3 Sheets—Sheet 1.

A. D. BROCK.

Water-Tube Steam-Generator.

No. 199,782. Patented Jan. 29, 1878.

Fig: 1

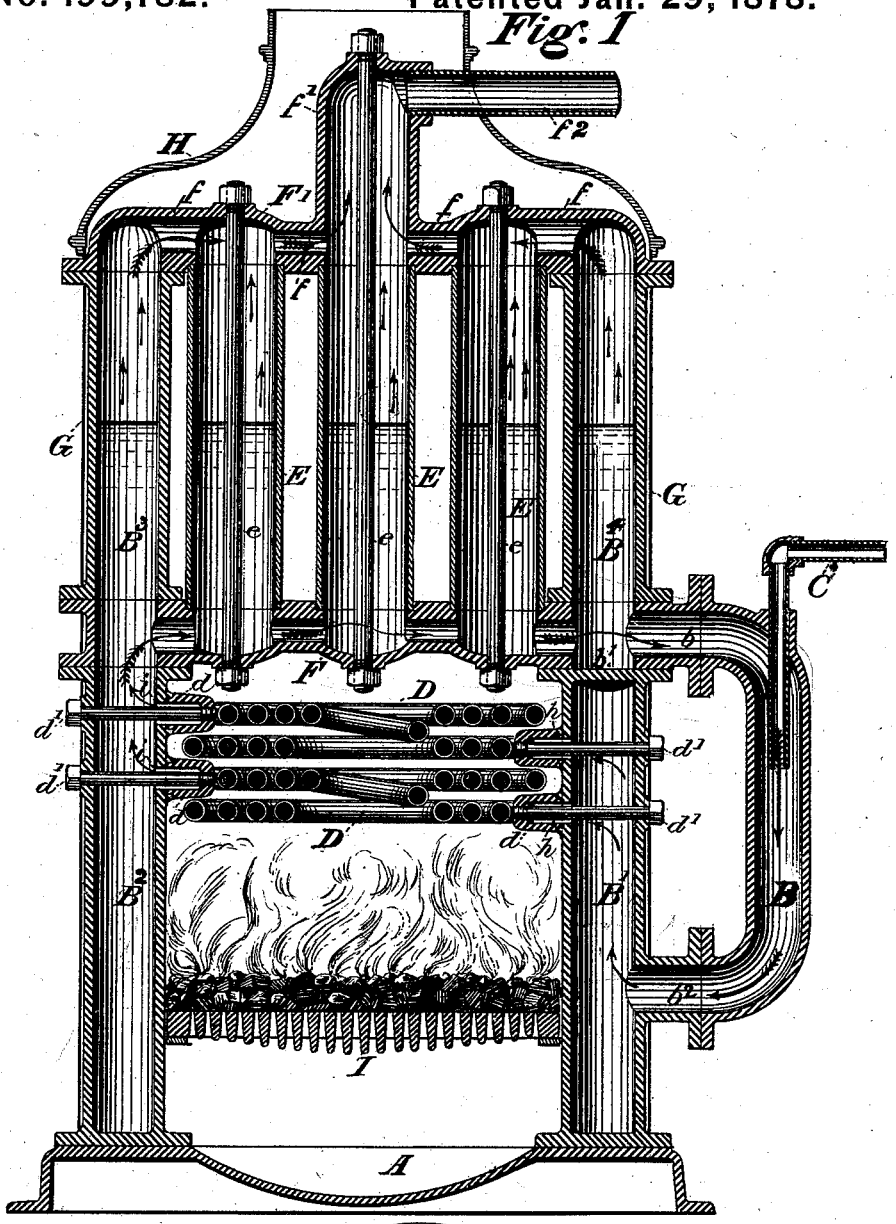
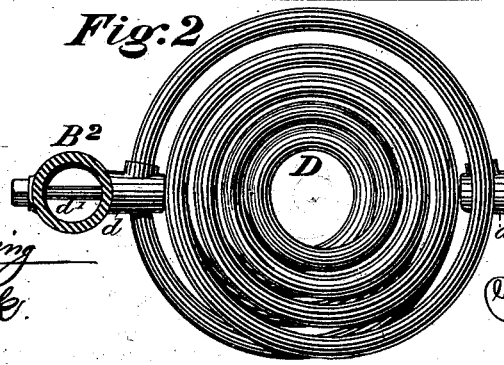


Fig: 2



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3 Sheets—Sheet 2.

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Water-Tube Steam-Generator.

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Fig. 3

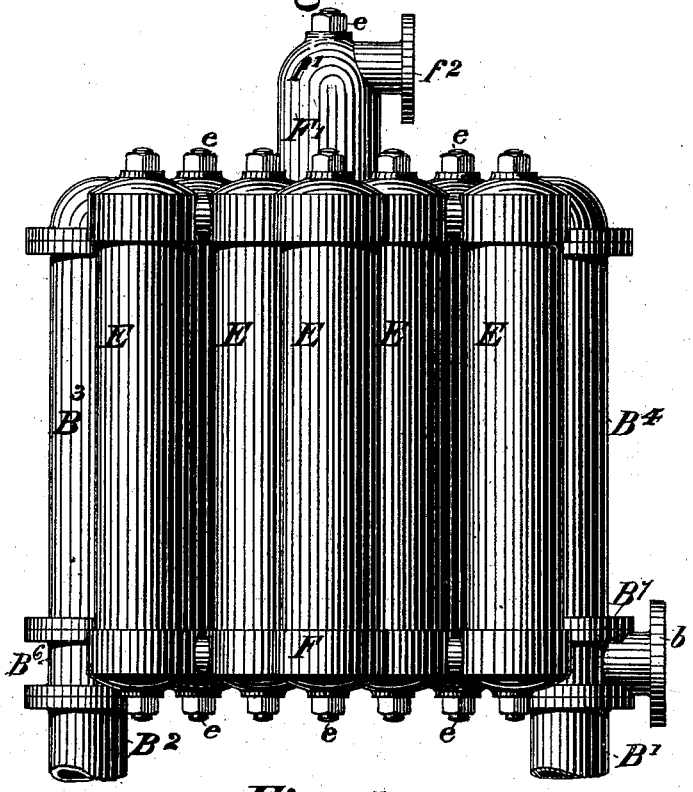
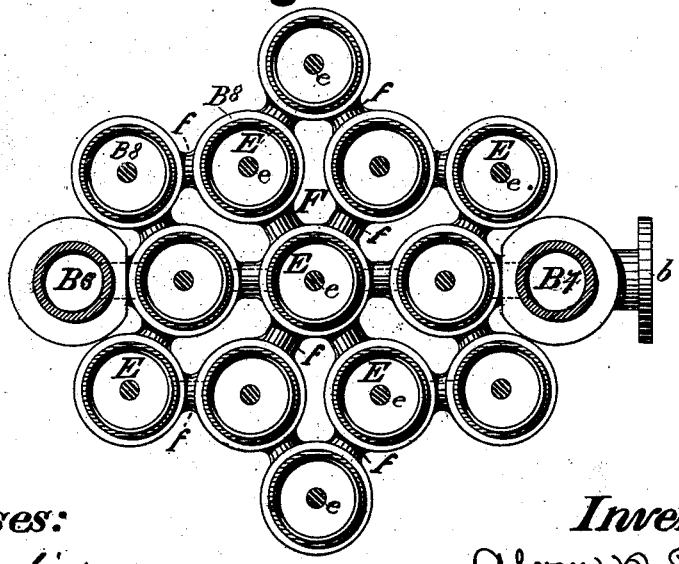


Fig. 4



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3 Sheets—Sheet 3.

A. D. BROCK.

Water-Tube Steam-Generator.

No. 199,782. Patented Jan. 29, 1878.

Fig: 5

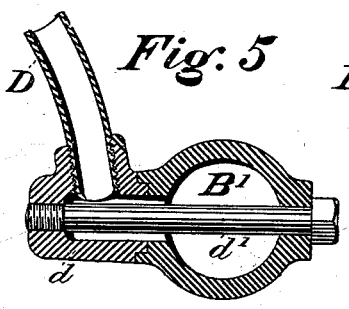


Fig: 6

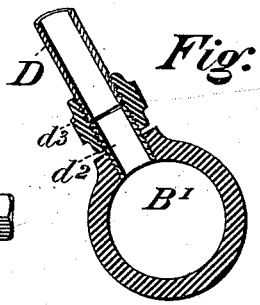


Fig: 7

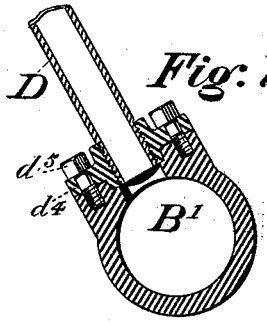


Fig: 8

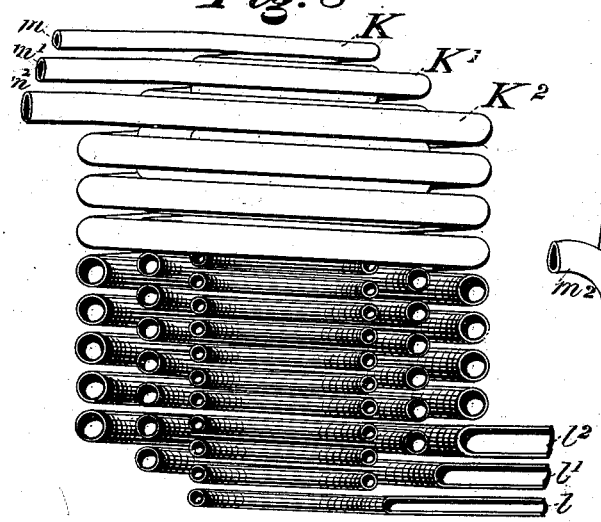


Fig: 9

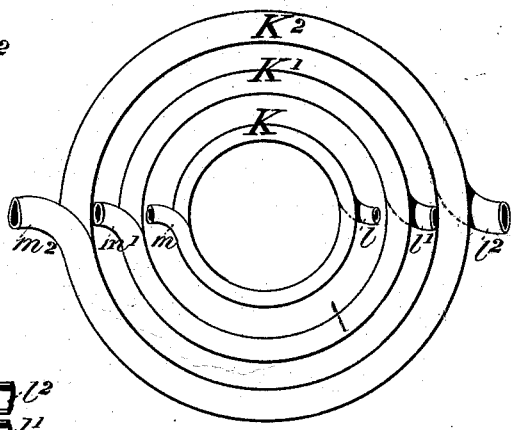
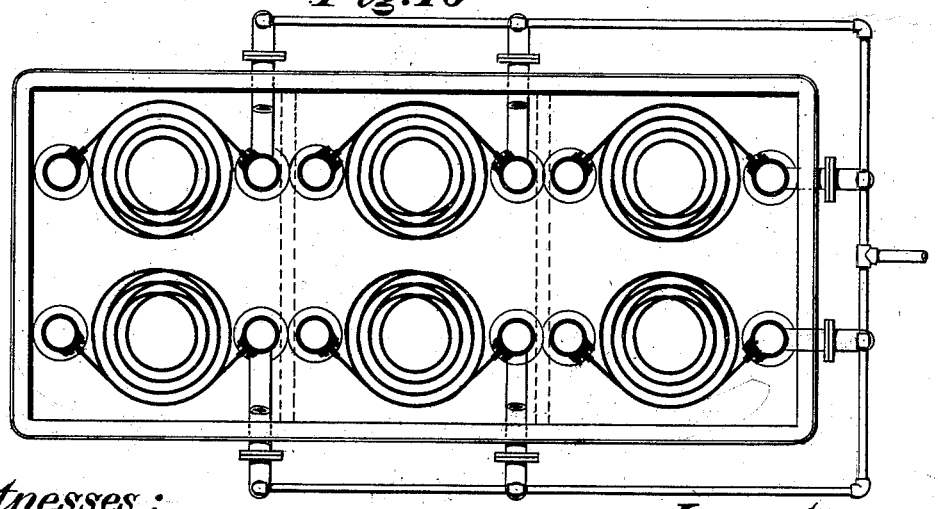


Fig: 10



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UNITED STATES PATENT OFFICE.

ALVAN D. BROCK, OF GRANTVILLE, MASSACHUSETTS.

IMPROVEMENT IN WATER-TUBE STEAM-GENERATORS.

Specification forming part of Letters Patent No. **199,782**, dated January 29, 1878; application filed October 6, 1877.

To all whom it may concern:

Be it known that I, ALVAN D. BROCK, of Grantville, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Steam-Generators; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

My invention relates to that class of steam-generators generally known as "tubular boilers," more particularly to that description of tubular boilers or generators in which the natural circulation of the water promoted by caloric is designed to be taken advantage of for the more rapid generation of steam, by causing it to pass through coils of pipes in direct contact with the products of combustion in the furnace or fire-box.

It is well known that the heating of water, and consequent generation of steam, is effected with much greater rapidity when the water is passed through pipes or tubes in direct contact with the flame or products of combustion than if the heat is merely applied to the surface of a vessel or boiler containing a large body of water, as in an ordinary steam-boiler; and when it is merely desired to heat the water, and thereby cause it to circulate through the pipes, as in the ordinary hot-water system for heating buildings, &c., the coils may be passed through the combustion-chamber and used with good effect; but when the object is to generate steam quickly and at a high pressure with intense heat, it has heretofore been found that the water could not be kept in the coils or made to circulate fast enough through them, and consequently the water in the coils of tubular pipe, instead of merely becoming heated, was converted into steam, which, in its efforts to escape, blew out of the pipes, and prevented the ingress of the water. As a consequence the tubes became empty, or partially empty, of water, and burned or melted through the intense heat of the furnace.

My invention obviates this difficulty, and insures a constant and rapid circulation of the water through the tubes, so that the coils in immediate contact with the products of combustion are always kept full of water.

My invention, by means of which this result is accomplished, consists, primarily, of a new arrangement and construction of the circulating-pipes, connecting with the heating-coils, located in the fire-box or combustion-chamber.

It also consists in a new construction and arrangement of the vertical tubes, in which the steam is generated and superheated, all as hereinafter more fully set forth.

In the accompanying drawings, Figure 1 is a central vertical section of a steam-generator, illustrating my invention.

A is the bed-plate. B is the circulating-pipe connecting the reservoir-tubes with the inner circulation column or pipe. The columns or pipes B^1 B^2 are firmly secured upon the bed-plate, so that B^1 is the inner inlet-pipe to, and B^2 the inner exit-pipe from, the coils. The pipe B^3 is a continuation of B^2, and forms the upper circulating-pipe. It is bolted to a flange on the upper side of the hollow or chambered tube-head F, which is inserted between the pipes B^2 and B^3. The circulating-pipe B^4 is secured in like manner to the tube-head F, and communicates therewith, but not with the pipe B^1, as communication is prevented by the partition or diaphragm b^1 at the upper end of the circulating-pipe B^1, for a purpose which will presently be described.

D D are double spiral flat coils of pipe, only two of which are shown, for convenience; but any number may be used, according to the capacity of generator desired. These coils are secured to the circulation-tubes B^1 and B^2 by fittings or elbows *d d* and bolts *d' d'*, their opposite ends having free communication with the circulation-columns B^1 and B^2. A series of vertical tubes, E E, are secured between the tube-heads F F′ by means of bolts *e e*. Each of these tube-heads consists of a series of sockets for the reception of the vertical tubes, said sockets being united by connecting-pipes *f f*, for the purpose of establishing a free circulation of the water and the proper communication of the steam within the tubes. An increase of steam-space is provided above the center tube by an elongated cape, *f'*, attached to the top tube-head F′, so

that superheated and dry steam may be obtained through the steam-outlet f^2.

The circulating-pipe B communicates at one end with the lower tube-head F through the opening *b*, while the lower end of the said pipe is attached to and communicates with the inlet-circulation column B^1 by means of the lower nozzle b^2. A water-feed pipe, C, is inserted in the top of the circulating-pipe B, and is preferably extended some distance downward within the same. The generator is inclosed within a casing, G, provided with proper fire and ash doors, and extending from the bed-plate to the top of the vertical tubes, above which is placed a hood or uptake, H, to which the chimney is connected. The grate I is placed at a suitable distance below the lowest of the coils D.

The casing G may be lined with a non-conducting material, to prevent the escape of heat, or be provided with an internal jacket, inclosing a dead-air space, (or both these expedients may be employed,) and is preferably divided vertically into two sections, hinged or bolted together, so that one or both may be readily removed to admit of access to the several parts. I also provide a door in the casing, so placed as to give access to the coils for renewal, repair, or cleansing.

Fig. 2 is a plan view of the coil. B^1 is a section of the inner inlet-circulation column; B^2, the inner exit-circulation column; *d*, the quarter-turn or elbow connecting the coils to the two circulation-columns, and *d'* the bolts by which the coils are secured firmly in their places steam and water tight.

Fig. 3 is a side view, in elevation, of the steam and water reservoir.

Fig. 4 is a sectional plan view of the lower tube-head, which, with slight modifications, serves also for the upper tube-head F'. B^6 B^7 are short flanged pipes for the reception and continuation of the circulation-columns, and B^8 the sockets for the reception of the vertical tubes E. *e* is a section of the bolt which secures the tube-heads and vertical tubes together.

Fig. 5 is a horizontal section of one form of a fitting, showing a section of the coil D attached to the circulation-column B^1. *d* is the quarter-turn or elbow, and *d'* is the bolt by which the coil is united to the circulation-columns, said bolt being, in this instance, tapped into the inner end of the quarter-turn, and having a head on its outer end.

Fig. 6 is a modification of Fig. 5, showing the coil united to the circulation-column by a union-coupling instead of a bolt.

Fig. 7 is another modification of Fig. 5, showing the coil united to the column by a flange and two bolts.

Fig. 8 is a view, partly in section, of another form of coil, and the method which I have devised for the connection of a series of them to the circulation-columns. The figure shows a nest of coils, the inner one, K, being of comparatively small internal diameter, for convenience of bending within a small circle, its length and amount of heating-surface being proportioned to the quantity of water which it will deliver to the reservoir above without conversion into steam. The next contiguous coil, K^1, is placed around it, its inner diameter being about one-half inch larger than the external diameter of the preceding coil, so as to afford space for the ascent between them of the products of combustion. The third coil, K^2, is necessarily longer than the first and second of the series, and has a larger internal diameter or orifice. The series may thus be carried on in proper proportions to any size or capacity desired.

Each coil may be connected to a common horizontal pipe across the center of the series, at top and bottom by means of either of the devices shown in Figs. 5, 6, and 7, and these horizontal pipes, in their turn, connected to the circulation-columns by means of the ordinary screw-joint, if desired, though I prefer to make the joint as shown in Figs. 2 and 5.

This arrangement of coils possesses some obvious advantages over that shown in Fig. 1, and is simple, compact, and effective to a remarkable degree.

Fig. 9 is a plan or top view of the arrangement shown in Fig. 8.

Fig. 10 is a diagram of a nest or battery of my generators, for marine or other purposes, where greater steaming capacity is desired than would be convenient in one generator. By combining them in this or some equivalent form, it is obvious that they may be adapted to any purpose for which large quantities of steam are required, and to almost any situation or location.

The operation of my generator is as follows: The generator being filled to the water-line and fire being kindled, the water in the coils D D is heated. Its gravity being thereby reduced, it rises, flows out of the coils at *i i* into the circulating-column B^2, and up into the reservoir-tubes E E, following the course of the large arrows. A tendency to form a vacuum being thus created, the colder water flows in from tube B, through B^1, to the coils D, and as the temperature is gradually increased the circulation is established, and accelerated as the temperature increases. The feed-water necessary to supply the loss of water which escapes as steam is taken in at C, and assists the circulation, both by its momentum and superior gravity. This circulation would be maintained, under ordinary circumstances, if there were free communication between circulating-columns B^1 and B^4, because, as will be observed, the inlet-orifices *h h* of the coils D D are below the outlet-orifices *i i;* but as it is desirable in most cases to produce an intense fire by a strong draft, there would be considerable danger of the water being forced out of the coils D D at both inlet and outlet orifices, by steam generated in the coils escaping into the reservoir-tubes by columns B^1 and B^4, as well as by columns B^2 and B^3, in

which case the coils would become overheated and speedily be destroyed; but by the stoppage of communication between B^1 and B^4, by means of the diaphragm b^1, the water is forced in the direction of B^2 and B^3, and the excess of heat is thus imparted to the water as it is forced through the coils.

I have found that with coils of proper length and internal diameter a blast of steam of three hundred pounds per square inch, the jet-orifice of which is one-half inch internal diameter, may be used to urge the fire without the slightest danger to the integrity of the coils. With coils one and one-fourth inch internal diameter and thirty feet in length, I have succeeded in twice melting down seven square feet of grate-surface, while the coils in immediate contact with the intense flame have not been injured in the slightest degree.

The double spiral coil of pipe is not only adapted for use in the generator hereinbefore described, but for generating steam in other structures, or for condensing it, for heating feed-water for boilers, and for heat-radiating purposes. The advantages of my double or right-and-left coil are economy of space, and the provision of a large amount of heating, condensing, generating, or radiating surface.

Referring to Figs. 1 and 2, it will be seen that the pipe is coiled spirally in two directions—at top from right to left, and at bottom from left to right, or vice versa—and that its ends are in different horizontal planes, which last-stated fact, as hereinbefore shown, is of special advantage in a generator constructed as before described. It might also be coiled conically inward and outward toward and from a central point, with lead in one direction, and thus likewise provide a double coil.

The advantages or new results accomplished by my improved generator may be stated as follows:

First, the steam is created and made available at pressures very much exceeding those in general use for stationary, locomotive, or marine engine propulsion, or in the arts or manufactures, and with safety from dangerous explosions.

Second, a remarkable increase in the amount of the heating-surface of the water-tubes exposed to the action of the products of combustion is obtained, as compared with other boilers, and at the same time the weight and bulk are reduced in a proportionate degree.

Third, the disposal and arrangement of the heating-surfaces are such as to secure the greatest possible effectiveness in the products of combustion, while at the same time the construction and arrangement of the coils are such that great economy of labor and material is obtained.

Fourth, a constant, effective, and natural circulation of water through the tubes is insured, whereby danger of overheating is avoided, and the formation of scale or sediment on the inside surfaces is measurably, if not wholly, prevented. Each series of coils has an independent connection with the general circulatory system, and, if desired, each coil can be readily detached or replaced without disturbing the other members of the series.

Fifth, the steam and water reservoir of the boiler is made in sections, so that each section may be of comparatively small diameter, and yet be so combined and connected each with the others that the water and steam may freely circulate through all of them, allowing the water to stand at the same level in them all, while at the same time contributing materially to the steam-producing capacity, and enabling the reservoir to resist great pressure, (the latter depending, of course, upon the diameter of sections;) and in the event of a rupture in any one of the sections of the coils or of the reservoir, the strain upon the remaining members will be gradually and safely relieved.

Sixth, by reducing the size and weight of the sections of water-tubes and of the reservoir, very large generators may be transported in separate sections; and the parts of the boilers being interchangeable and made to a certain determined scale, any number of parts likely to be required under ordinary circumstances may be kept in stock for emergencies.

Seventh, the size of a generator may be readily increased within certain limits by increasing its height, which would only involve the substitution of extra patterns for the castings of the circulating-tubes, the lengthening of the reservoir-tubes, and the bolts for securing to them the tube-heads, a correspondingly-lengthened jacket or casing for the complete generator, and an additional number of coils. For example, a one-half H. P. generator with three coils could be increased to one H. P. by the addition of three coils, and a corresponding increase in the length of the reservoir-tubes from seven inches to ten or twelve inches. The two H. P. generator, also, could be thus increased to four H. P., the five H. P. to ten, and the ten H. P., to twenty, and so on.

Eighth, the destruction of the joints by the contraction and expansion resulting from changes of temperature is obviated.

Both forms of coils hereinbefore described and shown by me are, in effect, spiral springs, and all vibration or contraction and expansion is taken up without undue strain upon the joints by which they are fastened to the circulating-columns.

The above invention was patented in England, and in my name, in 1876, No. 3,091.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination, in a steam-generator, of two vertical circulation-tubes, a series of spiral coils of pipe, each connected at its ends to the circulation-tubes, a transverse diaphragm placed in one of the circulation-tubes above the level of the coils, a steam and water reservoir communicating with the circulation-tubes above the level of the diaphragm, and a pipe which communicates at top with

the reservoir, and at bottom with one of the circulation-tubes at a point below the diaphragm therein, substantially as and for the purpose specified.

2. The combination, in a steam-generator, of one or more spiral coils of pipe connected to two vertical circulation-tubes, one of which is provided with a transverse diaphragm located above the level of the coils, a steam and water reservoir communicating with the circulation-tubes, and an inclosing casing, substantially as and for the purpose specified.

3. The combination, in a steam-generator, of two vertical circulation-tubes, a transverse diaphragm placed in one of the circulation-tubes, a steam and water reservoir connected with the circulation-tubes, and a pipe communicating at top of said reservoir, and at bottom with one of the circulation-tubes at a point below the diaphragm therein, substantially as and for the purpose specified.

4. The combination, in a steam-generator, of a steam and water reservoir communicating with two vertical circulation-tubes, a diaphragm placed in one of said circulation-tubes below the level of said reservoir, a pipe communicating at top with said reservoir, and at bottom with the circulation-tube containing the diaphragm at a point below the level of the diaphragm, and a feed-water pipe delivering to said communicating pipe, or to the circulation-tube to which it is connected, substantially as and for the purpose specified.

5. The combination, in a steam-generator, of two vertical circulation-tubes provided with a transverse diaphragm, and one or more coils of pipe, connected at each of their ends to the circulation-tubes, substantially as and for the purpose specified.

6. The combination, in a steam-generator, of two vertical circulation-tubes provided with a transverse diaphragm, and connected by coils of pipe, and a superposed or elevated steam and water reservoir, substantially as and for the purpose specified.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

ALVAN D. BROCK.

Witnesses:

ALBERT JENNINGS,

HENRY D. WINTON.