(No Model.)

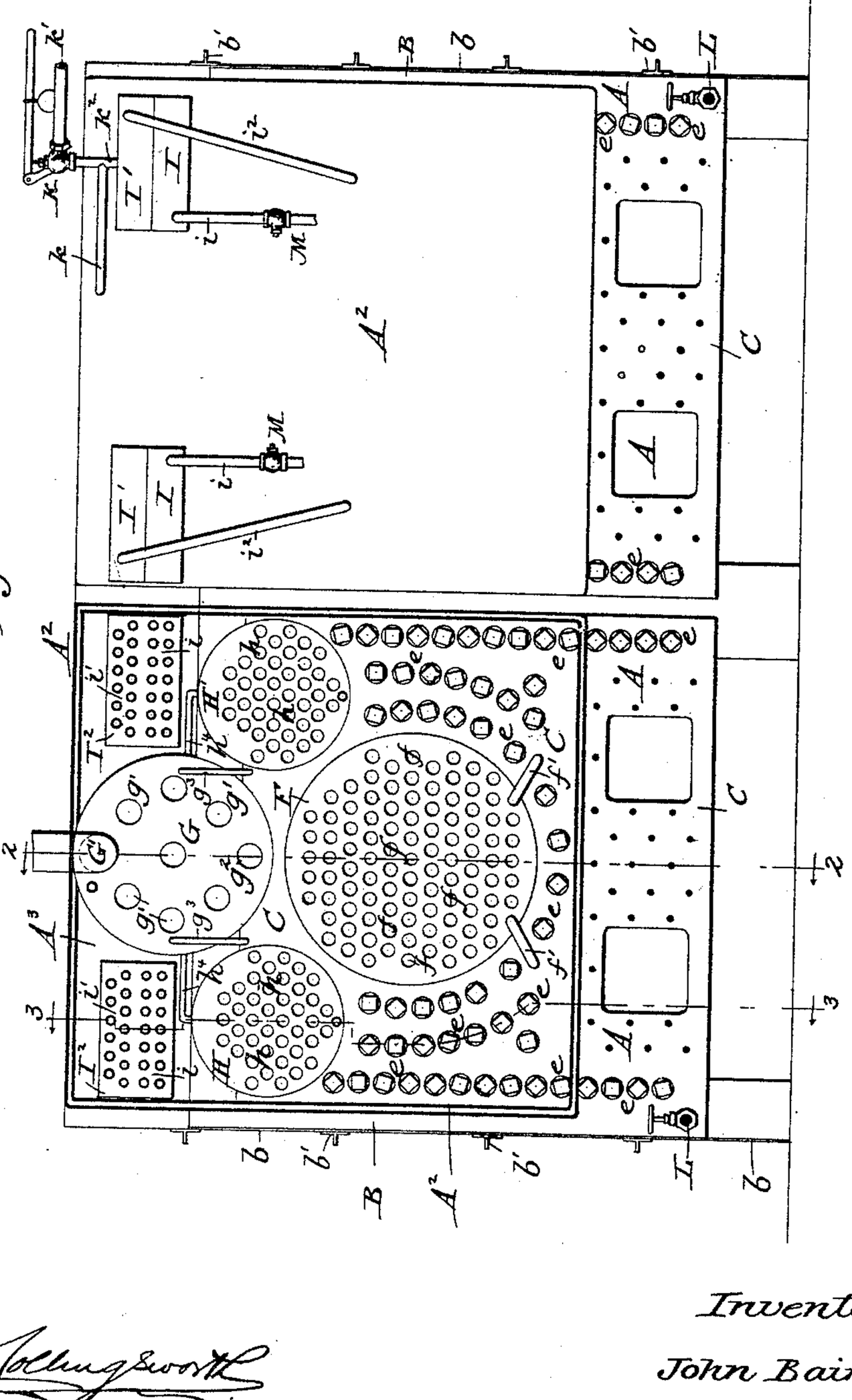
4 Sheets—Sheet 1.

J. BAIRD.

STEAM BOILER.

No. 437,745. Patented Oct. 7, 1890.

Fig. 1.



Attest.

Sidney P. Hollingsworth

Baltus D. Long.

Inventor:

John Baird

by his attorneys

Baldwin Davidson & Wright

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STEAM BOILER.

No. 437,745. Patented Oct. 7, 1890.

Fig. 2
ON LINE 2—2

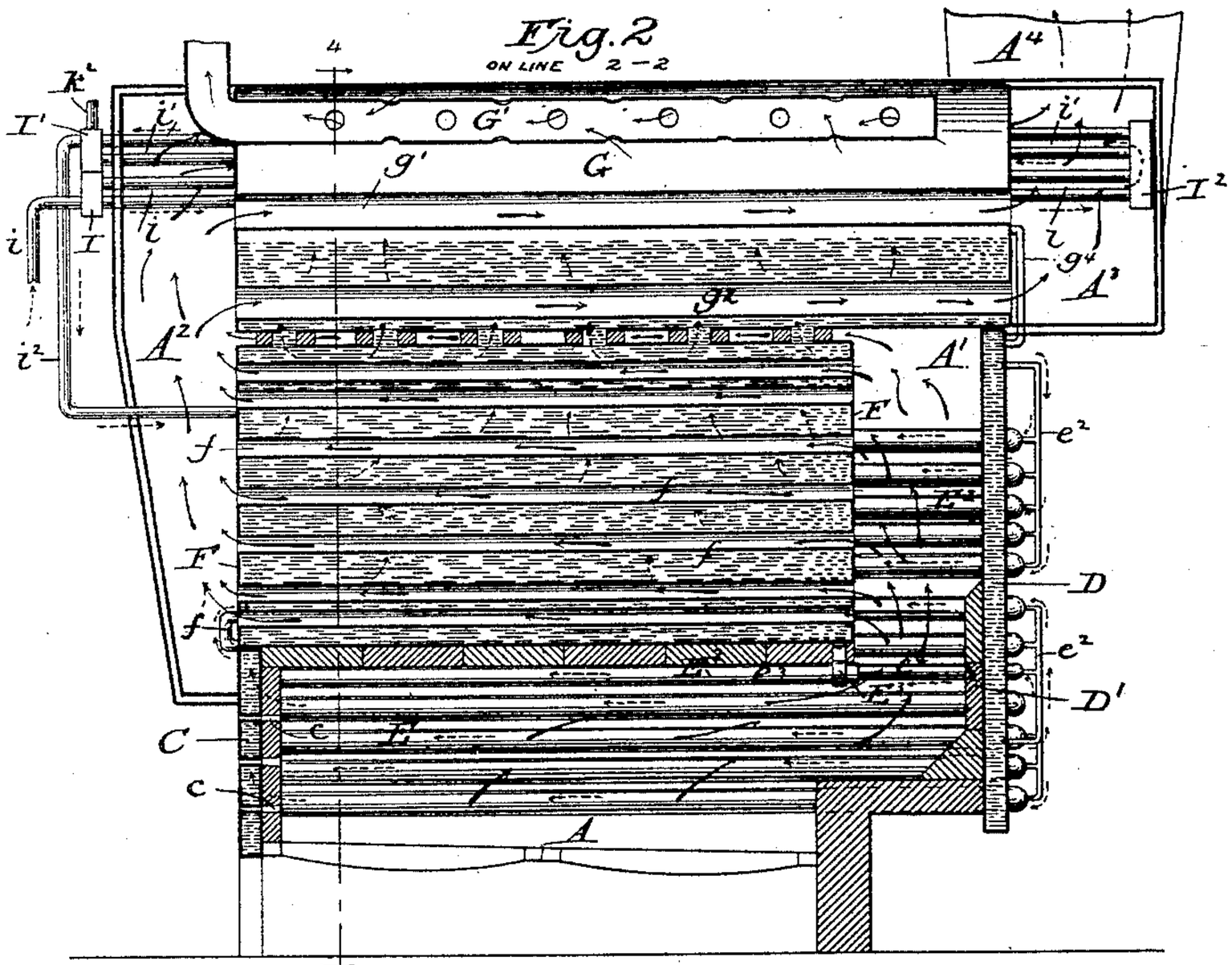
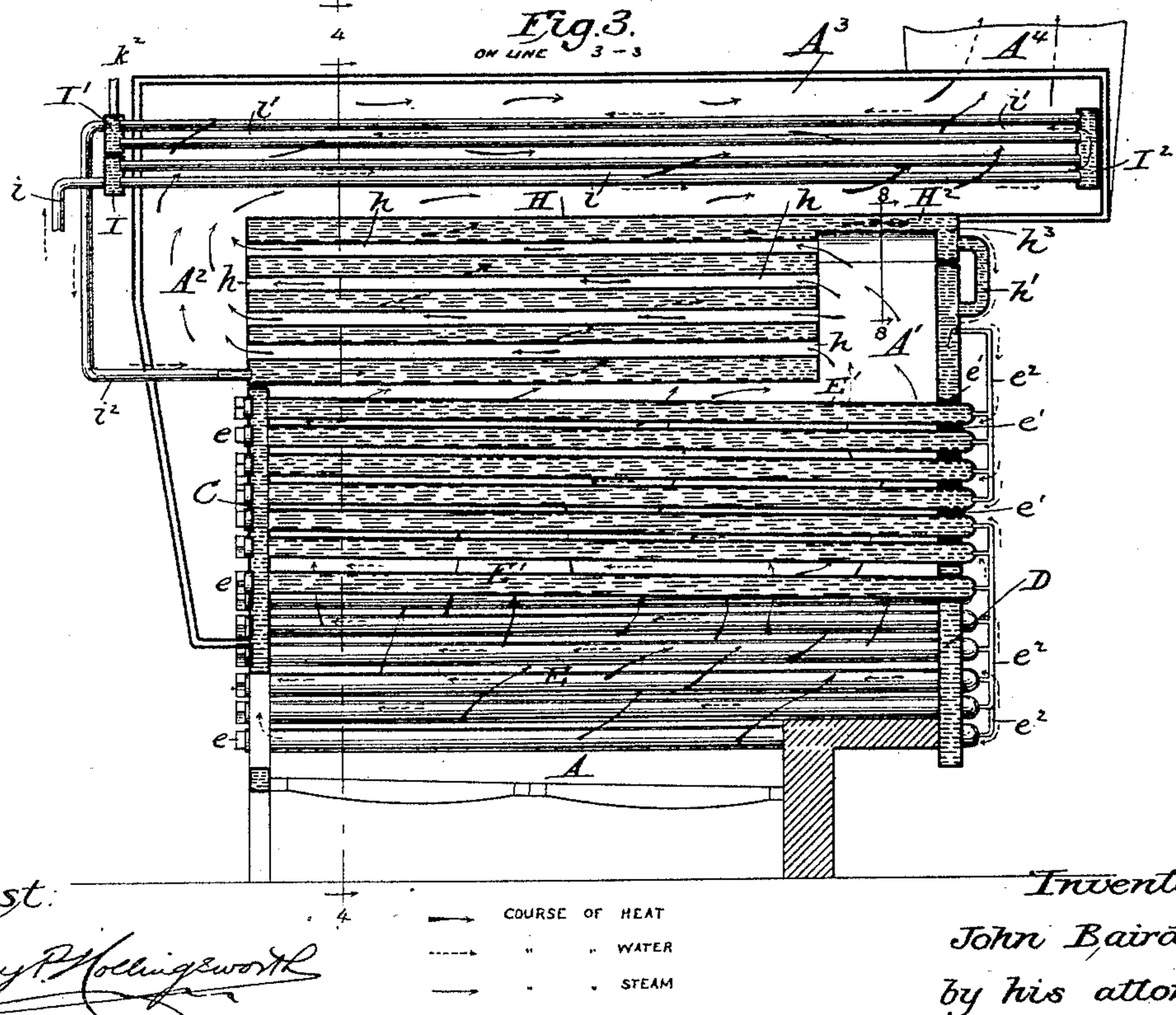


Fig. 3.
ON LINE 3—3



COURSE OF HEAT
" " WATER
" " STEAM

Attest:
Sidney P. Hollingsworth
Baltus D'Long.

Inventor.
John Baird
by his attorneys
Baldwin Davidson & Wright

(No Model.)

4 Sheets—Sheet 3.

J. BAIRD.

STEAM BOILER.

No. 437,745. Patented Oct. 7, 1890.

Fig. 4.

ON LINE 4 – 4

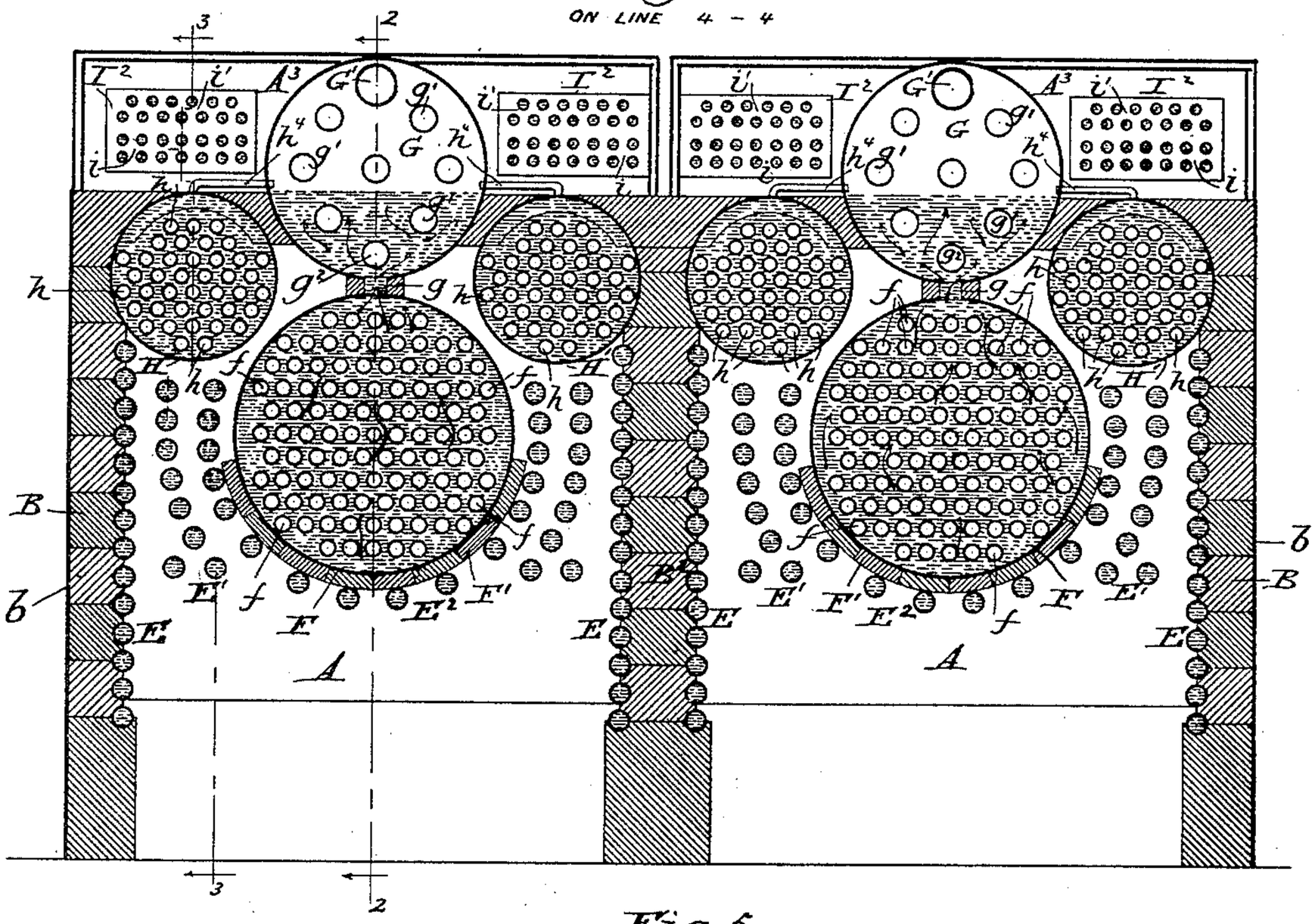


Fig. 5.

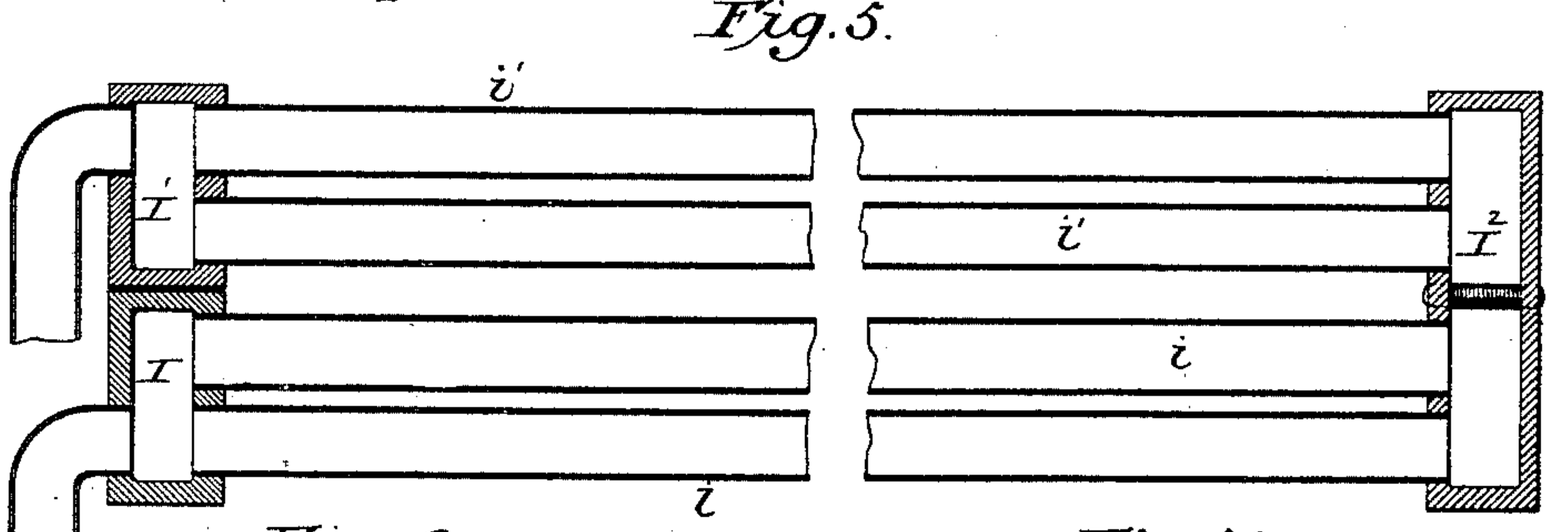
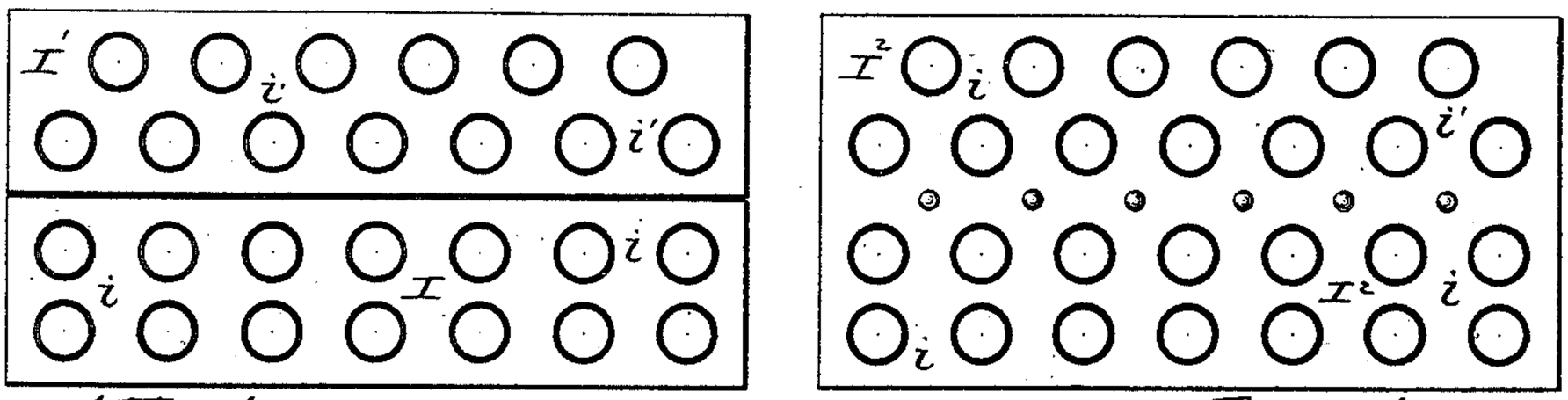


Fig. 6

Fig. 7.



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Sidney P. Mockingbourne

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(No Model.)

4 Sheets—Sheet 4.

J. BAIRD.

STEAM BOILER.

No. 437,745. Patented Oct. 7, 1890.

Fig. 9.

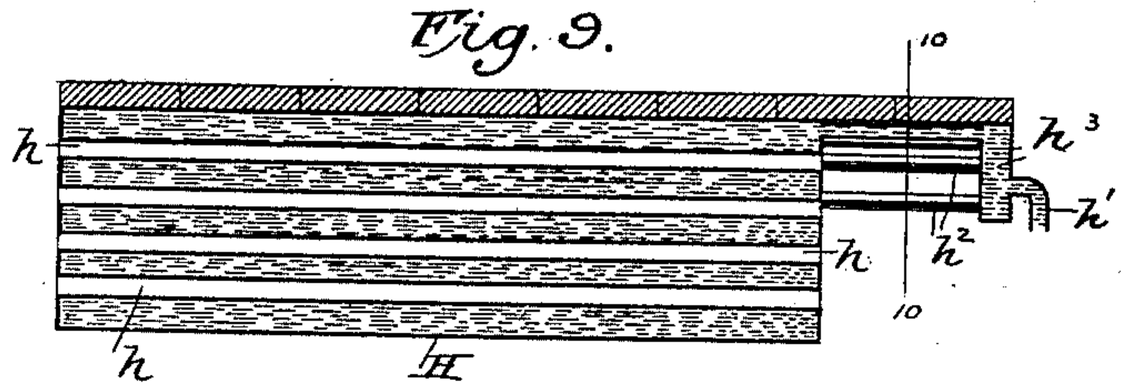


Fig. 8.

ON LINE 8—8

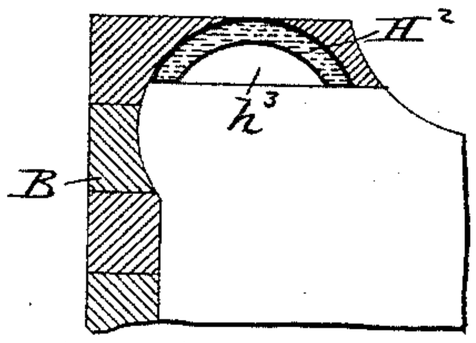


Fig. 10.

ON LINE 10—10

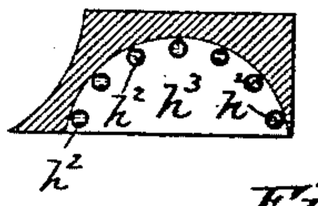


Fig. 12.

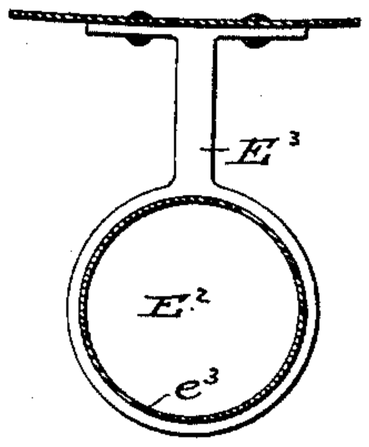


Fig. 11.

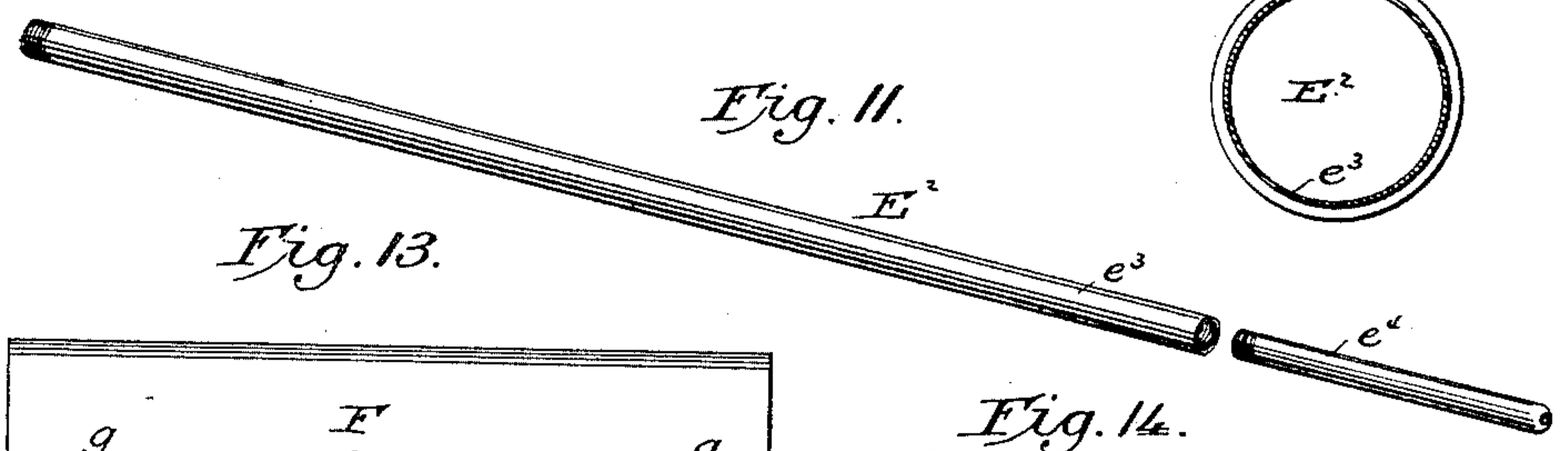


Fig. 13.

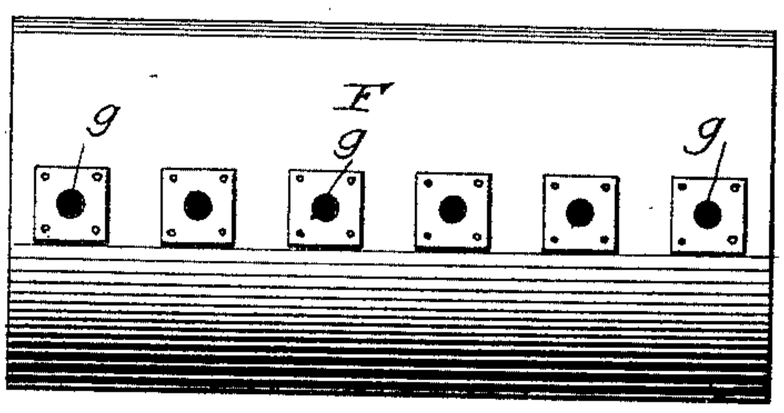


Fig. 14.

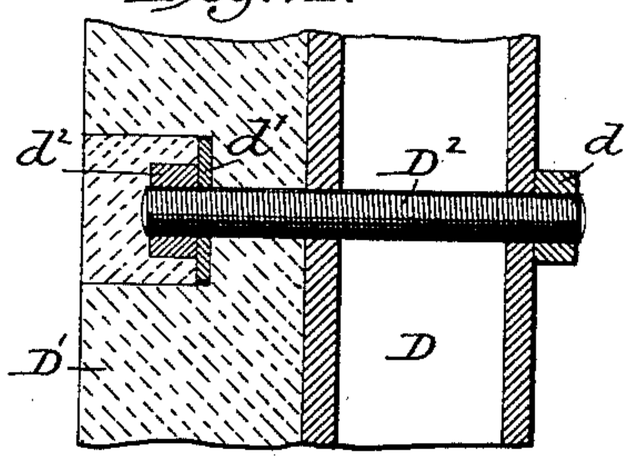


Fig. 15.

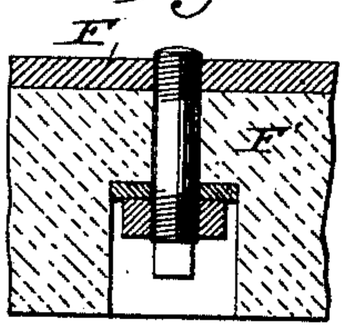
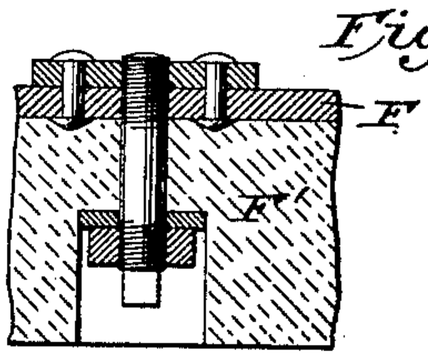


Fig. 16



Attest.

Sidney P. Hollingsworth

Baltus D. Long.

Inventor

John Baird

by his attorneys

Baldwin Davidson & Wright

UNITED STATES PATENT OFFICE.

JOHN BAIRD, OF NEW YORK, N. Y.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 437,745, dated October 7, 1890.

Application filed April 17, 1890. Serial No. 348,406. (No model.)

To all whom it may concern:

Be it known that I, JOHN BAIRD, mechanical engineer, a citizen of the United States, and a resident of the city, county, and State of New York, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a specification.

My invention more especially relates to the boilers of stationary steam-engines, and particularly to those of marine engines, in which it is essentially necessary to secure the highest attainable steam-generating capacity within the smallest practicable compass and with the lightest weight of material consistent with the necessity of resisting strains due not only to heat and steam pressure but to the working of the vessel.

In the construction and operation of steam-boilers economy of material and fuel is secured by having a large part of the heating-surface exposed to the direct action of the furnace-heat.

Cylindrical boiler-shells should be of small diameter to insure safety in using high-pressure steam. The limited area of such small shells, however, permits the use of a small number of fire-tubes only, and the use of such tubes of the diameter and length generally used in steam-boilers would leave the area for draft and the surface exposed to heat each too small for the ordinary grate-surface.

It is the object of my invention to obviate these and other disadvantages in steam-boilers; to insure strength to stand a high pressure of steam, a thorough circulation of the water, and a superior and economical combustion of material with less waste of material and water and occupying less space than has heretofore been required for boilers of equal capacity. These ends I attain by combining with the other parts of a steam-boiler four cylindrical shells arranged as follows: first, a horizontal lower shell containing fire-tubes and placed directly over the furnace; second, an upper shell directly over the lower one, connected therewith by vertical tubes, and, like the lower one, also provided with fire-tubes—some above and some below the normal water-level, which is at or slightly below the center of the boiler, thus leaving steam-room in its upper space; third, two intermediate supplementary cylindrical shells, also provided with fire-tubes and arranged on each side of and between the upper and lower shells, the top of these supplementary shells being about or just below the normal water-level of the upper shell. The organization is such that the heat from the back connection returns through the fire-tubes of both the lower and intermediate shells and then passes back through the upper shell to the smoke-box. Before entering the back connection, however, the heat acts on that portion of all the shells below the water-line. The increased fire-tube surface contained in these intermediate shells constitutes a valuable addition to the heating-surface; but the additional area for draft through those tubes is not only a valuable addition but an essential addition to the area for draft, without which the steam-generating capacity of the boiler would be very much restricted on account of inadequate area for draft in proportion to the grate-surface. Feed-water-heater pipes, around which the heat passes after escaping from the supplementary shells, are arranged above them and on each side of the upper shell.

My improvements comprise, further, constructions and combinations of instrumentalities hereinafter specified.

My invention contemplates the use, in connection with my improved boiler, of the most perfect apparatus of the present day. It is therefore unnecessary to describe in detail the construction of the various parts, such details, unless otherwise specified, being well known and constituting no part of the subject-matter herein claimed, which is specified at the end of this specification.

Steam-boilers embodying some of the details of construction and organization hereinafter described are shown in the following United States Letters Patents, respectively granted to me as follows: No. 334,156, dated January 12, 1886; No. 402,887, dated May 7, 1889; No. 411,882, dated October 1, 1889, and No. 415,135, dated November 12, 1889.

I do not of course claim herein anything shown in the above-mentioned patents, except as embodied in my new combinations and organizations.

In the accompanying drawings, which represent so much of a steam-boiler embodying

all my improvements in one form, and that the best known to me, as is necessary to illustrate the subject-matter hereinafter claimed, Figure 1 represents a front elevation of two of my improved boilers side by side with the uptake or front casing removed from one of them; Fig. 2, a vertical longitudinal section therethrough on the line 2 2 of Figs. 1 and 4, looking to the left, with the uptake or casing in place; Fig. 3, a similar section on the line 3 3 of the same figure, looking the same way; Fig. 4, a vertical transverse section through both boilers on the line 4 4 of Figs. 2 and 3, looking backward; Fig. 5, a vertical longitudinal section through one of the feed-water heaters, illustrating its details; Fig. 6, a vertical transverse section through the feed-water heater, looking forward, and showing its tubes in section; and Fig. 7, a similar view of its back head; Fig. 8, a vertical transverse section on the line 8 8 of Fig. 3, showing the details of the arched-head water-space connecting the back end of one of the supplementary shells with the back head of the boiler; Fig. 9, a vertical longitudinal section through a supplementary shell, showing a modification of this arched head, consisting of parallel tubes instead of a continuous water-space; Fig. 10, a vertical transverse section on the line 10 10 of Fig. 9, further illustrating this modification; Fig. 11, a view in perspective of one of the sectional tubes of the lower shell, showing its detachable connection; Fig. 12, a vertical transverse section through the bottom sheet of the lower shell, showing the way in which the sectional fire-tubes are supported; Fig. 13, a plan view of the upper sheet of the lower boiler-shell, illustrating its connection with the upper shell; Fig. 14, a sectional detail illustrating the mode of connecting the brick-work with the front and back heads, and Figs. 15 and 16 similar details of the connection between the brick-work and other parts of the boiler.

The figures illustrating details are on an enlarged scale.

That end of the boiler in which the fuel is inserted I call the "front," the opposite end the "rear" or "back." That side of the boiler on the left of a person facing its front I call the "left," the opposite side the "right."

The short unfeathered darts show the direction in which the sections are shown. In Fig. 3 the solid feathered arrows show the course of the heat, the corresponding unfeathered arrows that of the steam, and the dotted arrows that of the water.

The drawings show a fire-box or furnace A, from which the products of combustion pass around and through the various water and fire tubes by way of the back connection A′, front hood or uptake A^2, smoke-box A^3, and chimney or smoke-stack A^4. The brick-work of the boiler will be hereinafter described.

The front head C and back head D are each made of two parallel plates of metal properly stayed with a water-space between them. The inside of the front head above the grate-bars is fitted with fire-brick and fastened as shown in the detail drawing Fig. 14, except that the tube-stays fitted in the front head are hollow. Corresponding holes *c* are made through the brick-work opposite them, thus admitting air to the furnace above the fire and simultaneously heating it by passing through the hot brick-work. The lower part of the back head D is lined inside with fire-brick D′, like the front head. A stay D^2, passing through the back head, has a screw-nut *d* on its outer end. The inner end of the stay-bolt passes into a recess in the brick-work and is held by a plate *d′* and nut d^2. The stay-bolt D^2 may or may not be hollow, as preferred.

Three series of water-tubes E E′ E^2 go from the back to the front head. They may be either horizontal or inclined upward from back to front. These tubes are arranged alongside the side walls of the furnace, also under and alongside the lower shell, and also in the space between the lower shell and side walls. They are fastened to the inner plate of the front head, and holes fitted with plugs *e* are made in the outside plate opposite each tube to allow for cleaning or taking out or putting in a tube. These water-tubes pass through sleeves *e′*, fitted water-tight in the back head, and are supplied with water therefrom by small bent tubes e^2. This construction prevents any leakage from expansion or contraction of the water-tubes. The water-tubes E^2, which go under and alongside of the lower shell, usually lie so close together that when in place entrance to the back connection would be prevented. I obviate this difficulty by making one or more of these tubes in two lengths or sections e^3 e^4, Fig. 11, one section extending from the front head of the back connection, (see Fig. 2,) the other screwing into it through a sleeve in the back head. The rear end of the front section is supported by a bracket E^3, fitted and fastened to the lower shell F. (See Fig. 12.)

The water-tubes E run along the sides of the furnace, close to and parallel with each other, but not contiguous. To prevent the exit of flame and hot gases between these tubes, a fire-brick wall B is built outside of them, and backed on the outside with plates *b*, the joints of which are covered by angle-iron bars or plates *b′*, secured to the ends of the front head C and back head D by bolts and nuts. This construction, while not absolutely necessary in land engines, is very serviceable on board ships exposed to rolling and pitching, as it prevents the displacement of the brick-work by the motion of the vessel.

The openings between the sides of the boiler and between the upper shell and the intermediate supplementary shells, are to be filled with fire-brick and lute, as shown, or any suitable substance, so as to prevent the passage of the products of combustion except through the proper channels.

By the construction of this boiler with fire-

brick over and at the sides of the furnace I secure a higher temperature than usual in steam-boiler furnaces, thus insuring more perfect combustion and more effective heating-surface.

The lower shell F rests on the front head and extends rearward to the front end of the back connection, a suitable space A′ being left between the back end of the lower shell and the back head to form the back connection.

In order to insure an improved combustion by retaining the heat from the products of combustion, I cover the bottom of the lower shell with fire-bricks F′, which extend around nearly one-half of the shell, and retain them in place by water-tubes E^2, extending from the front to the back head. I fasten the fire-bricks to the shell in a manner similar to that above described, and shown in Fig. 16, to retain them properly in place and permit of the withdrawal of a tube when necessary. The lower shell is filled with fire-tubes *f*, through which the products of combustion pass.

The upper shell G runs from the front end of the boiler over, close to, and parallel with the lower shell, with which it is connected at frequent intervals by pipes *g*, Figs. 2 and 13, extends over the back connection, and rests upon the back head, thus supporting the lower shell. The upper shell is likewise filled with fire-tubes *g′*, through which the products of combustion pass. This shell is normally about half-full of water. Consequently its lower portion constitutes a water-space and its upper portion a steam-space. The lowest g^2 of the fire-tubes of the upper shell lies directly over the openings or pipes *g*, connecting its water-space with that of the lower shell. Consequently the water and steam rising through these openings strike against and are deflected laterally by this tube. As their ascent continues they successively strike against the upper tubes *g′* and separate the steam and water, the former being superheated in the upper part of the boiler, thus supplying dry superheated steam. A perforated steam-pipe G′ leads from the upper part of this shell to the steam-pipes supplying the engine.

The intermediate supplementary shells H H′ are arranged on opposite sides of, parallel with, and in the spandrel-recesses between the upper and lower shell, their front ends being supported by the front head and their fire-tubes *h* running back to the front end of the back connection. An arched hood H^2, having a water-space therein, connects the back ends of the fire-tubes with a downwardly-projecting end or water-box h^3, which rests upon the top of the back head, thus supporting the back end of the intermediate supplementary shells. A bent water-tube *h′* connects this water-box and back head. (See Fig. 3.) Figs. 9 and 10 represent a modification in which the arched hood H^2 is shown as composed of a series of pipes h^2. Both forms of these arched hoods are to be covered with fire-brick or pottery, as shown in the drawings.

Small pipes h^4 connect the tops of the back ends of the supplementary shells with the upper shell G, thus allowing any steam generated in the former to escape into the latter. These pipes also serve for the passage of air in filling the boiler, as hereinafter described. Similar pipes g^3 g^4 connect the upper parts of the front and back heads, respectively, with the steam-room of the upper shell.

The sides of the boiler are run up to a level with the top of the upper shell, and the space between them is covered over by plate-iron or other suitable material. The space thus inclosed forms a channel on each side of the upper shell, into which the products of combustion from the uptake are discharged. This channel runs across the back end of the boiler and discharges into the smoke-pipe there.

Feed-water-heater pipes *i i′* are arranged in the channels along side the upper shell and over the intermediate shells. These water-tubes are shown as arranged in two sets divided horizontally and extending from the front end of the uptake to the back end of the channel. A vertical tube-box I^2 extends across each channel, being securely fastened in place. The rear ends of the feed-water-heater tubes *i i′* are secured to the front of this box, while their front ends are secured to two separate boxes I I′, lying one above the other, the incoming tubes passing through one box and the outgoing ones through the other. These boxes are so secured in place as to prevent any movement vertically or laterally relatively to the pipes, but are so arranged as to move backward or forward to compensate contraction or expansion of the pipes. These pipes, being placed in the smoke-channels, are heated by the products of combustion just before their escape into the smoke-pipe, thus economizing fuel and heating the feed-water.

The feed-water inlet is furnished with the usual check-valve M.

A safety-valve K, fitted on the upper side of each of the upper tube-boxes I′ at the front end of the side channels has its discharge-pipes *k k′* connected with the steam-space of the upper boiler-shell, a pipe k^2 connecting it with the feed-box I′. When the boiler is being filled with water, these safety-valves are opened to allow the air to escape. A blow-off pipe L is fitted to the lower tube-box at the front end of the boiler. When in operation, the feed can be shut off and the blow-off and safety valves opened. A current of steam will then flow through the water-tubes in the channel and clear them of sediment or scale.

The smoke-box is sometimes placed at the front end of the boiler directly over the uptake.

The uptake A^2, of usual construction, is

fitted to the front end of the boiler, and the products of combustion from the fire-tubes of the lower and intermediate shells are discharged into it.

In batteries of two or more boilers the after channel runs across their ends to a common smoke-pipe. In some cases a duplicate set of boilers and batteries is placed with their back ends facing each set, discharging into a common smoke-pipe.

When the boilers are arranged in battery or side by side, one fire-brick wall B^2 between them and their side pipes E, Fig. 4, answers for each pair of boilers and holds the pipes securely against any tossing of the vessel. These partition-walls I prefer to make of sufficient thickness to inclose metal stanchions connecting the decks above and below the boilers, the thickness of the brickwork protecting the stanchions from injury from the heat of the furnace.

The following is a description of the operation of the boiler: The water in the front and back heads and in the tubes E E′ E^2 in the furnace is heated by the direct action of the flame. The side tubes E are further heated by heat absorbed by and reflected from the side walls B. The tubes E^2 are similarly heated. The fire-bricks F′ interposed between these tubes and the bottom of the lower shell become highly heated and transmit their heat to the lower shell. The products of combustion, after acting externally on all the shells, pass up through the back connection and forward through the fire-tubes of the lower, upper, and intermediate shells to the uptake in front, thence passing back around the feed-water-heater tubes and the outside of the upper shell, and finally escaping through the smoke-box at a much lower temperature than ordinary. The feed-water enters the lower front tube-boxes I through the tubes *i* and passes backward and forward in them through the channel, thence passing through the rear tube-boxes I^2 into the upper tubes *i*, and through the front upper tube-boxes I′ and pipes i^2 to the water-spaces of the intermediate shells, thence through the hood H^2, head h^3, and pipes *h′* to the back head. Small pipes e^2 connect the back head with the water-tubes E E′ E^2 in the furnace, through which the water passes to the front head, which is connected by suitable pipes *f′* with the lower shell, thence passing through the connecting-pipes into the upper shell. All the steam generated passes through its proper channels, as indicated by the arrows, into the steam-space of the upper shell.

It will be seen from the foregoing description that the lower shell is located centrally in the fire-box, so as to be exposed on all sides to its heat, that the lower portion of the upper shell, or that portion below the water-line, as well as the tubes connecting the upper and lower shell, is likewise directly exposed to the heat, and that the intermediate shells are also inclosed in the brick-work of the fire-box and similarly exposed externally to its heat, the advantage of which organization will readily be understood. Another advantage incidental to this improved organization is that the parts are compactly arranged, occupying a comparatively small space vertically, which is especially advantageous in marine boilers.

The particular construction of feed-water heater herein shown and described is not claimed herein, such apparatus being only claimed generically in combination with other instrumentalities.

I claim as of my own invention—

1. The combination, substantially as hereinbefore set forth, of a furnace or fire-box, a back connection, a front hood, a central lower shell, an upper shell parallel therewith, water-tubes directly connecting these shells, and an intermediate shell on each side of the lower shell below the water-line, all the shells being provided with horizontal fire-tubes and the organization being such that the products of combustion after impinging on the exterior of all the shells return simultaneously to the front hood through the tubes of the lower and intermediate shells and then escape in the reverse direction.

2. The combination, substantially as hereinbefore set forth, of a furnace or fire-box, a central lower shell therein, an upper shell, water-tubes directly connecting them, intermediate shells in the spandrel-recesses between and on opposite sides of the upper and lower shells below the water-line, and horizontal fire-tubes filling all the shells, the organization being such that all the shells are inclosed within the casing of the fire-box and are exposed to the direct action of the products of combustion, which first act simultaneously upon the exterior of the shells and then pass through the fire-tubes.

3. The combination, substantially as hereinbefore set forth, of the furnace, the lower shell therein, and the fire-brick directly secured to the outer surface of the bottom of the shell.

4. The combination, substantially as hereinbefore set forth, of the furnace, the lower shell therein, the water-tubes surrounding the shell, and the fire-brick interposed between the tubes and shell and secured directly to the latter.

5. The combination, substantially as hereinbefore set forth, of the furnace, the lower shell therein, the upper shell, the intermediate shells, and the water-tubes surrounding the lower shell.

6. The combination of the side walls of the furnace, its external plates *b* and angle-iron bars *b′*, and its internal bracing water-tubes, the combination being and operating substantially as hereinbefore set forth.

7. The combination, substantially as hereinbefore set forth, of the lower shell, the upper shell, the intermediate shells, the fur-

nace-walls, their internal bracing water-tubes, and the water-tubes interposed between them and the lower shell.

8. The combination, substantially as hereinbefore set forth, of the lower shell, the upper shell, the intermediate shells, the fire-brick secured to the lower shell, the furnace-walls, their bracing-tubes, the tubes surrounding the bottom of the lower shell, and the tubes intermediate between these tubes and the furnace-wall tubes.

9. The combination, substantially as hereinbefore set forth, of a fire-box, a back connection, a front hood, a rear smoke-box, a fire-box, a central lower shell therein, an upper shell, water-tubes directly connecting these shells, intermediate shells in the spandrel-recesses between and on opposite sides of the upper and lower shells below the water-line, and horizontal fire-tubes filling all the shells, the organization being such that all the shells are inclosed within the casing of the fire-box and are exposed to the direct action of the products of combustion, which first act simultaneously upon the exterior of all the shells on their way to the back connection, whence they return simultaneously to the front hood through the tubes of the lower and intermediate shells and again pass backward to the smoke-box through the tubes of the upper shell.

10. The combination, substantially as hereinbefore set forth, of the fire-box, its back head, a back connection, a front hood, a smoke-box projecting beyond the back head, a boiler-shell between the back connection and front hood, its fire-tubes terminating at the front of the back connection, a hood extending over the back connection to the back head, and pipes connecting said hood and head, the organization being such that the products of combustion act upon both sides of the hood in passing from the back connection to the smoke-box.

11. The combination, substantially as hereinbefore set forth, of a fire-box, a back connection, a front hood, a smoke-box projecting beyond the back connection, a boiler-shell between the back connection and the front hood, its fire-tubes, and feed-water-heater tubes in the smoke-channel above the boiler-shell and projecting beyond it at each end into the front hood and smoke-box, respectively.

12. The combination, substantially as hereinbefore set forth, of a lower shell, an upper shell, intermediate shells on opposite sides thereof, and feed-water-heater tubes above the intermediate shells on each side of the upper shell.

13. The combination, substantially as hereinbefore set forth, of feed-water-heater tubes, intermediate shells, a lower shell, an upper shell, and connecting-pipes through which the water flows successively from the feed-water-heater tubes through the intermediate shells, the lower shell, and the upper shell, the upper part of which constitutes the steam-space.

14. The combination, substantially as hereinbefore set forth, of a furnace containing water-tubes, a lower shell, the lower part of which is surrounded thereby, an upper shell connected with the lower shell, intermediate shells on opposite sides of the upper and lower shells, and feed-water-heater tubes on opposite sides of the upper shell above the intermediate shells.

15. The combination, substantially as hereinbefore set forth, of the furnace, the front and back heads, and the central water-tubes having a removable section in the back connection to permit access thereto.

16. The combination, substantially as hereinbefore set forth, of the lower shell, the sectional water-tubes, and the brackets sustaining the rear end of the fixed section.

17. The combination, substantially as hereinbefore set forth, of the heads of the steam-boiler, their fire-brick lining, a stay-bolt passing through the head into a recess in the brick-work, and a holding-plate and clamp-nut in said recess.

18. The combination, substantially as hereinbefore set forth, of a shell, its arched hood crossing the back connection, its water-box, the back head on which it rests, and a pipe connecting them.

19. The combination, substantially as hereinbefore set forth, of a boiler-shell, a water-box, tubes connecting the shell and water-box and crossing the back connection, a back head on which the water-box rests, and a pipe connecting them.

20. The combination, substantially as hereinbefore set forth, of a safety-valve, the feed-water-heater-tube box connected therewith, and the pipes connecting the safety-valve with the steam-space of the boiler.

21. The combination, substantially as hereinbefore set forth, of the lower shell, the upper shell, the pipe connecting them, and the lower fire-tube of the upper shell, arranged directly over these pipes to act as a deflector.

In testimony whereof I have hereunto subscribed my name.

JOHN BAIRD.

Witnesses:
A. J. BAIRD,
ADDISON W. BAIRD.