(No Model.) 2 Sheets—Sheet 1.

F. M. STEVENS.

Steam Generator.

No. 232,773. **Patented Sept. 28, 1880.**

Fig. 1.

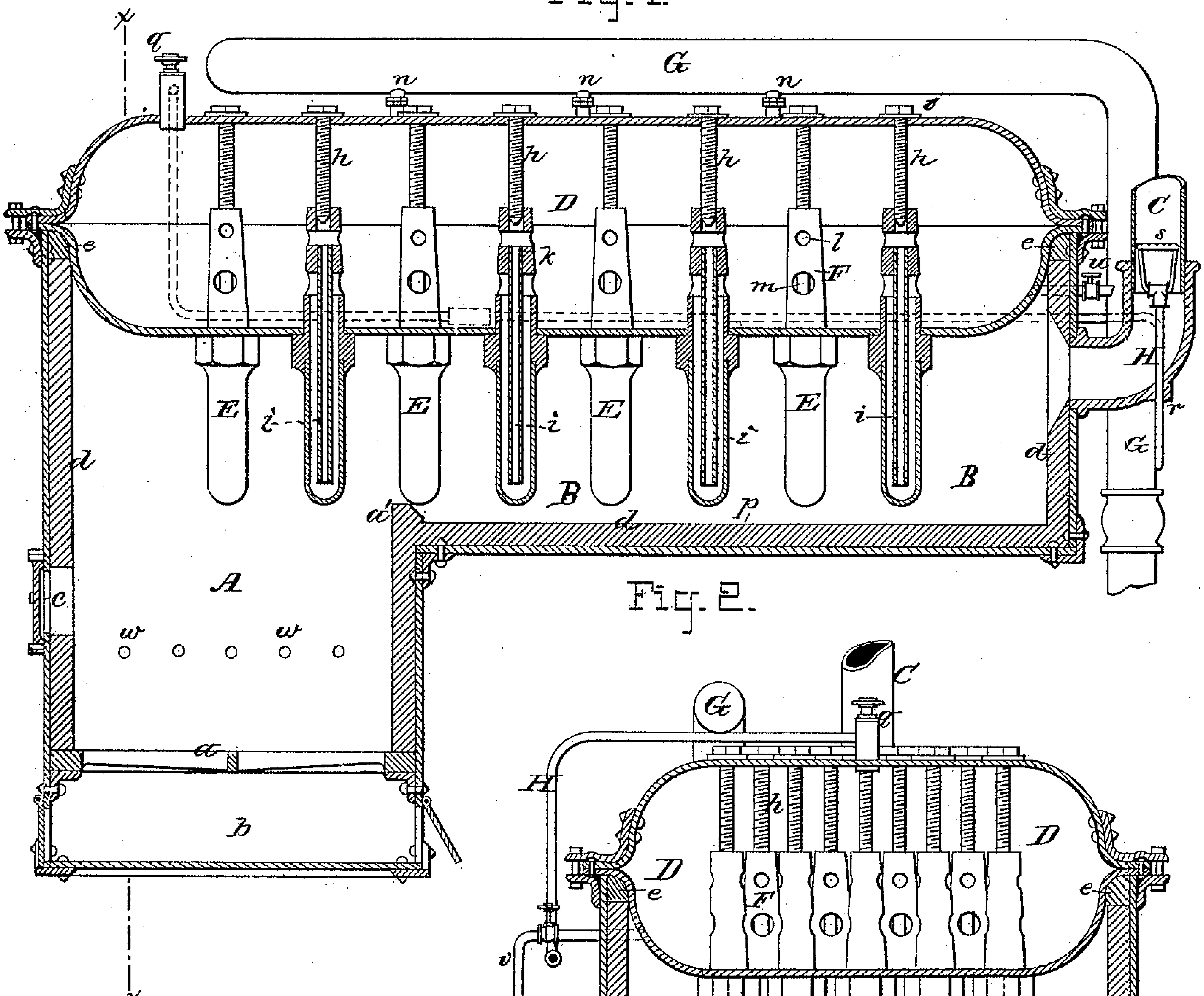
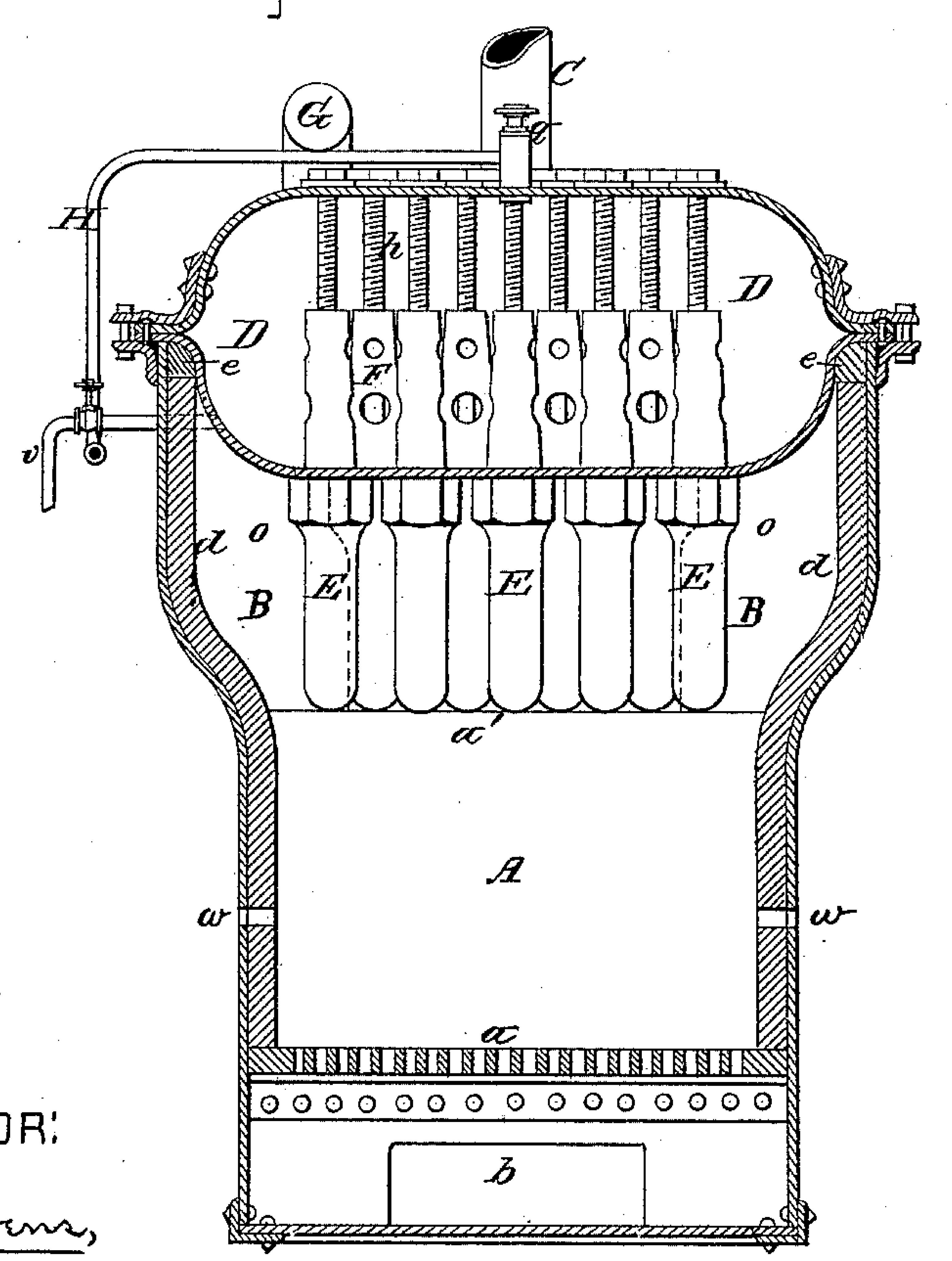


Fig. 2.



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Saml Russell

INVENTOR:

Frank M. Stevens,

by his Attys.

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(No Model.)

2 Sheets--Sheet 2.

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Fig. 3.

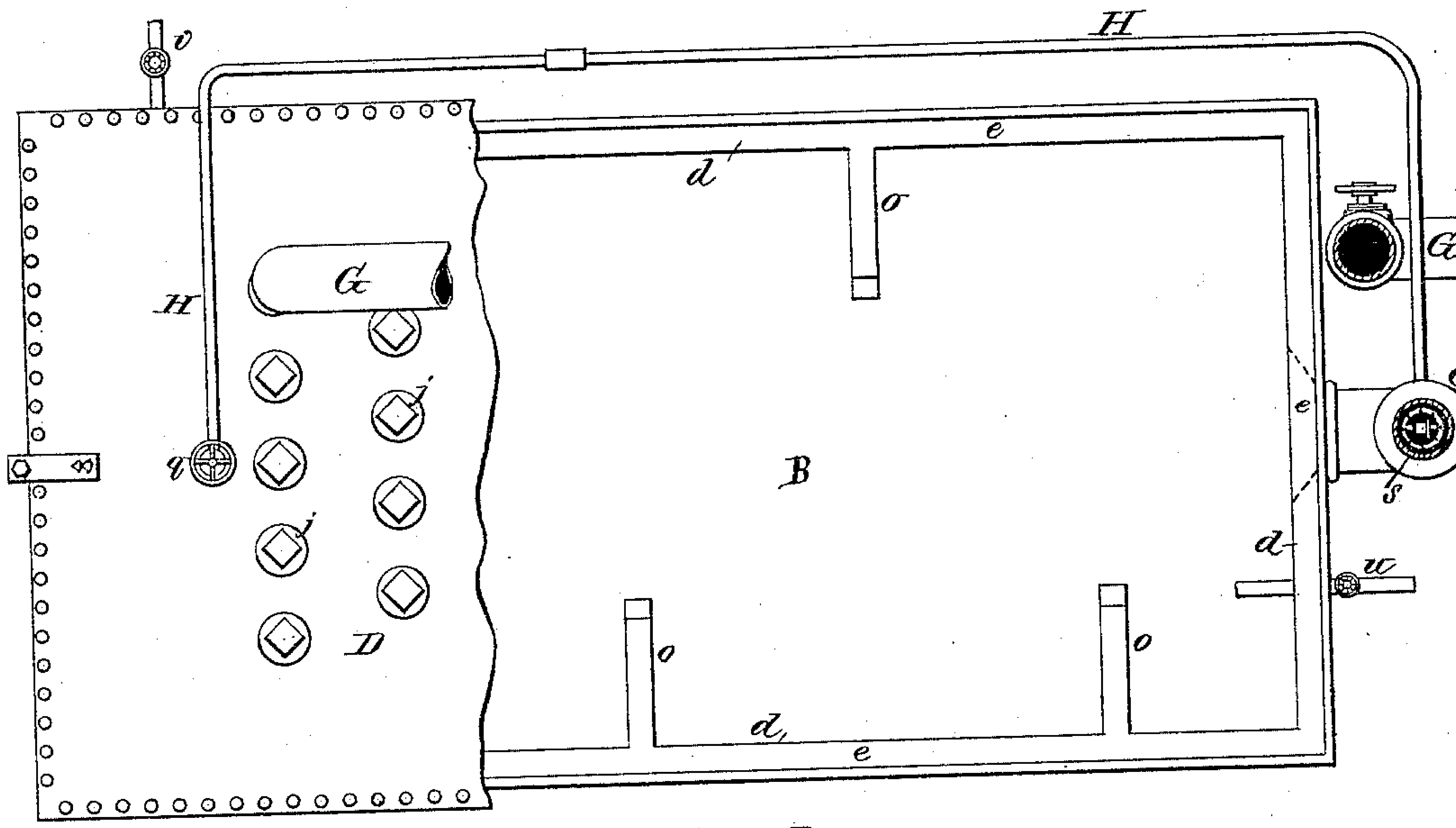


Fig. 4.

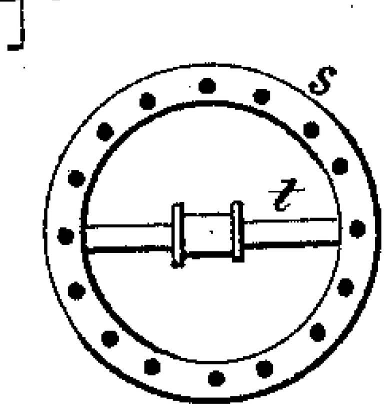


Fig. 5.

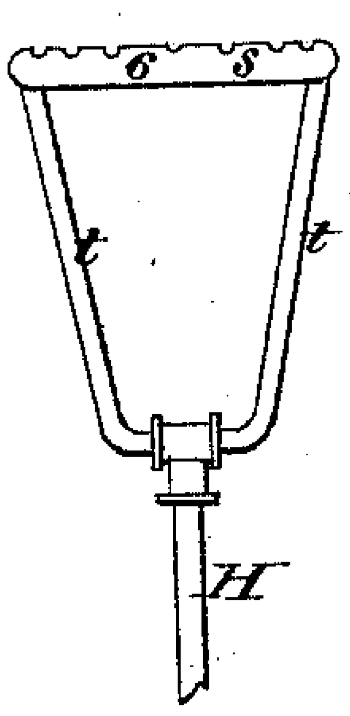


Fig. 6.

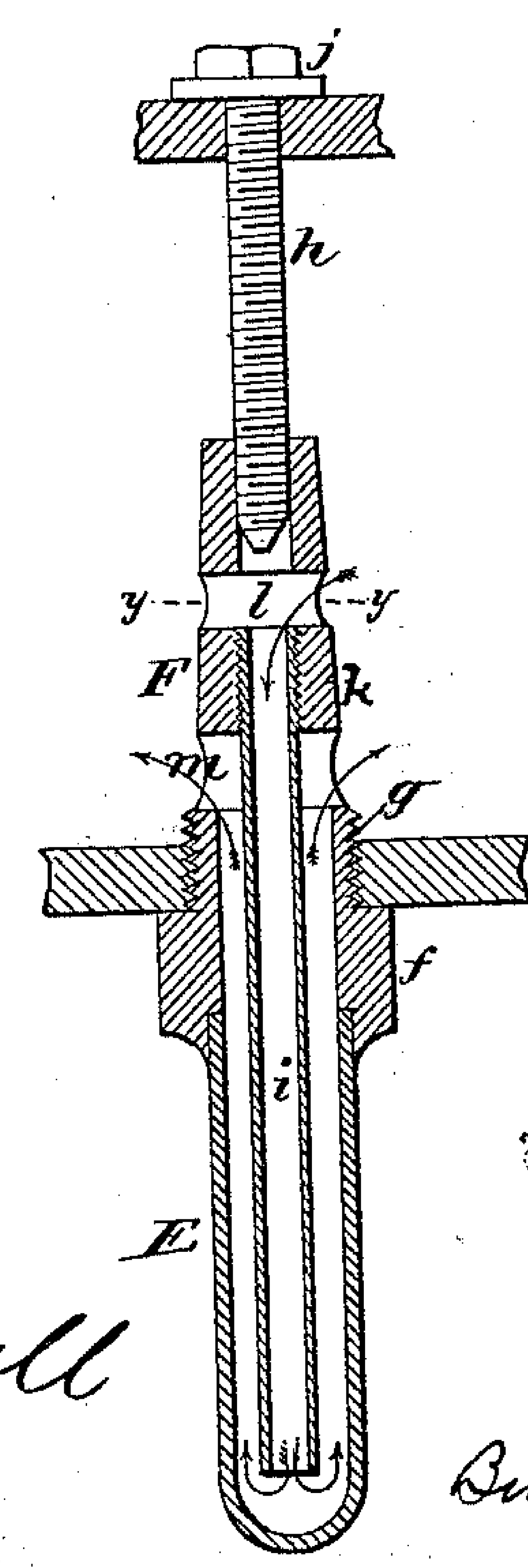
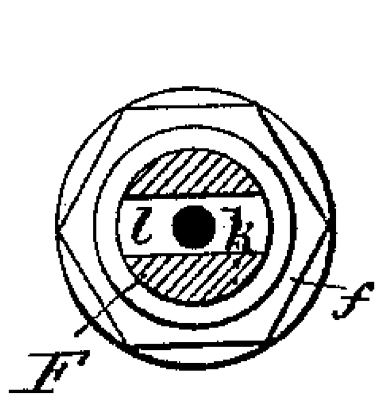


Fig. 7.



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UNITED STATES PATENT OFFICE.

FRANK M. STEVENS, OF CONCORD, N. H., ASSIGNOR OF ONE-HALF OF HIS RIGHT TO JOHN H. PEARSON; SAID PEARSON ASSIGNOR OF ONE-HALF OF HIS RIGHT TO CHARLES C. PEARSON, ALL OF SAME PLACE.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 232,773, dated September 28, 1880.

Application filed March 23, 1880. (No model.)

To all whom it may concern:

Be it known that I, FRANK M. STEVENS, of Concord, in the county of Merrimack and State of New Hampshire, have invented certain Improvements in Steam-Generators, of which the following is a full, clear, and exact description.

My improved generator or boiler may be employed for the economical generation of steam for all purposes; but, as herein shown, it is especially adapted to be employed on locomotives in lieu of the ordinary horizontal tubular boiler.

The improvements relate partly to the construction and arrangement of the fire-box and combustion-chamber, partly in the form and construction of the boiler-shell, and partly in the construction and arrangement of the compound pendent water-tubes and the stay-bolts of the boiler-shell.

In the drawings which serve to illustrate my invention, Figure 1 is a longitudinal vertical mid-section of my improved generator. Fig. 2 is a transverse section of the same, taken in the plane of line *x x* in Fig. 1. Fig. 3 is a plan of the same, the generator-shell being removed from the right-hand end, so as to reveal the interior of the furnace. Fig. 4 is a plan, and Fig. 5 an elevation, of a jet apparatus for introducing steam into the stack. Fig. 6 is a vertical mid-section of one of the compound water-tubes, and Fig. 7 is a transverse section of the same, taken in the plane of the line *y y* in Fig. 6. The last four figures are drawn to a scale double that of the first three figures.

Let A represent the fire-box, which may be provided with a grate, *a*, an ash-pan, *b*, and a fire-door, *c*, in the usual way. B is a combustion-chamber, which opens out of the fire-box and extends forward to the stack or uptake C. The entire inner faces of the fire-box and combustion-chamber are lined with fire-brick *d*, or other equivalent refractory material.

D is the boiler-shell, which is made from boiler-plate, and preferably of two concave flanged halves, joined together at the horizontal median line by means of rivets, as shown. All of the hollow of the shell might be formed in one of the parts and the other part be flat; but for strength, convenience of manufacture, and cheapness I prefer to form half the hollow of the shell in each part, flange the edges, and join them together, as shown. This boiler-shell rests directly upon the walls of the fire-box and combustion-chamber, and the interstices between the fire-brick and the boiler-shell are filled in with fire-clay or other refractory material, as indicated at *e e* in the figures, so as to prevent the air from entering at the joint between them.

The boiler-shell being broad, flat, and thin, it will require to be properly stayed, and I provide for this, in connection with compound water-tubes arranged to depend from the lower or tube sheet of the shell, as will now be described. In Figs. 6 and 7 I have shown the compound tube and stay enlarged.

E is a thin metal tube closed at the bottom and attached at the top to a tubular cast-metal nut, F. This nut is provided with a squared or polygonal portion, *f*, to receive a wrench, a screw-threaded portion, *g*, to screw into the tube-sheet or shell, and an elongated tubular portion to form a nut to receive the stay-bolt *h*, and an inner tube, *i*. The stay-bolt may be threaded throughout its entire length, and be made conical at its top, and when it is screwed down through the crown-sheet of the boiler it engages the bore of the nut, which is internally screw-threaded to receive it.

To make a close joint a washer or gasket, *j*, of copper or some other suitable material, may be inserted under the head of the stay-bolt, if necessary. The inner tube, *i*, screws into the tubular nut at *k*, and the lower end is free and open. An opening, *l*, is made through the nut above the end of the tube *i*, and another, *m*, is made through it below the point *k*. These openings may be of any size or shape, and serve to permit the circulation of water through the tubes.

In putting in my compound tube the parts E F and *h* and *i* are made in separate parts. The tube *i* is inserted and screwed in from below. The outer tube, E, is inserted in its socket and brazed in place. The compound tube is then screwed into the tube-sheet, and the stay-bolt *h* screwed down into the nut and through the crown-sheet until its head rests firmly on the said sheet. By this construction I am enabled to employ the thinnest possible material for the tube E consistent with strength, and the heat imparted to the said tube and the exposed part *f* of the nut F is conducted, by the internal parts of the nut and the stay-bolt *h*, to the water in the boiler.

The arrows in Fig. 6 show the circulating travel of the water. Entering the upper end of the tube *i* through the aperture *l*, the water descends to the bottom of the tube E. There it is heated and rises around the inner tube, passing out at the aperture *m* into the boiler-shell again. By this means a constant circulation is kept up through all the tubes.

Although but few tubes are shown in the drawings, I may, and generally do, employ a large number in practice. In a full-sized boiler for a locomotive more than five hundred tubes will be employed, arranged close together and "staggered," as indicated in Figs. 1 and 2, so that the tubes of one row across the combustion-chamber may cover the spaces between those in the adjacent rows. Thus the flames and heated gases are caused and compelled to impinge forcibly against all of the tubes on their way to the uptake, the said tubes being arranged directly across their path. The close order of the tubes and their peculiar arrangement has a somewhat retarding effect on the gases, and prevents, in a good degree, the escape of any of the uncombined gases to the stack, and insures perfect combustion. The tubes should reach down nearly to the floor *p* of the combustion-chamber.

To insure the most intense heat in the fire-box and combustion-chamber from end to end, I avoid all water-spaces around the same, which serve to lower the temperature of the gases, and line the whole interior surface of the fire-box and combustion-chamber with fire-brick or other similar refractory material, as before stated.

To prevent the passage of the gases from the fire-box to the stack along the sides of the combustion-chamber, where no tubes can well be set, I provide refractory deflectors *o o*, arranged at intervals, and extending from the floor *p* of the chamber up to the shell of the boiler.

G is the steam-pipe leading to the engines. This serves as a steam-drum also, and is mounted on several short hollow legs, *n n*. By thus providing the pipe with more than one inlet from the boiler I prevent priming to a great extent.

The method heretofore usually employed on locomotives for obtaining draft while under way has been to exhaust from the cylinder into the stack. The force of the exhaust-steam is injurious, as it causes nearly all the trouble arising from sparks, and the wear and tear on the interior parts of the stack are very great.

I supply the jet of steam to the stack by means of the following-described mechanism: H is a steam-pipe, which, by preference, taps the boiler-shell at or near the rear end of the boiler, and as low down as possible, so that the valve *q*, which controls it, may be within the reach of the fireman. This pipe H leads forward to the stack, which it taps at *r* in Fig. 1. On the inner end of the pipe, which is arranged in the axis of the stack and is directed upward, is mounted a jet-ring, *s*. This ring is tubular, and is provided with regularly-arranged perforations in its upper face, as shown in Figs. 4 and 5, and it is connected with the pipe H by means of supporting-pipes *t t*. The jet-ring *s* supplies the steam to the stack in equally-distributed jets, and the streams commingle and expand just above the ring, filling the entire area of the stack and producing the proper vacuum by the upward movement. I thus obtain the maximum of effectiveness with the least expenditure of steam, and with the expenditure of very little injurious force upon the stack.

The water is introduced into the generator-shell at *u*, and the blow-off pipe *v* is arranged at the opposite end.

The shell D is secured to the outer casing by means of angle-irons on the casing and corresponding angle-irons secured to the shell. I prefer to employ four, one at each end and one at each side, and to slot the bolt-holes, so as to permit of both lateral and longitudinal expansion and contraction.

Air may be admitted to the fire-box above the grate by means of apertures *w w*, as shown.

As indicated in Fig. 2, the walls of the fire-box and combustion-chamber are widened or extended laterally above the bottom of the said chamber, whereby I am enabled to employ a wider boiler-shell and to get in a greater number of tubes than would be possible if the walls were carried up parallel with the sides of the fire-box. The latter must be narrow enough to drop between the drivers of the locomotive.

To cause the flames and gases to be deflected upward into or among the tubes, I place at the angle formed by the back wall of the fire-box with the floor *p* of the combustion-chamber a deflector, *a'*. This prevents the flames from passing back along the floor of the chamber B. I may or may not extend the tubes down close to the said floor; but I prefer to leave a few inches of space below them, to give room for clearing out soot or ashes that may collect on said floor.

I do not broadly claim a depending water-circulating tube.

I am aware that fire chambers or boxes in steam-generators have been lined with fire-brick opposite the fuel being consumed therein; but in this my invention the entire outer metal casing within which is the combustion-chamber is lined with fire-brick or refractory material.

I am also aware, in upright circular boilers, that tubes have depended from a shell into the combustion-chamber and been irregularly set; but in that class of steam-generators the products of combustion do not have a continuous flow horizontally, or substantially so, or toward one end of the combustion-chamber to one uptake, so as to form a continous current, such as it is herein aimed to interrupt by staggering the tubes, as set forth.

It will be noticed that the generator-shell herein described is made of wrought metal, suitably flanged to be united together and to the metallic outer casing of the combustion-chamber; whereas if said shell were composed of cast metal it could not be adapted for locomotive-engines, because of its great weight, liability to crack from unequal expansion, and lack of strength for steam at high pressure.

Having thus described my invention, I claim—

1. In a steam-generating apparatus, the fire-box A and combustion-chamber B, in combination with the wrought-metal flattened concaved generator-shell D, arranged to cover the combustion-chamber, as shown, and water-tubes connected with the flattened under side of the said shell, substantially as described.

2. The combination, with the shell, of the outer tubes, inner tubes, and tubular nut and the stay-bolts, to operate substantially as described.

3. In a steam-generator, the tubular nut provided with the screw-threaded part to enter the generator-shell, and the openings and water-ways, combined with the thin outer tube, brazed or permanently attached to the said nut, and the inner tube, *i*, attached to the said nut, substantially as shown.

4. The combination of the tubular nut F, provided with openings *l m*, the stay-bolt *h*, secured to the top of the nut, and the tubes E and *i*, all arranged for the purposes set forth.

5. In a steam-generator, the elongated horizontally-placed concaved wrought-metal shell, the combustion-chamber covered by the said shell, the fire-box at one end of the combustion-chamber and shell, and the uptake at the other end of the combustion-chamber and shell, as explained, combined with the pendent water-tubes E, attached to the said shell at its under side between its ends, and arranged in rows across the track of the flames and gases passing horizontally along under the shell to its front end and into the uptake, the tubes in each row being arranged opposite the spaces between the tubes in the adjoining row or rows, so that the body or column of flame and gases flowing to the uptake is broken up to utilize to the highest degree the heat of all parts of the flame and gases directly upon the tubes, substantially as set forth.

6. The combination of the generator-shell D and pendent water-tubes E, constructed and arranged as shown, with the fire-box A, the combustion-chamber B, and the lateral deflectors *o o*, all arranged substantially as set forth.

7. The flattened wrought-metal generator-shell D and the pendent water-tubes connected therewith, substantially as described, combined with the metal casing for the combustion-chamber and the refractory lining for the fire-box and entire casing up to the shell, the fire-box portion of the metal casing being made narrow, as set forth and shown, to rest between the drivers, leaving the upper widened portion of the casing from end to end to receive the tubes, thus increasing the fire-surface, substantially as described.

8. The combination of the rectangular casing of the furnace, lined with fire-brick or tiles, with the rectangular flattened shell D, having a peripheral median flange arranged to rest upon the said casing, and the interposed refractory material *e*, substantially as and for the purpose set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

FRANK M. STEVENS.

Witnesses:
HENRY CONNETT,
ARTHUR C. FRASER.