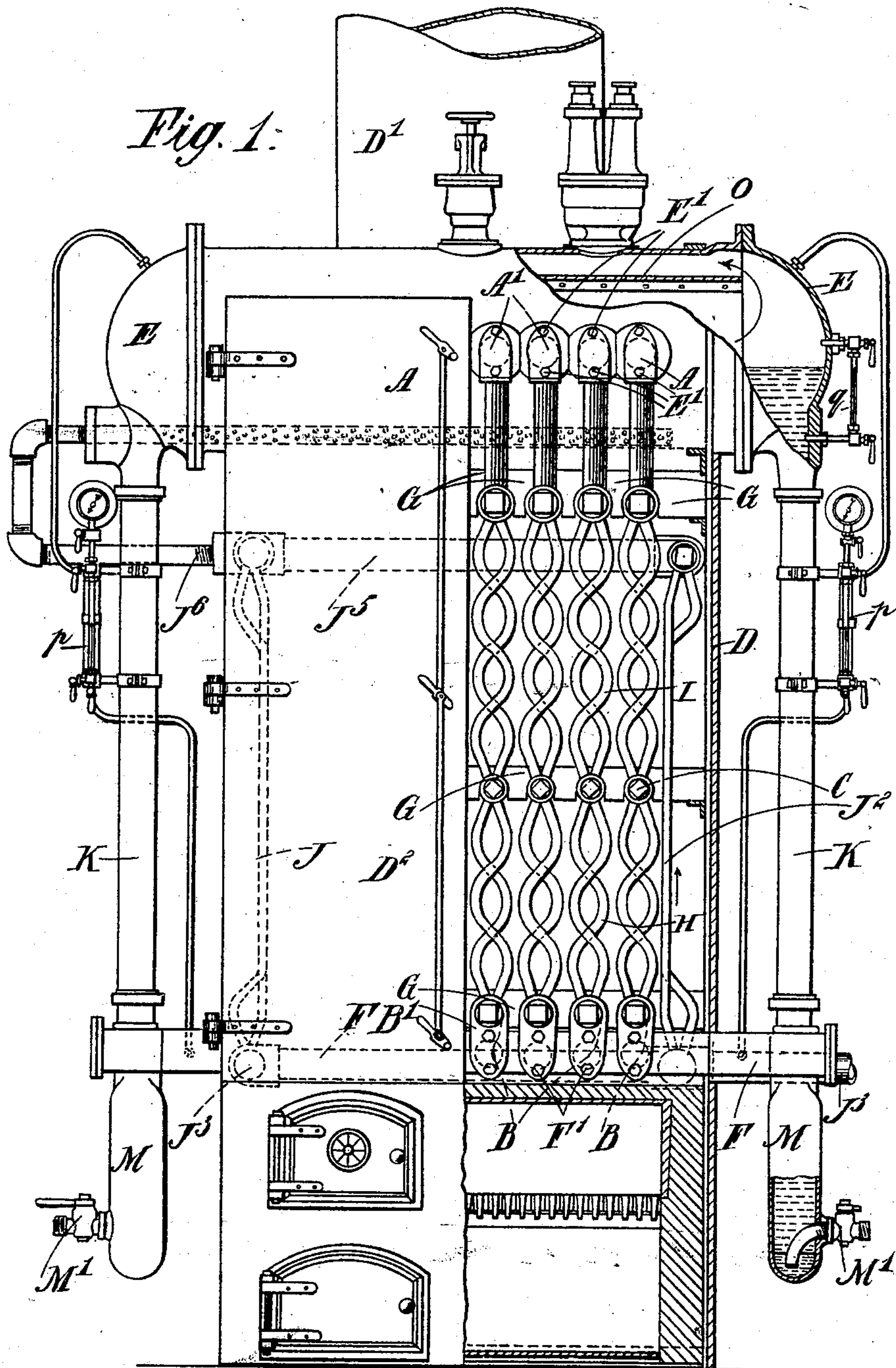
Patented Mar. 18, 1902.

F. G. HAMPSON.
WATER TUBE BOILER.

(Application filed June 4, 1901.)

(No Model.)

7 Sheets—Sheet 1.



Witnesses:

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Inventor:

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his Attys.

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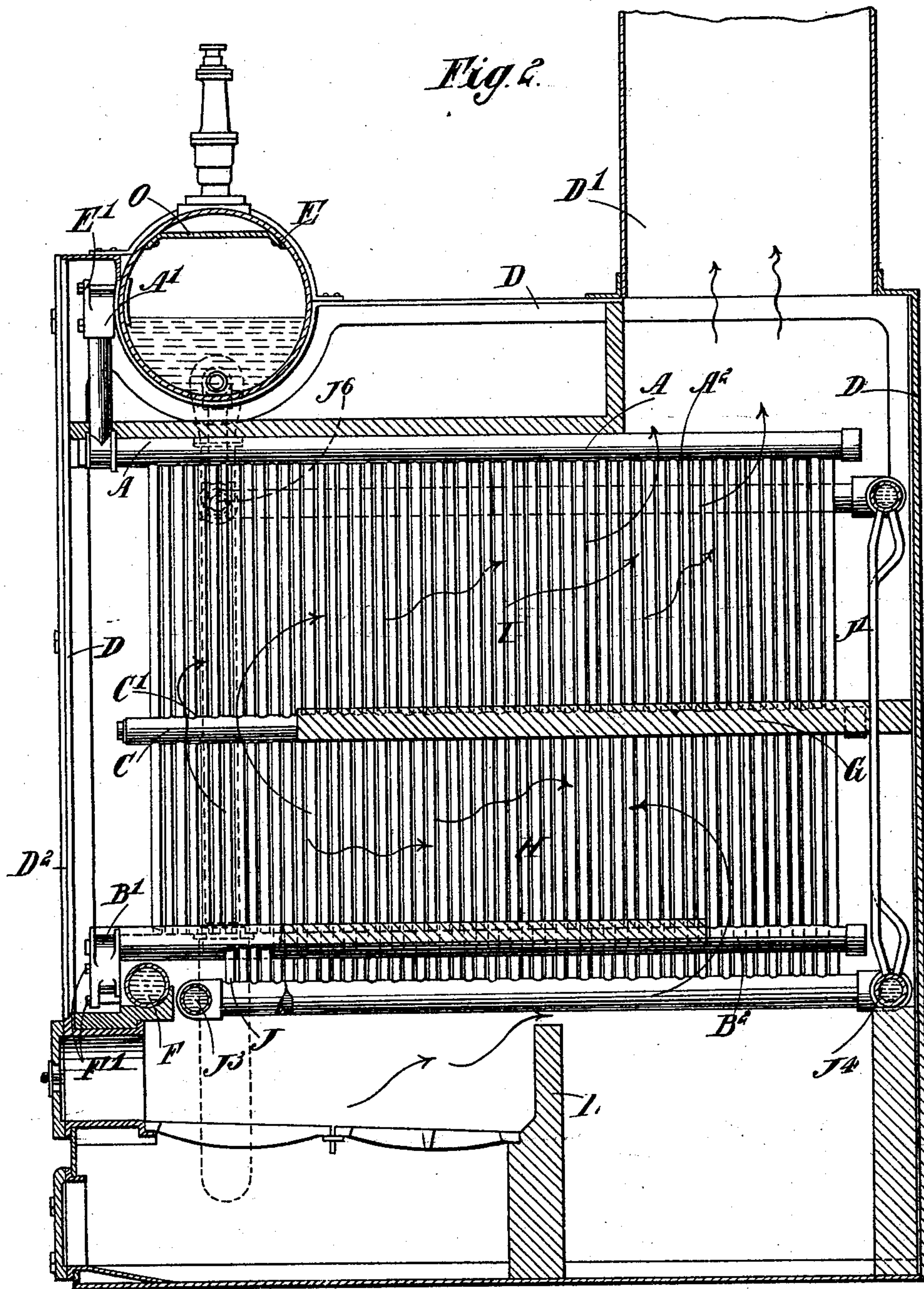
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7 Sheets—Sheet 2.



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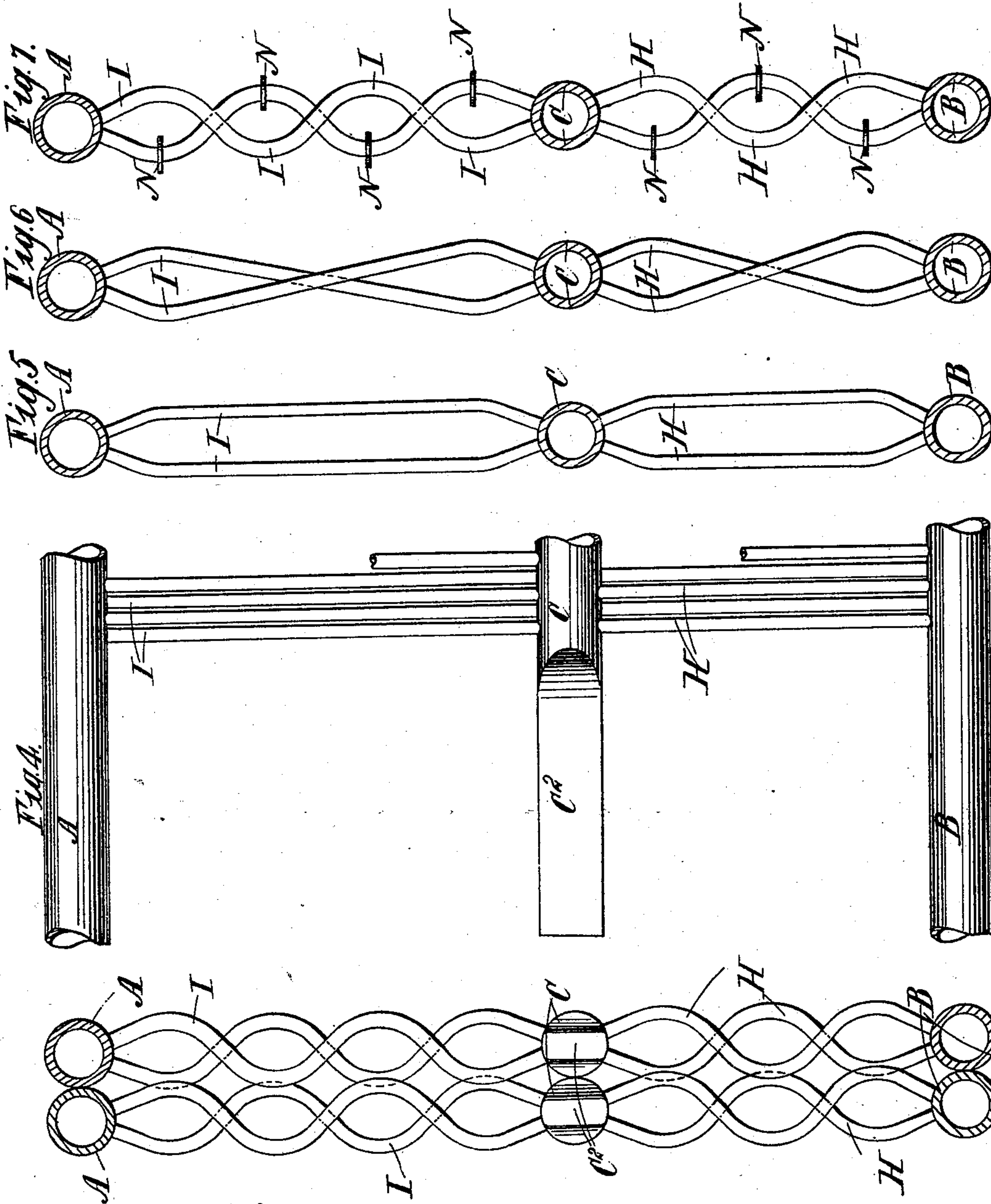
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7 Sheets—Sheet 3.



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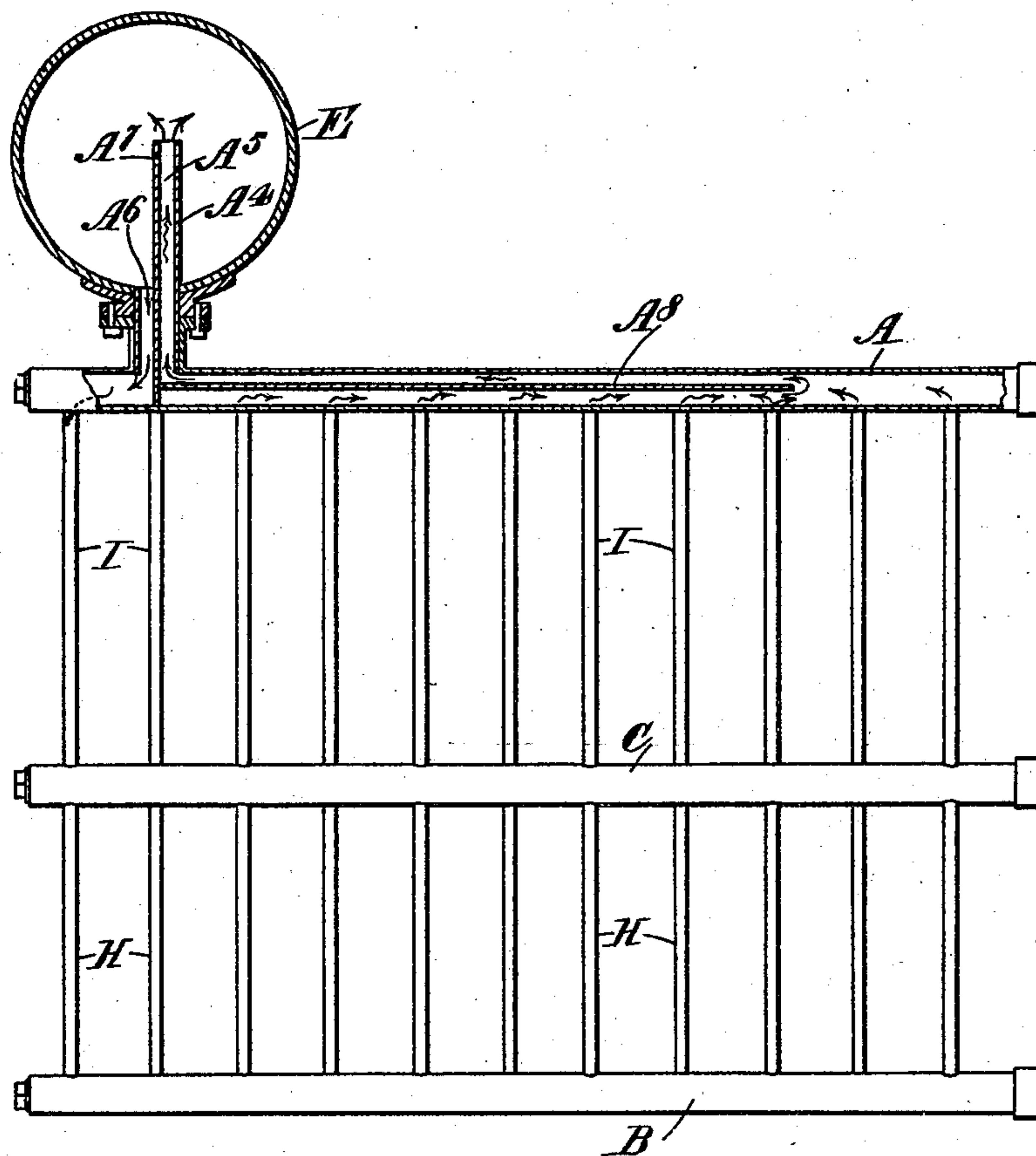
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Fig. 8.



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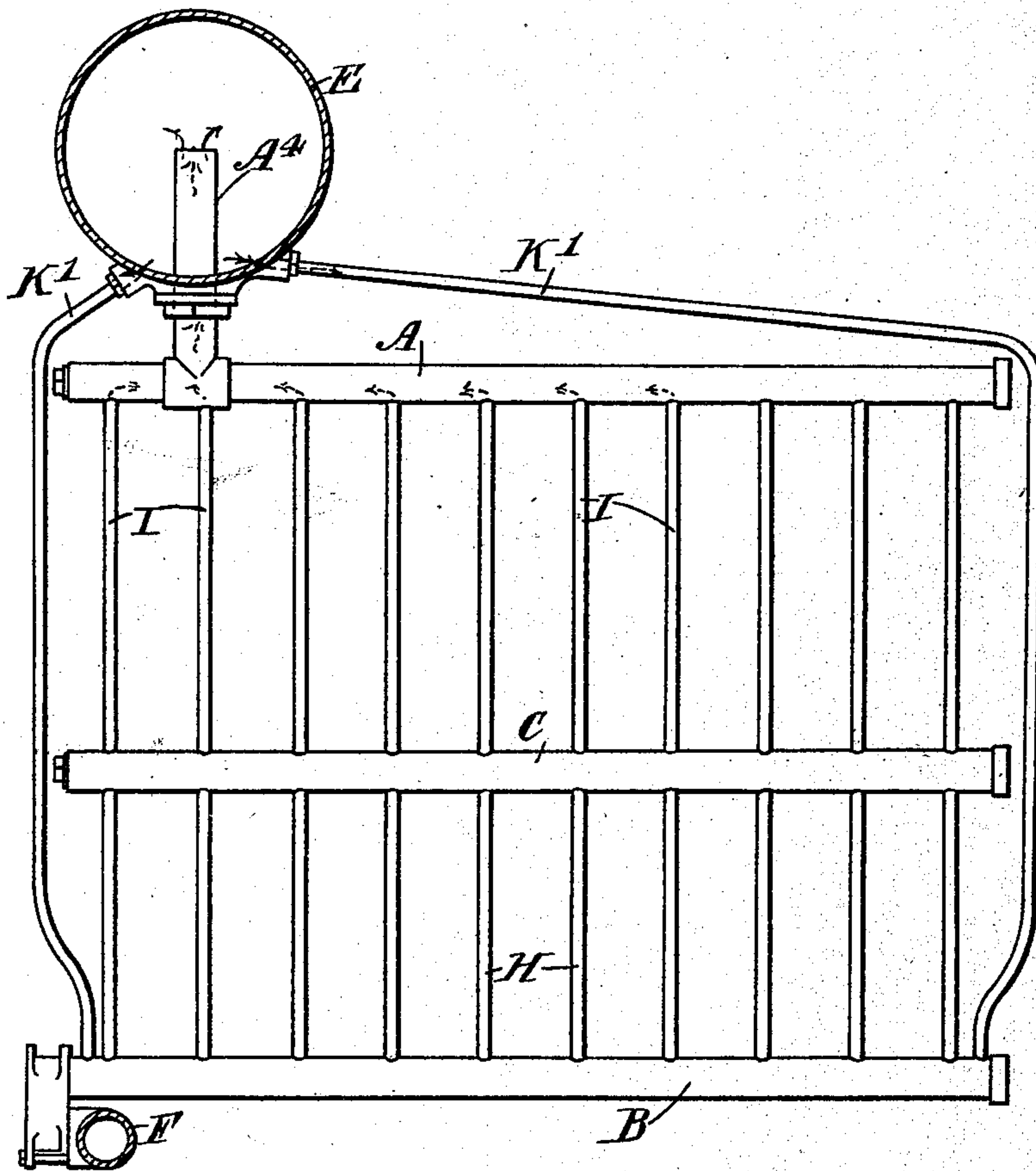
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Fig. 9



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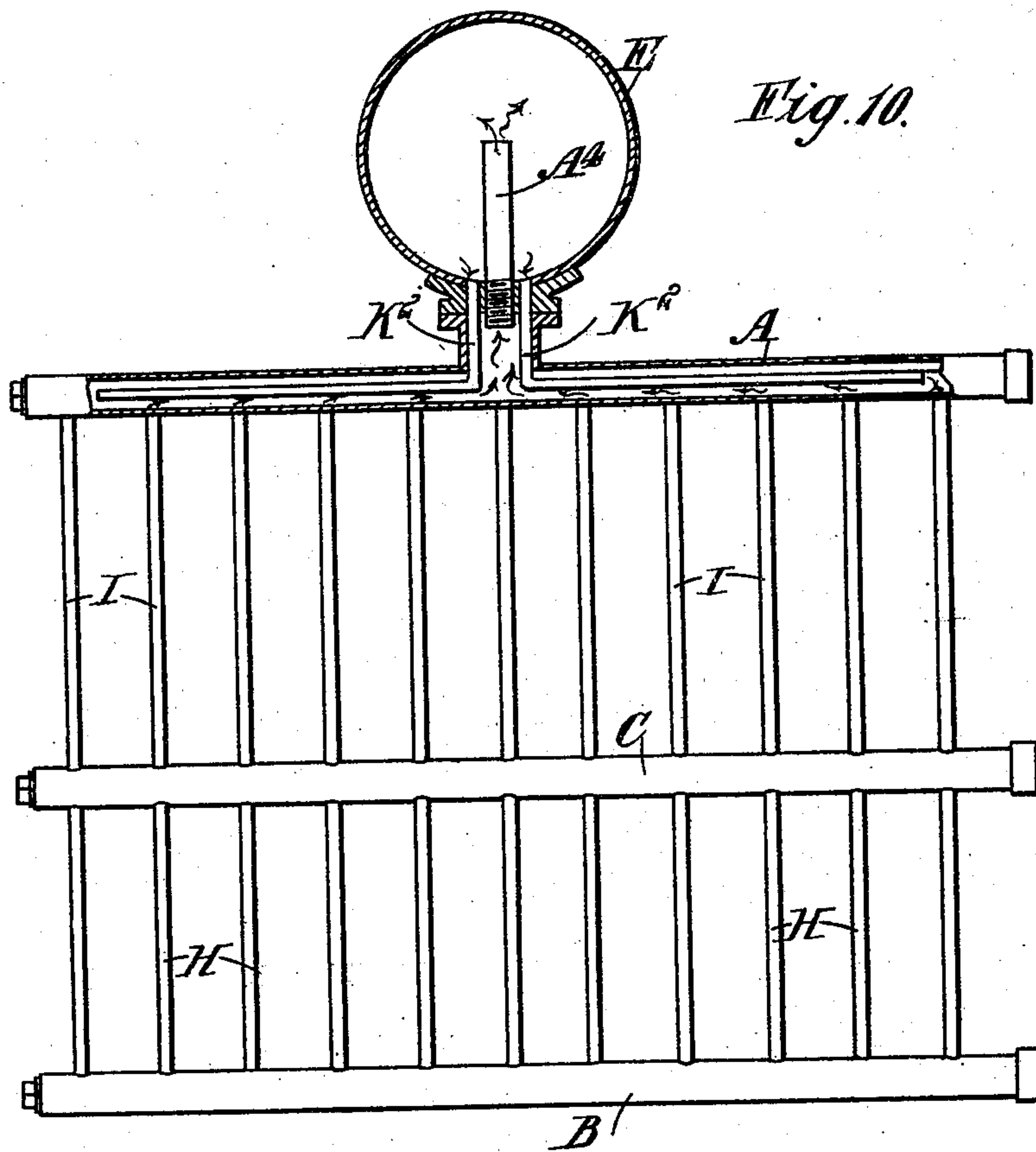
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(No Model.)



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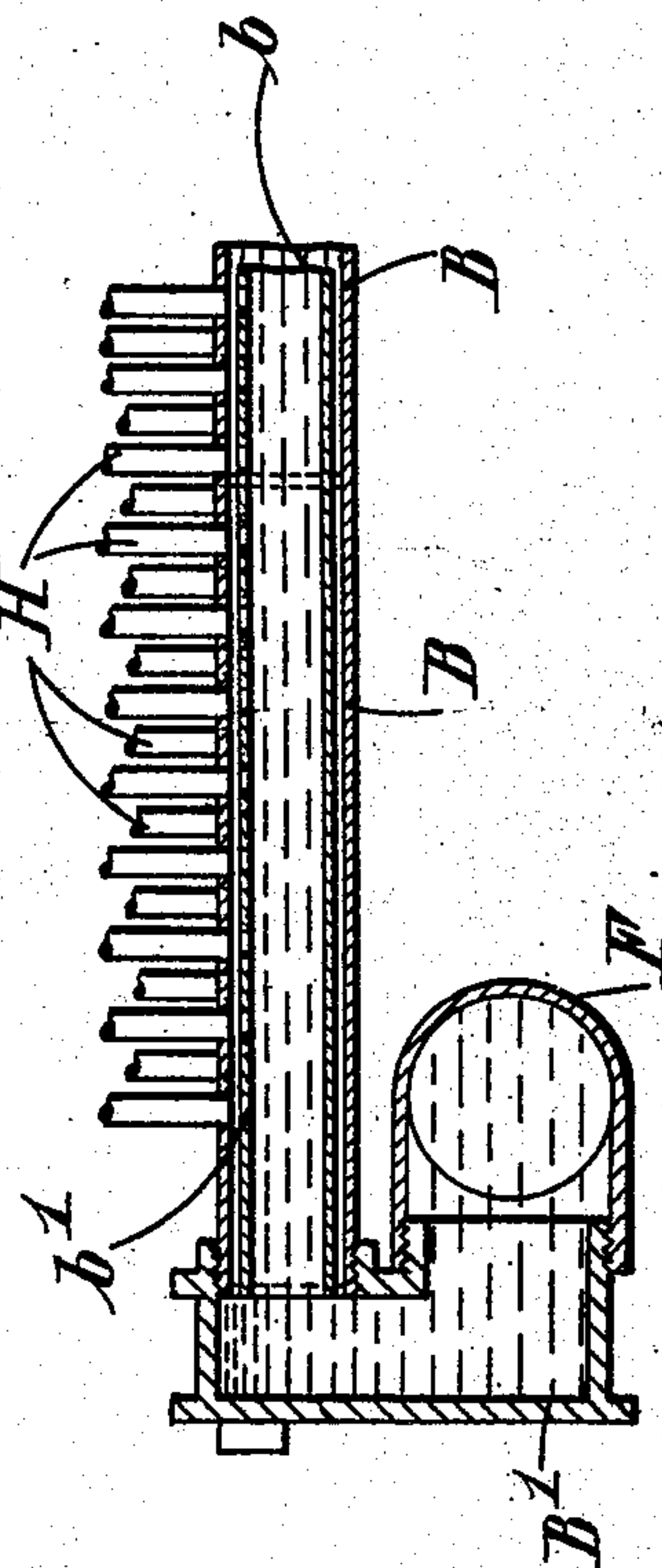
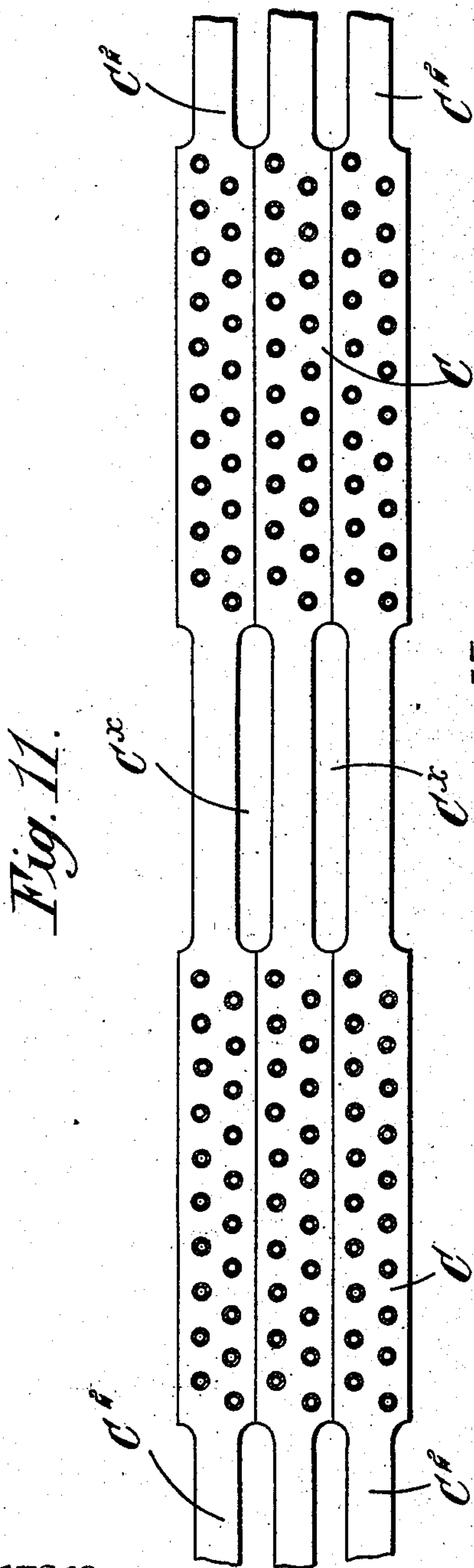
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(Application filed June 4, 1901)

(No Model.)

7 Sheets—Sheet 7.



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UNITED STATES PATENT OFFICE.

FRANK GEORGE HAMPSON, OF CLAPHAM, ENGLAND.

WATER-TUBE BOILER.

SPECIFICATION forming part of Letters Patent No. 695,641, dated March 18, 1902.

Application filed June 4, 1901. Serial No. 63,131. (No model.)

To all whom it may concern:

Be it known that I, FRANK GEORGE HAMPSON, a subject of the King of England, and a resident of Clapham, county of Surrey, England, have invented certain new and useful Improvements in or Relating to Water-Tube Boilers, (for which I have made application for Letters Patent in Great Britain, under No. 3,497, dated February 18, 1901,) of which the following is a specification.

This invention relates to steam-generators of the water-tube type and composed of any desired number of elements inclosed in a suitable casing, with doors and other fittings and accessories, such as may be necessary. Each element comprises at top and bottom and also at one or more points between the top and bottom a series of horizontal or inclined tubes or manifolds. All the bottom manifolds are preferably connected at one end with the feed-water collector or supply and the top manifolds with the steam-drum, which in some cases may also be the feed-water collector. Preferably each horizontal manifold has its own connecting box or chamber opening into the steam-drum and secured thereto by two bolts or screws, so that upon removing these and similar screws connecting the connecting-chamber of the bottom manifold with the feed-water tube the whole element may be bodily removed from the boiler or casing for examination or repair. The furnace is placed underneath the bottom row of horizontal manifolds, the products of combustion proceeding first to the back end of the furnace, then up between the previously-mentioned manifolds, then back to the front underneath the intermediate horizontal manifolds, then passing up between these latter manifolds proceed again to the back, where they escape to the chimney, the number of turns depending upon the number of intermediate horizontal manifolds. In order to prevent the hot gases from escaping upward or direct to the chimney between the horizontal manifolds, the spaces between these latter are closed, excepting for a short distance at their ends. This may be effected either by special saddle-shaped bricks placed between the horizontal manifolds inclosing the spaces between them or by so spacing the horizontal manifolds that they approxi-

mately touch each other, any insignificant space between them being, if desired, closed with fire-clay or the like. When the manifolds are arranged to touch each other, their ends are reduced in diameter or flattened, so as to provide the necessary space between them for the passage of the gases. In some cases this may be effected by shortening the manifolds and allowing the gases to pass over their ends. The horizontal manifolds are connected by small-diameter water-tubes extending upward to the next horizontal tube. These vertical manifolds are preferably arranged in pairs lying in the same transverse vertical plane, but twisted so as to cross each other several times, whereby their length is increased. These small manifolds all enter the horizontal manifolds. The back and, if desired, the sides of the boiler are composed of walls formed of these small water-tubes connected with the rest of the boiler in any convenient manner.

Any convenient arrangement of headers, downcomer-tubes, mud-collectors, &c., may be used either inside or outside the boiler-casing.

In some cases instead of making the small water-tubes in serpentine form I may make them approximately straight, bending their ends slightly where they enter the horizontal manifolds, the small tubes running parallel to each other or arranged so as to appear to cross each other when an element is viewed in end elevation.

For the purpose of distributing the gases I may mount on the tubes by shrinking or otherwise a series of circular plates of suitable metal. I may also dispose the element so that the horizontal manifolds may be vertical and the vertical small tubes be horizontal or at any angle.

Referring to the drawings, Figure 1 is a sectional side elevation, and Fig. 2 an end elevation, partly in section, of a generator constructed according to my invention. Fig. 3 is an end elevation, and Fig. 4 a side elevation, of a modified construction of horizontal manifolds. Figs. 5, 6, and 7 show modified constructions of the members of the generator. Figs. 8, 9, and 10 are diagrammatic views of modified constructions of the pipe connections for each element. Fig. 11 shows

a modified construction of manifolds. Fig. 12 is a longitudinal section of a modified form of feed-water pipe or drum.

A represents the top horizontal manifolds, B the bottom horizontal manifolds, and C the intermediate horizontal manifolds.

The tubes forming the boiler are inclosed in a casing D, and each tube of the top row or series is provided with a separate connecting box or chamber A', by means of which they communicate with the steam-drum E. The connecting-boxes are shown fixed to the steam-drum by means of bolts E', but they may be fixed thereto in any appropriate manner. The feed-water pipe F is disposed beneath the bottom series or row of manifolds B, each of which manifolds communicates with the feed-pipe through a separate connecting box or chamber B', attached to the feed-pipe by bolts F' or otherwise.

The spaces between the adjacent manifolds A, B, or C are closed by fire-bricks G or other material, excepting for a short distance at the inner end of the manifolds A and B and at the outer end of the manifolds C, where short spaces A² B² C', respectively, are left to allow the products of combustion to pass up between the manifolds at these parts, or, as shown at Figs. 3 and 4, the ends of the manifolds may be flattened, as at C², so as to leave spaces for the products of combustion to pass up between them. I may also, as shown in Fig. 11, form the horizontal manifolds A, B, or C with flattened portions or portions of decreased diameter A^x B^x C^x at one or more points intermediate of their ends to allow part of the heating-gases or products of combustion to pass up between them at these points.

The water enters the manifolds B from the feed-water pipe F and passes up into the manifolds C by means of a series of water-tubes H, the upper ends of which are connected to the manifolds C and their lower ends to the manifolds B in any appropriate manner. A similar series of water-tubes I is connected to the manifolds C and A to allow the water from the manifolds C to pass into the manifolds A. The water in passing from the manifolds B to the manifolds C and A through the tubes H and I becomes converted into steam, which passes from the manifolds A to the steam-drum E. As shown in Fig. 2, the water-tubes H and I are arranged in pairs and cross each other at various points in such a manner as to leave spaces between them for the products of combustion.

In order to insure that all the vertical pipes H may be equally supplied with water, I arrange, as shown in Fig. 12, in the horizontal pipes B internal feed-water pipes b, having openings or perforations so arranged that they deliver the feed-water to the said vertical pipes at points in the length of the pipes A corresponding to the vertical pipes.

Additional heating-surface is provided in the generator by means of water-tubes J J'

J², arranged at the sides and back of the aforesaid elements. The feed-water from the source of supply enters at the lower ends of the tubes J at one side of the generator by a feed-pipe J³, and after passing through these tubes enters the tubes J' at the inner end of the generator through the pipe J⁴, thereafter passing into the tubes J² at the other side of the generator. From the pipes J² the water is conveyed by means of pipes J⁵ J⁶ to the drum E. The water next passes from the drum E by the pipes K to the feed-pipe F, which communicates with the manifolds B, as aforesaid.

In the modified arrangement illustrated in Fig. 8 the connecting-box A' of each element is bolted, as at A³, to the lower part of the steam-drum. A pipe A⁴, communicating with the box A', extends for a considerable distance into the steam-drum and is divided vertically into two chambers A⁵ A⁶ by a diaphragm A⁷, which also divides the tube A into manifold parts. The steam passes from the manifold A through the chamber A⁵ and enters the upper part of the steam-drum, and any water of condensation falls to the bottom of the drum and is carried away to the horizontal manifolds along with the feed-water through the chamber A⁶, which is partly cut away or provided with an opening where it enters the drum. In this arrangement the pipes K are dispensed with and the feed is conveyed to the horizontal manifold B or C by such of the vertical manifolds as are in communication with the steam-drum through the chamber A⁶. The manifold A is divided longitudinally by a diaphragm or partition A⁸, which extends from the diaphragm A⁷ to within a short distance of the opposite end of the manifold A, thereby preventing steam from entering the drum straight from the tubes I and causing it to circulate in the manner indicated by the arrows on the drawings, or, as illustrated in Fig. 9, I may dispense with the diaphragm A⁷ and employ the pipe A⁴ entirely for admitting the steam to the drum. In this case I convey the feed-water and water of condensation from the lower part of the drum to the manifold B of each element by means of pipes K', or I may connect the pipes K' to the feed-pipe F, in which case one pipe K' may be sufficient for the entire generator.

Instead of disposing the steam-drum near one end of the horizontal manifolds, as above described, I may, as shown in Fig. 10, arrange the drum at or near the middle of the horizontal manifolds and suspend each element from the drum in any convenient manner. In order to cause an equal distribution of the feed-water to the elements, I arrange at each side of the pipe A⁴ tubes K², which communicate with the lower part of the drum and extend along the manifold A in both directions, so as to deliver the feed-water at each end of the manifold A. The water is then led to the lower part of the element by the

vertical tubes I and H at each end of the element and the steam generated in the element passes up the central tubes and enters the drum by the pipe A⁴, as in the previous arrangement.

The products of combustion or heating-gases are directed against the under side of the bottom series of manifolds by the fire-bridge L, as shown by the arrows in Fig. 1. At the inner end of these manifolds the gases pass up through the spaces B² and are led to the front of the boiler between the rows of manifolds B and C. Passing up through the spaces C' between the manifolds C they travel between the rows of manifolds B and A to the inner ends of the latter manifolds and up through the spaces A² between the manifolds to the chimney D'.

The front of the casing D is closed by a hinged door D², which is large enough to permit any of the elements or members of the generator to be disconnected and removed from the casing for examination or other purposes.

Downcomer-tubes may, if desired, be connected in any convenient manner to each of the elements. Mud-collectors M are attached to the lower ends of the tubes K and are provided with blow-off cocks M'.

O is a baffle-plate disposed in the upper part of the steam-drum to prevent the steam escaping from the drum straight from the pipes and causing it to circulate, as shown by the arrow.

P is a water-gage for indicating the water-level in the elements when the boiler is working, so that there is no body of water in the steam-drum, but when the generator is so working that there is a body of water in the drum, as shown in the drawings, the level of the water is indicated by the gage Q.

Instead of arranging the water-tubes G and H in serpentine form, as shown in Figs. 1 and 2, they may be arranged approximately straight and have their ends (see Fig. 5) bent where they are connected to the horizontal manifolds, or these tubes may be arranged in planes intersecting each other, as shown in Fig. 6.

In order to distribute the heating-gases or products of combustion more equally, I attach to the tubes in any appropriate manner a series of deflecting or baffle plates N, as shown in Fig. 7.

I have described my invention as employed for steam-generating; but I wish it to be understood that I do not limit myself to the use of the removable element to such, as it will be obvious that they may be employed as feed-water heaters, steam-superheaters, evaporators, and economizers, and I do not wish to limit myself to the precise details of arrangement, construction, and connections of the parts, as these may be modified without departing from my invention.

What I claim as my invention, and desire to secure by Letters Patent, is--

1. In a steam-generator the combination of a series of removable elements comprising upper lower and intermediate manifolds connected together by vertical tubes *a*, of a steam-drum, a feed-water pipe or drum, connections between the upper part of each element and the steam-drum and between the lower part of each element and the feed-water pipe, the connections being such that each element can readily be detached and removed from the generator.

2. In a steam-generator the combination with a series of separate and removable elements comprising upper, lower and intermediate manifolds the lower manifolds being located above the fire-box, of a steam-drum, a feed-water pipe or drum, vertical tubes connecting the manifolds, readily-detachable connections between the elements and the steam-drum and between the elements and the feed-water pipe; substantially as described.

3. In a steam-generator the combination with a removable element, of a steam-drum, a feed-water pipe or drum, a manifold communicating with the steam-drum, a manifold communicating with the feed-water pipe an intermediate manifold and tubes connecting the intermediate manifold with the end manifolds, substantially as described.

4. In a steam-generator the combination with a removable element, of a steam-drum, a feed-water pipe or drum, an end manifold communicating with the steam-drum, an end manifold communicating with the feed-water pipe, an intermediate manifold, and tubes connecting the intermediate with the end manifolds substantially as described.

5. In a removable element for a steam-generator the combination of an upper manifold, a lower manifold, an intermediate manifold and of vertical tubes connecting the intermediate with the upper and lower manifolds.

6. In a steam-generator the combination with a removable element, of an upper manifold a lower manifold, an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper-manifold tube and the steam-drum, a conduit between the lower manifold and the feed-water pipe and a conduit between the steam-drum and the feed-water pipe.

7. In a steam-generator the combination with a removable element of an upper "manifold," a lower manifold, an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate one, a steam-drum, a feed-water pipe, a chamber connecting the upper manifold and the steam-drum, a chamber connecting the lower-manifold tube and the feed-water pipe and a conduit between the steam-drum and the feed-water pipe.

8. In a steam-generator the combination with a removable element, of an upper manifold, a lower manifold, an intermediate mani-

- fold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper manifold and the steam-drum, a conduit between the lower manifold and the feed-water pipe and a pipe for conveying the feed-water from the steam-drum to the lower part of the element substantially as described.
- 10 9. In a removable element the combination of an upper manifold, a lower manifold, an intermediate manifold vertical tubes connecting the intermediate manifold with the top and bottom manifolds a steam-drum, a feed-water pipe or drum and a tube connecting the lower part of the steam-drum with the lower part of the element substantially as described.
- 15 10. In a steam-generator the combination with a removable element of an upper manifold, a lower manifold, an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper manifold and the steam-drum, a conduit between the lower manifold and the feed-water pipe, a pipe connecting the lower part of the steam-drum with the feed-water pipe of the element and a mud-collector substantially as described.
- 20 11. In a steam-generator the combination with a removable element of an upper manifold, a lower manifold, an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper manifold and the steam-drum, a conduit between the lower manifold and the feed-water pipe, a pipe connecting the lower part of the steam-drum with the feed-water pipe of the element and portions on the manifolds having decreased diameter to permit the heating-gases to pass between adjacent manifolds substantially as described.
- 25 12. In a steam-generator the combination with a removable element of an upper manifold, a lower manifold, an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper manifold and the steam-drum, a conduit between the lower manifold and the feed-water pipe, a pipe connecting the lower part of the steam-drum with the feed-water pipe of the element, stop-pieces between the manifolds and of portions of reduced diameter at the ends of the manifolds.
- 30 13. In a steam-generator the combination with a removable element of an upper manifold, a lower manifold, an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper manifold and the steam-drum, a conduit between the lower manifold and the feed-water pipe, a pipe connecting the lower part of the steam-drum with the feed-water pipe of the element and stop-pieces between the manifolds.
- 35 14. In a removable element for a steam-generator the combination of an upper manifold, of a lower manifold, of an intermediate manifold, of vertical tubes connecting the intermediate manifold with the top and bottom manifolds, a steam-drum, a feed-water pipe, a conduit between the top manifold and the steam-drum, a conduit between the bottom manifold and the feed-water pipe, portions of reduced diameter on the manifolds for the passage of the heating-gases between the manifolds and of a tube connecting the lower part of the steam-drum with the lower part of the element substantially as described.
- 40 15. In a removable element for a steam-generator the combination of an upper manifold, a lower manifold, an intermediate manifold, of vertical tubes connecting the intermediate manifold with the top and bottom manifolds, a divided pipe one part of which communicates with the top manifold and with the upper part of the steam-drum, and the other part with the lower part of the steam-drum and some of the vertical tubes, of a horizontal diaphragm in the upper manifold, substantially as and for the purpose described.
- 45 16. In a steam-generator the combination with the removable elements the feed-water pipe and the steam-drum, of vertical heating-tubes at the back and at each side of the elements, and communicating with the feed-water supply and through which the water circulates before entering the steam-drum to pass to the elements substantially as described.
- 50 17. In a steam-generator the combination with the removable elements the feed-water pipe and the steam-drum, of vertical heating-tubes at the back and at each side of the elements, a pipe connecting the heating-pipes with the feed-water pipe, a conduit between the heating-tubes and the steam-drum, and a pipe for conveying the water from the steam-drum to the feed-pipe of the elements substantially as described.
- 55 18. In a steam-generator the combination with a removable element of an upper manifold, a lower manifold, an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper tube and the steam-drum, a conduit between the lower tube and the feed-water pipe, a pipe connecting the lower part of the steam-drum with the feed-water pipe of the element and deflecting plates on the vertical tubes as and for the purpose described.
- 60 19. In a steam-generator the combination with removable elements the feed-water pipe, the steam-drum and vertical heating-tubes at the back and at each side of the elements, of a pipe connecting the heating-tubes with the

steam-drum a pipe conveying the water from the steam-drum to the feed-pipe of the elements, a baffle-plate in the steam-drum arranged in the manner and for the purpose described.

20. In a steam-generator the combination with a removable element, of an upper manifold, a lower manifold an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper manifold and the steam-drum, a conduit between the lower manifold and the feed-water pipe, a pipe connecting the lower part of the steam-drum with the feed-water pipe of the element, stop-pieces between the horizontal pipes of a high-level water-gage and of a low-level water-gage.

21. In a steam-generator the combination with a removable element, of an upper manifold, a lower manifold, an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper manifold and the steam-drum, a conduit between the lower manifold and the feed-water pipe, a pipe connecting the lower part of the steam-drum with the feed-water pipe of the element, a high-level water-gage and a low-level water-gage.

22. In a steam-generator the combination with a removable element, of an upper manifold, a lower manifold, an intermediate manifold, vertical tubes connecting the upper and

lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper manifold and the steam-drum, a conduit between the lower manifold and the feed-water pipe, a pipe connecting the lower part of the steam-drum with the feed-water pipe of the element, stop-pieces between the horizontal pipes, a high-level water-gage, a low-level water-gage, and a furnace beneath the bottom manifolds.

23. In a steam-generator the combination with a removable element, of an upper manifold, a lower manifold, an intermediate manifold, vertical tubes connecting the upper and lower manifolds with the intermediate manifold, a steam-drum, a feed-water pipe, a conduit between the upper manifold and the steam-drum, a conduit between the lower manifold and the feed-water pipe, a pipe connecting the lower part of the steam-drum with the feed-water pipe of the element, stop-pieces between the horizontal pipes, a high-level water-gage, a low-level water-gage, a furnace beneath the bottom horizontal tubes, a surrounding casing inclosing the tubes and doors on said casing.

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

FRANK GEORGE HAMPSON.

Witnesses:

HAROLD WADE,
HARRY B. BRIDGE.