No. 750,916. PATENTED FEB. 2, 1904.

E. C. VILLIERS.

STEAM GENERATOR.

APPLICATION FILED JAN. 14, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

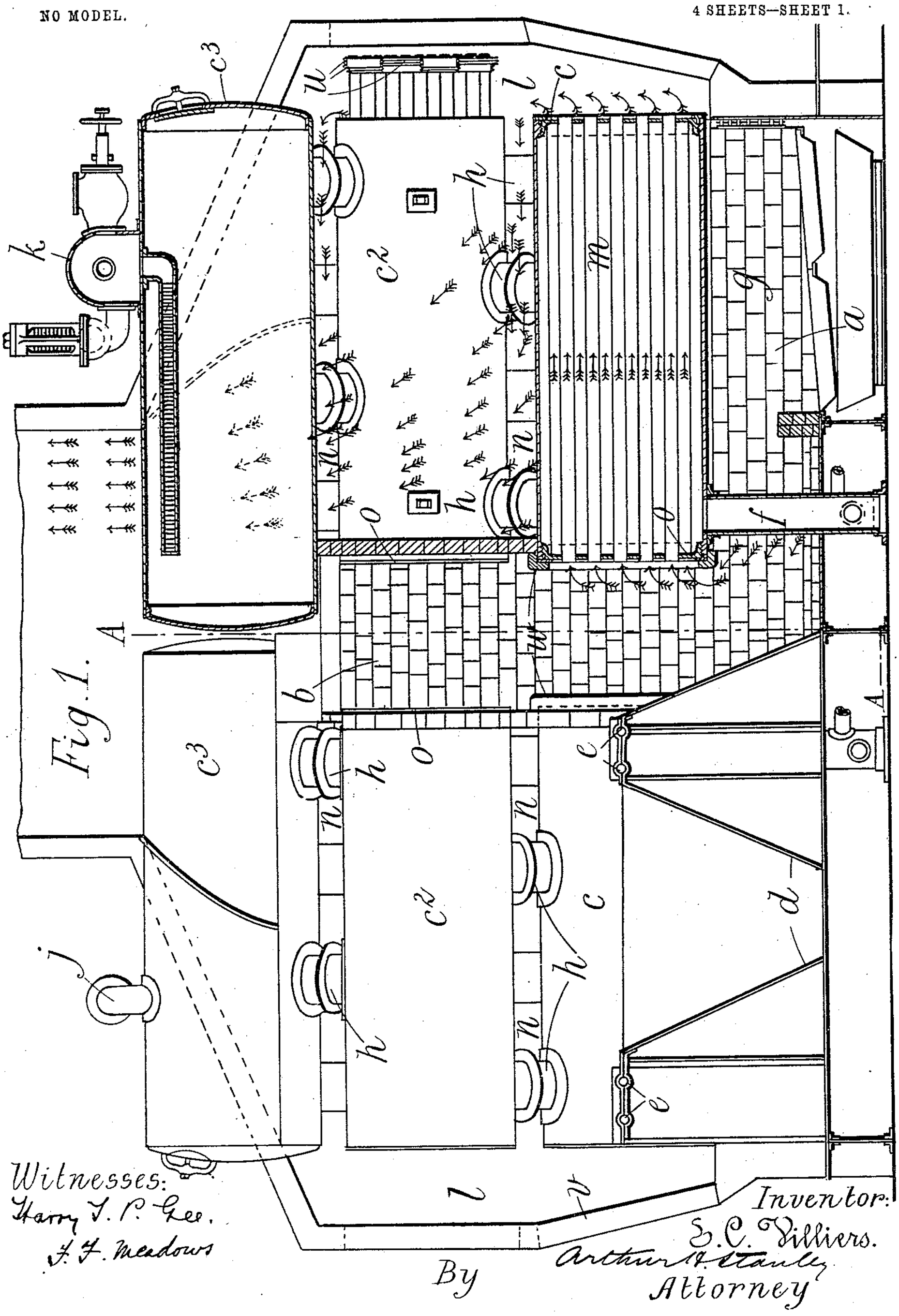


Fig. 1.

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NO MODEL. 4 SHEETS—SHEET 2.

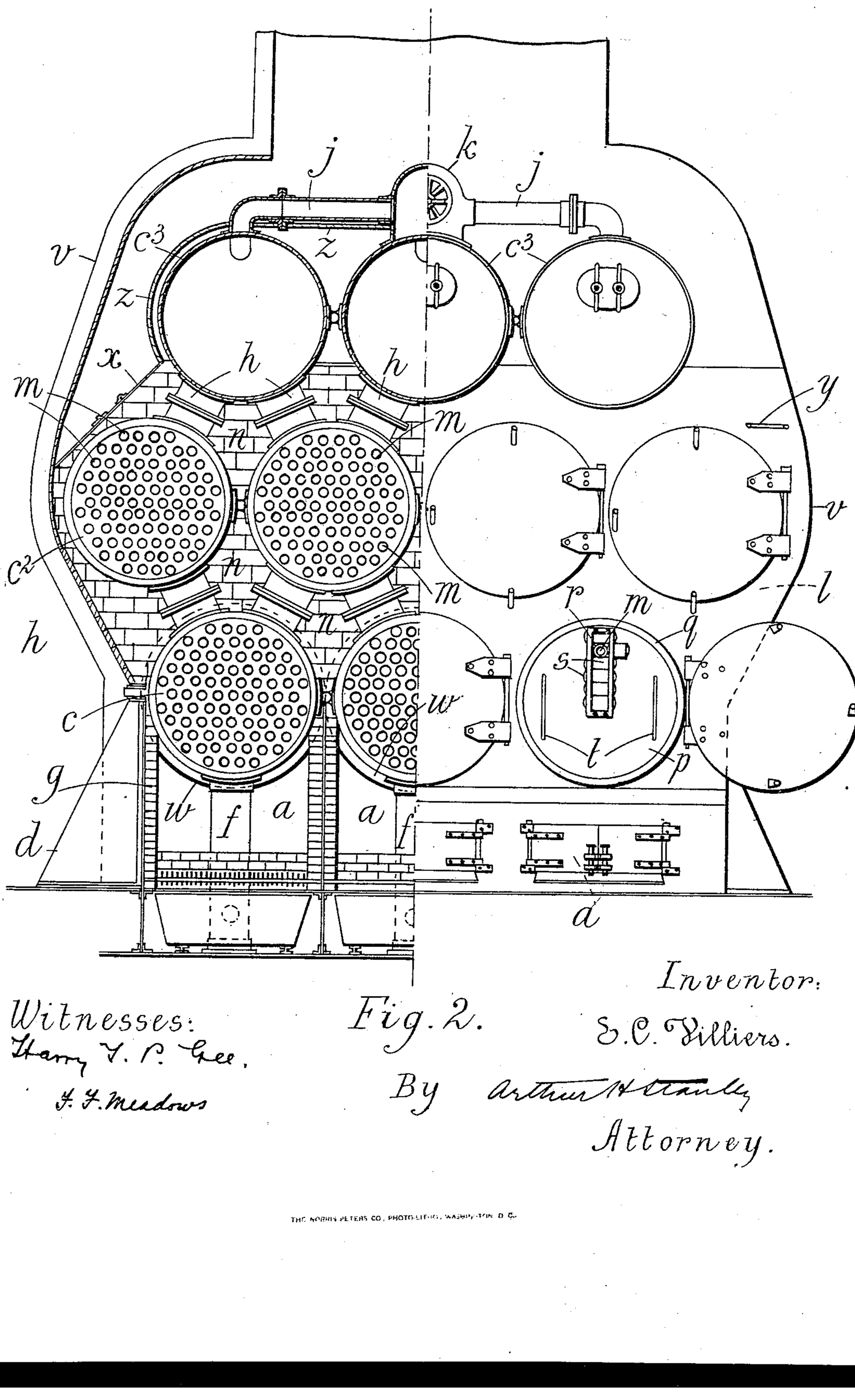


Fig. 2.

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NO MODEL. 4 SHEETS—SHEET 3.

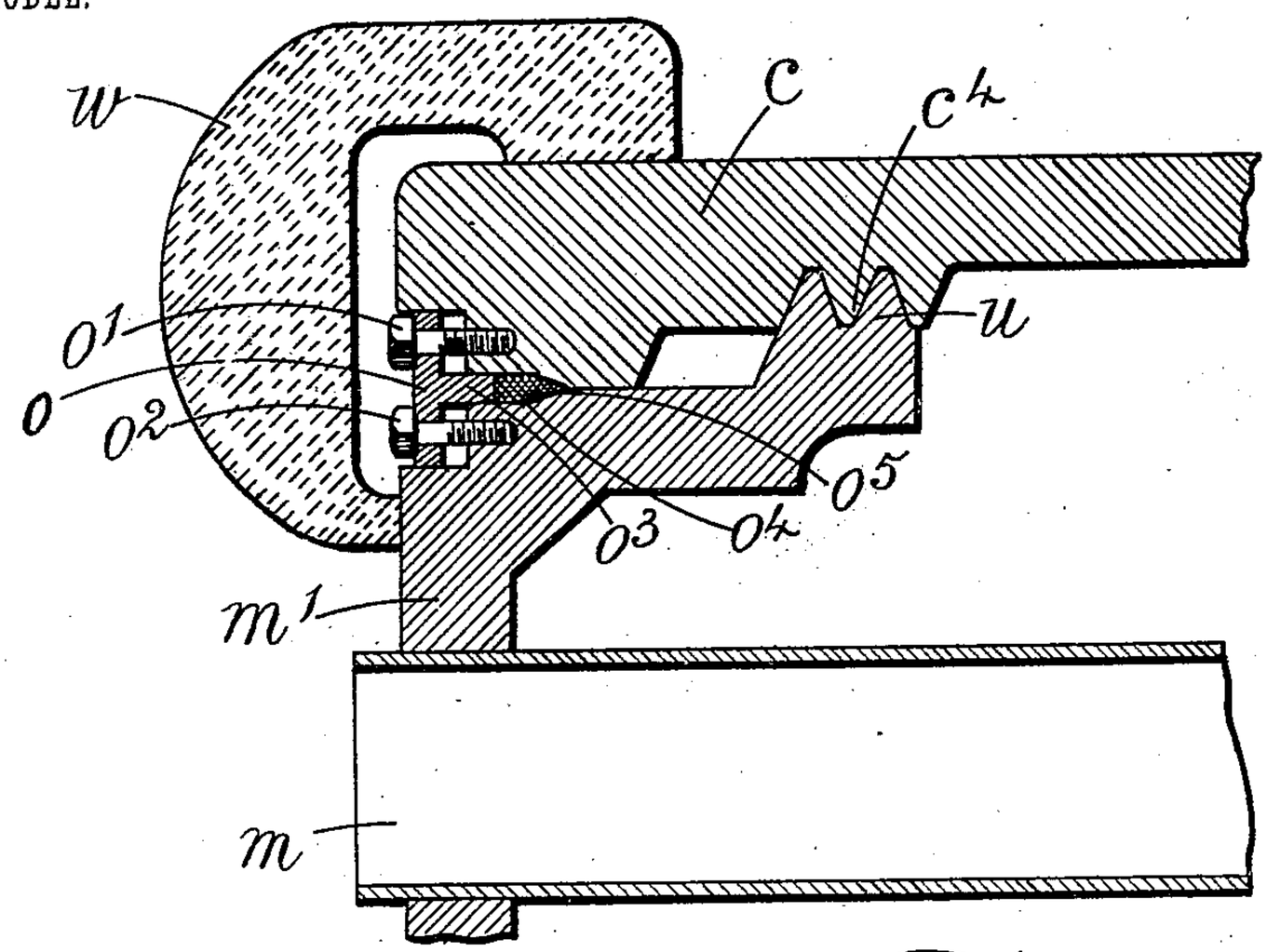


Fig. 3.

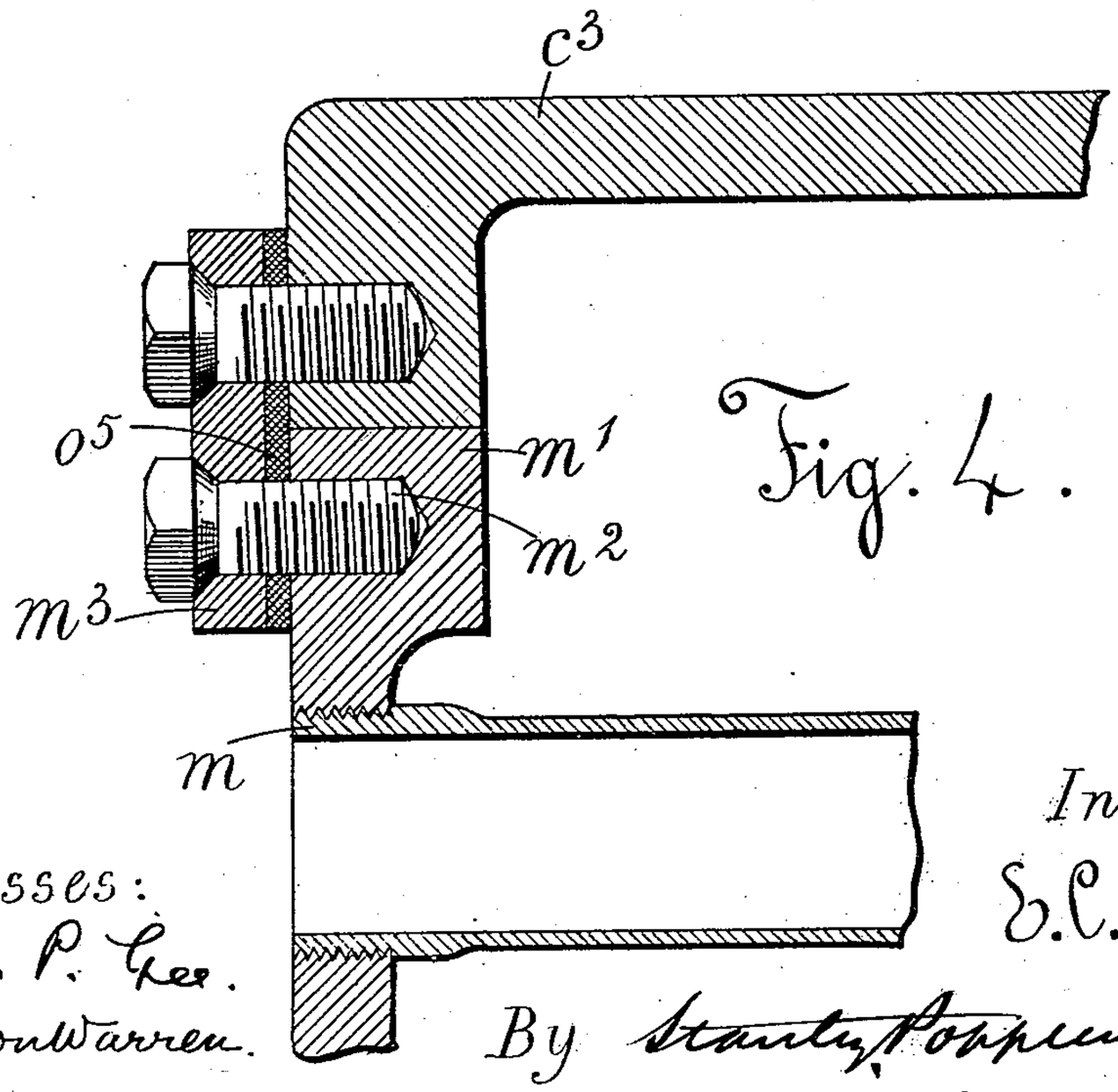


Fig. 4.

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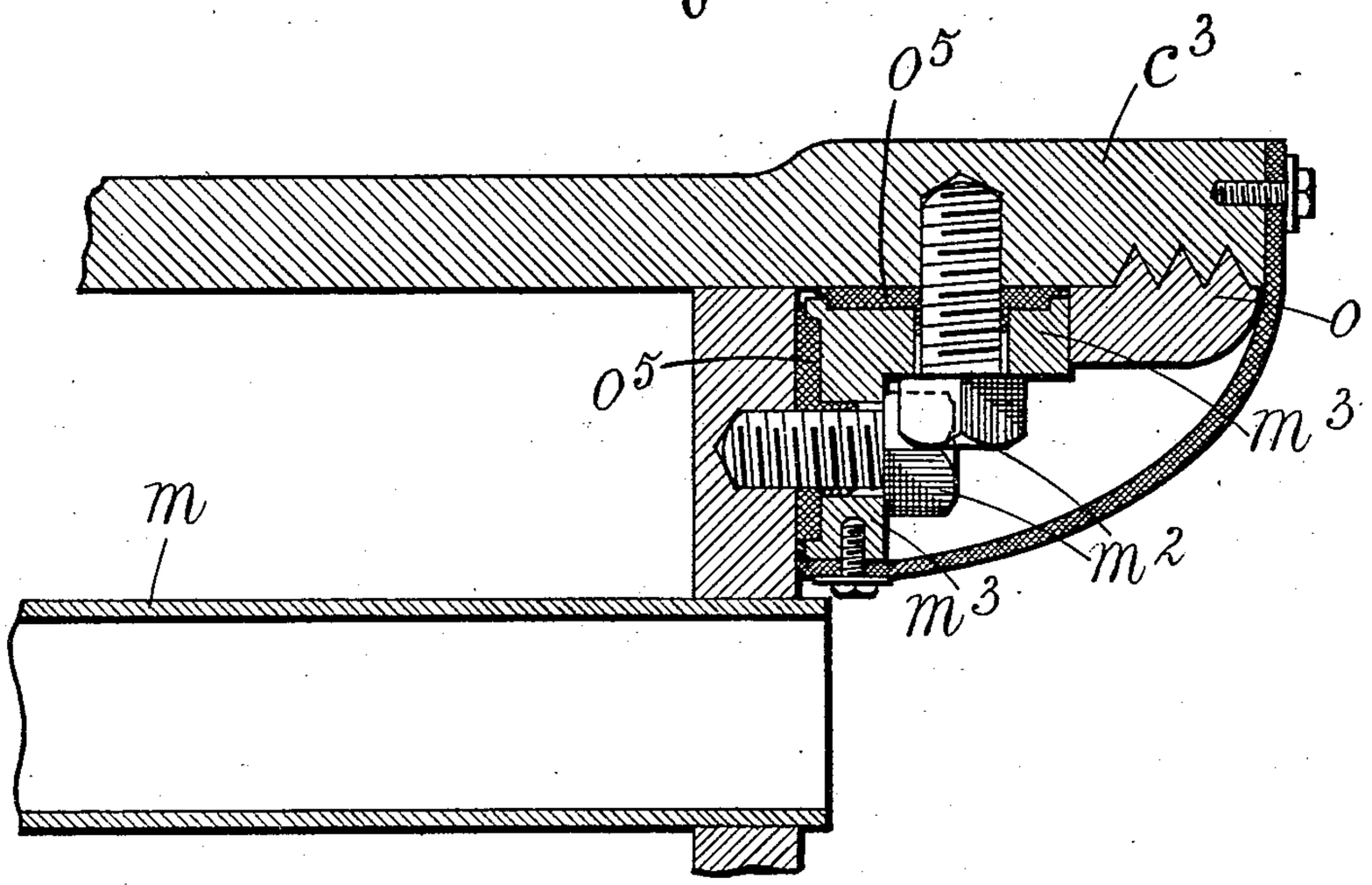
NO MODEL. 4 SHEETS—SHEET 4.

Fig. 5.




Witnesses:
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No. 750,916. Patented February 2, 1904.

# UNITED STATES PATENT OFFICE.

EDWARD CECIL VILLIERS, OF WINDSOR, ENGLAND, ASSIGNOR OF ONE-HALF TO WILLIAM HAYNES SMITH, OF QUEEN'S ACRE, ENGLAND.

## STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 750,916, dated February 2, 1904.

Application filed January 14, 1903. Serial No. 139,021. (No model.)

*To all whom it may concern:*

Be it known that I, EDWARD CECIL VILLIERS, a subject of Edward, King of Great Britain, residing at 2 Bolton Crescent, Windsor, in the county of Berks, England, have invented certain new and useful Improvements in or Relating to Steam Generators or Boilers; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to steam generators or boilers; and it consists of certain novelties in construction whereby great efficiency is secured with the consumption of a comparatively small quantity of fuel, which, however, is more thoroughly consumed than with other known boilers and the heat of combustion used to a greater extent than heretofore. Not only is the great area in my improved boiler small in proportion to the heating-surface, but the boiler itself is exceedingly compact, light, and durable, and is therefore especially suitable for steamships of all kinds, though obviously it can be used for any other purpose to which a steam generator or boiler can be applied. Its special construction provides for very rapid generation of steam at a high pressure, while the parts are so arranged that there shall be mutually equal expansion or contraction as the temperature varies, thus reducing to a minimum the risks usually incurred by too sudden firing on the one hand, or, on the other hand, by drenching of the furnaces.

Referring to the accompanying drawings, Figure 1, Sheet 1, is a sectional side elevation of a double-ended boiler constructed according to the said invention, the side casing being absent, the left of the figure being an elevation, and the right a vertical central section. Fig. 2, Sheet 2, is partly a section on line A A of Fig. 1 and partly a front elevation. Figs. 3, 4, and 5 show sections, on an enlarged scale, of three methods of securing the tube-plates within the boiler.

My invention may be described as a high-pressure, multicylindrical, multitubular boiler, it being composed of several cylinders situated in rows above the furnace or furnaces and joined together by pipes, such cylinders containing a number of tubes through which the hot gases pass, as hereinafter explained.

According to my invention the boiler and its appurtenances will be constructed or arranged as follows: Three separate fireplaces *a a a* are arranged in a row in the form of a triple furnace delivering into a common combustion-chamber *b* at the rear. Each fireplace *a* is surmounted by a horizontally-placed cylinder *c*, the dimensions of which may be three feet six inches in diameter by nine feet in length, the shell being about five-eighths of an inch thick. Such cylinders *c*, composing the lowermost row, may be supported upon steel frames *d* in trunnion fashion, the bearing-pins *e* being carried by plates riveted to the cylinder sides, other support being given by a hollow column *f*, which is also a water-feed tube, under each cylinder *c* at the combustion-chamber end. The walls of the fireplaces are lined with fire-brick *g* or other refractory substance, protecting the supporting-frames *d* of the cylinders, the bottoms of the cylinders and the feed-tubes *f*, however, remaining exposed to the direct heat of the furnace. The cylinders $c^2$ in the second row, four in number, may alternate in position with the three cylinders beneath, with which they are connected by a few pipes *h* of rather large diameter, permitting of free circulation of water between the two rows. Above these is a third row of cylinders $c^3$, communicating with the second row in similar fashion and each carrying a common steam-pipe *j*, connected to a steam-dome *k*. The normal water-level in the whole system as described will be up to about one-quarter the depth of the uppermost cylinders $c^3$. These last-mentioned cylinders do not contain tubes, as do all the others. A baffle-chamber *l* is provided in the front of the boiler. The gases or other products of combustion pass from the furnaces *a* beneath the lower row of cylinders *c* to the combustion-chamber *b*, common to all the fires, and return through numerous fire-tubes *m* in the two lower rows of cylinders *c* and $c^2$ into the baffle-chamber *l*. From said baffle-chamber the gases pass back through the interstices *n* between the cylinders, thus completely envel-

oping the latter, as also the connection-pipes *h*, before mentioned. From thence they pass out to the uptakes and funnel, the spaces between the cylinder ends nearest the combustion-chamber *b* being sealed up in order to compel the gases to traverse the fire-tubes *m* first, the upper cylinders $c^3$, containing steam and water, form a part of the top of the combustion-chamber *b*.

My improved boiler may be either single or double ended. In the latter case the combustion-chamber *b* may be common to all the fireplaces, thus insuring regularity of temperature throughout. The mingling of the products of combustion in this chamber produces further combustion and heat and prevents flaming at the funnels.

The cylinders *c* $c^2$ $c^3$ are inclosed within a casing *v*, containing flues for admitting a draft into the fireplace.

In the roof of the combustion-chamber *b* there is a hinged draft-plate *x*, Fig. 2, giving direct communication from the chamber to the funnel when such plate is raised and an opening thus made by operating a handle *y*. This arrangement is useful for creating a draft in the funnel when the fires are first lighted.

It will be seen from the foregoing description that the gases which pass through the fire-tubes are at the maximum temperature when they enter the tubes, thus aiding in the rapid generation of steam, an important consideration for ships of war. In practically all other Scotch or marine cylindrical boilers the gases come in contact with comparatively cool surfaces before entering the tubes, which, being the thinnest portions of the boiler, ought to receive the greatest heat possible. My invention provides also for very rapid circulation of water in the several shells composing the boiler by reason of the great difference in temperature between the gases and the water at opposite ends of the boiler, such difference being eight times greater at the combustion-chamber end than at the baffle-chamber end, causing the water to ascend quickly through the large connection-pipes *h* near the combustion-chamber and descend through the corresponding pipes *h* near the baffle-chamber. The division of the boiler into a number of small cylinders, as in my invention, enables a very high pressure to be obtained without unduly increasing the thickness of the shell. Weight is saved in the boiler-casing, which, not being subjected to high temperature as in other boilers, is made of thin sheet metal, so that brickwork and other expensive and heavy means for resisting heat are not necessary. Space is greatly economized and facility for cleaning the interior of the fire-tubes is afforded, which may be done immediately the fires are extinguished through doors in the front of the baffle-chamber while steam is still in the boiler, or the tubes may be swept while the fires are still alight and even under forced draft by means consisting of circular plates *p*, revoluble within the door-frames *q* of the baffle-chamber *l*, such plates, which are situated opposite to the cylinders *c* $c^2$, having small ports *r* in them to allow a brush to be put through into each tube *m*. A single row or set of such ports *r*, arranged radially or otherwise in the circular door-plate *p*, will suffice, and each port may have a shutter *s* for closing it, excepting when the brush is to be inserted, and handles *t* for turning the plates are also provided. The water throughout the whole boiler is in close proximity to a heating-surface of high temperature, so that there is no waste of space or weight taken up by the idle water.

Provision may be made for withdrawing the tubes *m* or tube-plates wholly or partly for the purpose of removing any injurious deposit therefrom and cleaning the interior of the cylinders *c* $c^2$. For this purpose the tube-plates may carry interrupted screw-threads *u* on their peripheries, which are accordingly thicker than the remaining part of the plates instead of being flanged. The insides of the cylinder extremities are likewise threaded in an interrupted way, and the plates lock into the threads when inserted and given a partial turn in a similar manner to the closing of the breech of a gun. It is necessary that the front tube-plates be larger than the rear ones to enable the plates and tubes to be completely withdrawn *en masse*. The joint of the rear tube-plate may be protected against excessive heat of the furnace by a covering of fire-clay bricks *w*. A steel ring *o* may be fastened into the cylinder end by screws and bears a spigot or ridge which enters a groove fitted with asbestos, thus forming a tight joint. The section shown in Fig. 3 illustrates this form of joint more clearly, *m* being the fire-tube; *m'*, the tube-plate; *u*, the interrupted thread on the tube-plate locking into a corresponding interrupted thread $c^4$ on the cylinder end *c*; *o*, the steel ring fastened into the cylinder-shell by means of screws *o'* and $o^2$ and having a ridge $o^3$, which enters groove $o^4$, containing an asbestos packing $o^5$, the joint being protected by fire-clay *w*. Other convenient means for removing the tubes may be employed. For example, as shown in Fig. 4, the rear tube-plate *m'* may be unflanged and bolted by screws $m^2$ against the inside face of a flange $m^3$ on the rear end of the boiler-shell $c^3$, which will thus take the end strain, a packing of asbestos or other suitable substance $o^5$ being interposed to insure a steam-tight joint. As shown in Fig. 5, the front tube-plate may be flanged at $m^3$ and bolted by screws $m^2$ $m^2$ into a plain cylinder end $c^3$, in either case, however, being furnished with steam-tight packing $o^5$, the bolts or screws $m^2$ $m^2$ being readily removable. The strain upon the fastenings of the front tube-plate may be relieved by screwing a steel ring *o* into the cylinder tight

against said flange. Alternatively the front tube-plate, itself unflanged, may be secured within the boiler-shell by a steel packing-ring of ⅂ or any other suitable section bolted to the plate and to the shell with asbestos or other packing interposed, an additional steel ring for taking the strain being screwed into the boiler-shell, as already mentioned, being, if desired, bolted therein also. Either or both of said rings may be divided into three parts to facilitate removal, their extremities being scarf-jointed.

The usual water and pressure gages, valves, cocks, and other devices common to most boilers may be employed in any suitable manner.

The boiler can be used for evaporating and distilling purposes instead of or in addition to its use as a high-pressure steam-generator, the removal of the tubes greatly facilitating the removal of deposit.

What I claim is—

1. A multicylindrical multitubular boiler composed of cylinders surmounting one another in tiers, furnaces beneath the lowest tier, all except the top cylinders traversed by numerous fire-tubes, a common combustion-chamber into one wall of which all the cylinders containing fire-tubes are built so as to leave interstices between the cylinders which are closed at the combustion-chamber end by said wall, a common baffle-chamber at the other end of the cylinders and open to the interstices between them.

2. In a boiler of the kind described, a plate mounted in each of the door-frames of the baffle-chamber opposite to the fire-tubes, such plate having ports within it, in combination with shutters carried upon said plate for closing said ports when they are not required to remain open, also means for rotating said plate so as to bring the ports successively in line with the tubes, the whole substantially as described.

3. In multitubular boilers, means for securing the tube-plates within the cylinder ends, comprising a flange adapted to overlap the joint between the shell of the cylinder and the tube-plate, screws for securing said flange to the cylinder end and to the tube-plate, and packing between said cylinder end and said flange.

4. In multitubular boilers, means for securing the tube-plates within the cylinder ends, comprising a flange upon the tube-plate, screws for securing the flange to the tube-plate and to the cylinder-shell, packing between the flange and the tube-plate and between the flange and the cylinder-shell and a steel ring adapted to be screwed into the cylinder end tight up against said flange.

5. In multitubular boilers, means for securing the tube-plates within the cylinder ends, comprising a steel packing-ring fastened by screws to the tube-plate and to the cylinder-shell, packing between said ring and the tube-plate and shell and an additional steel ring screwed into the end of the cylinder-shell tight up against said packing-ring.

In testimony whereof I have hereunto set my hand in the presence of two witnesses.

EDWARD CECIL VILLIERS.

Witnesses:

GEORGE I. BRIDGES,

WALTER BROMLY.