3 Sheets—Sheet 1.

J. EVERDING.

Steam-Generator.

No. 213,556. Patented Mar. 25, 1879.

Fig. 1

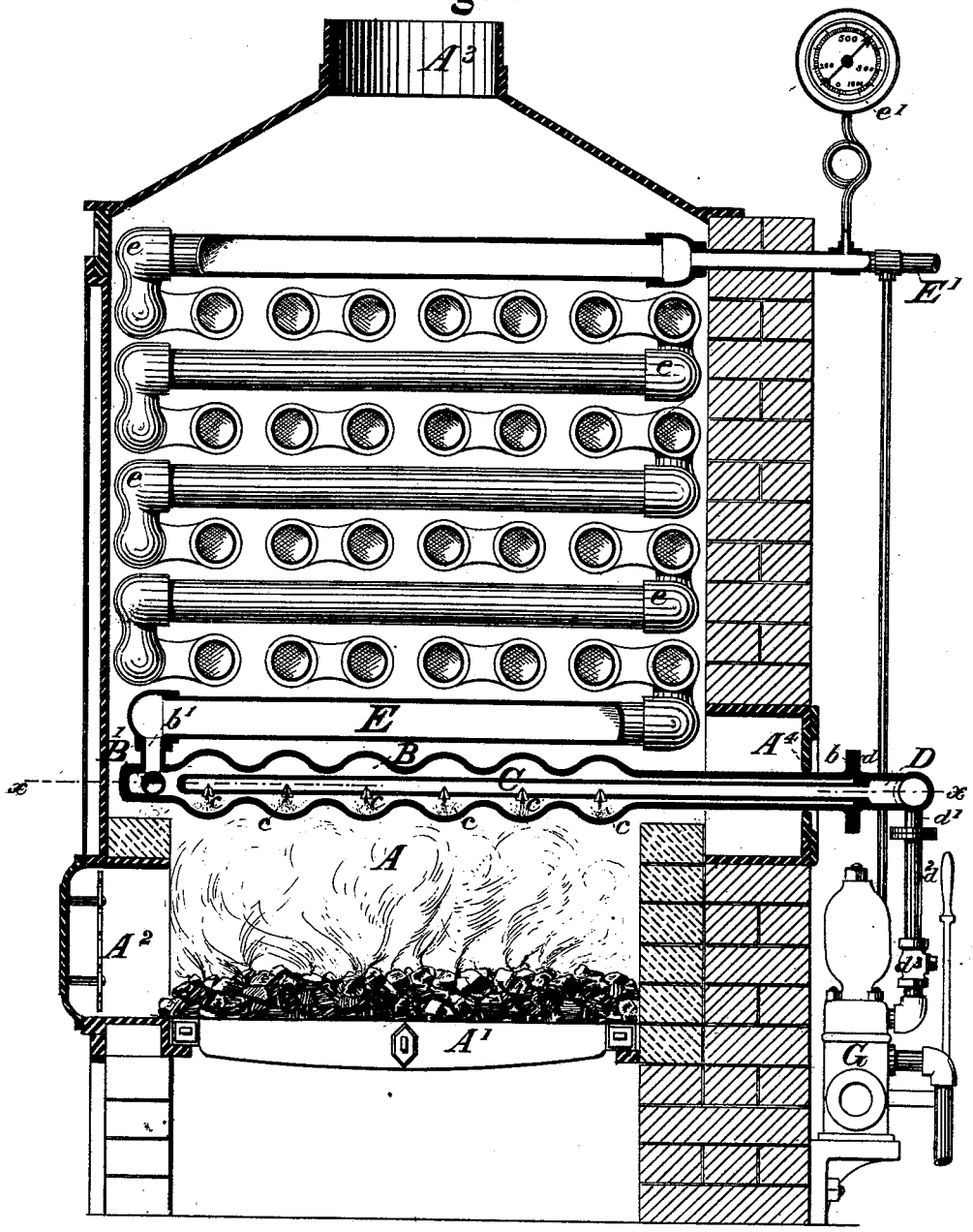

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Fig. 2

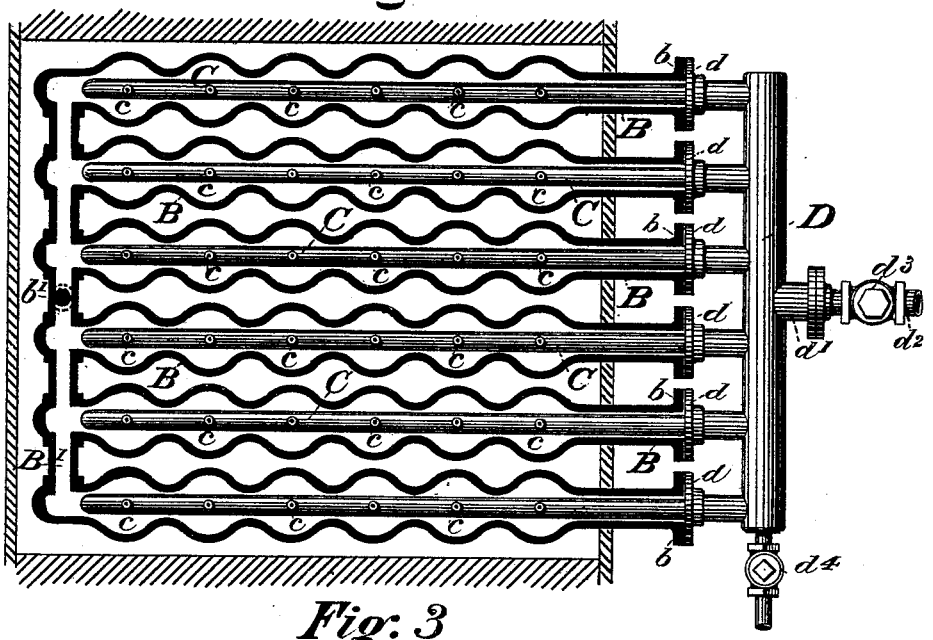
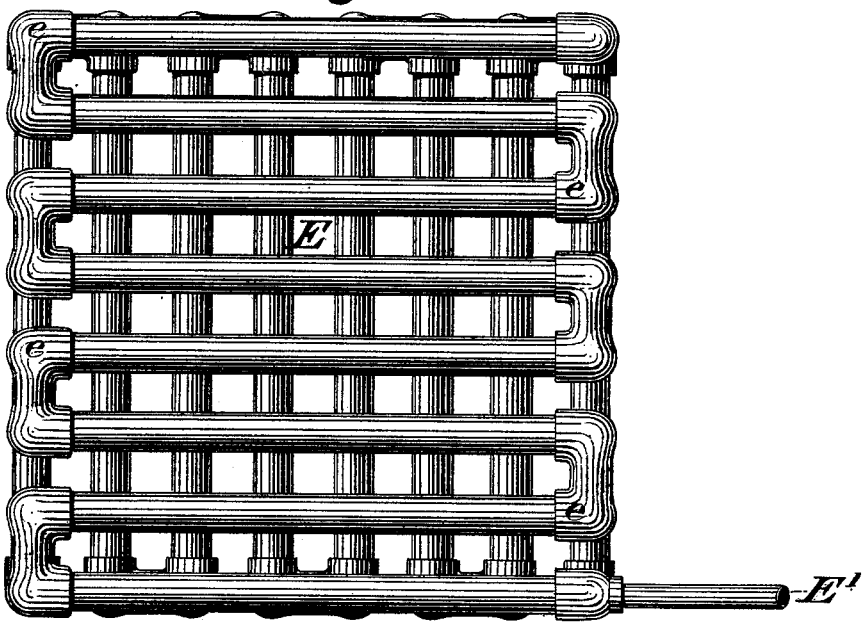


Fig. 3



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3 Sheets—Sheet 3.

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Fig: 4

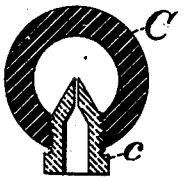


Fig: 5

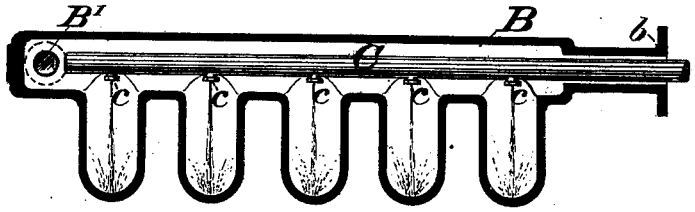


Fig: 6

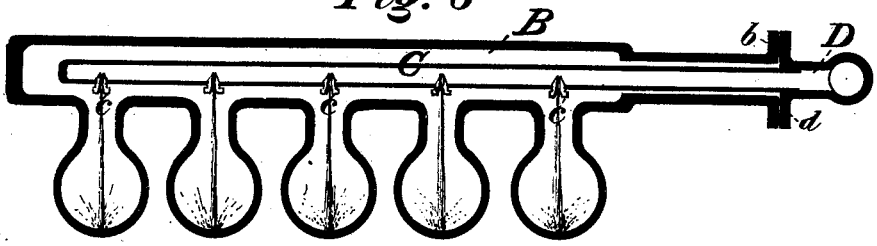


Fig: 7

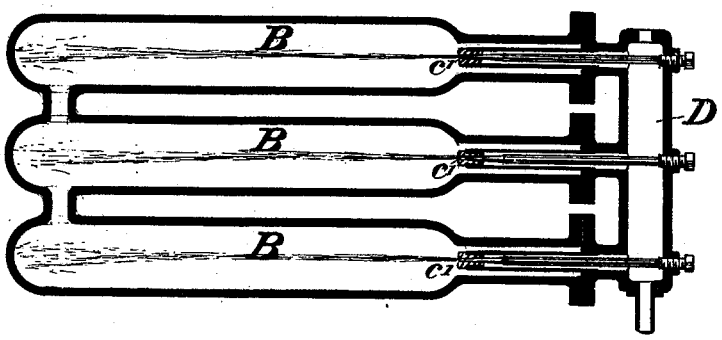
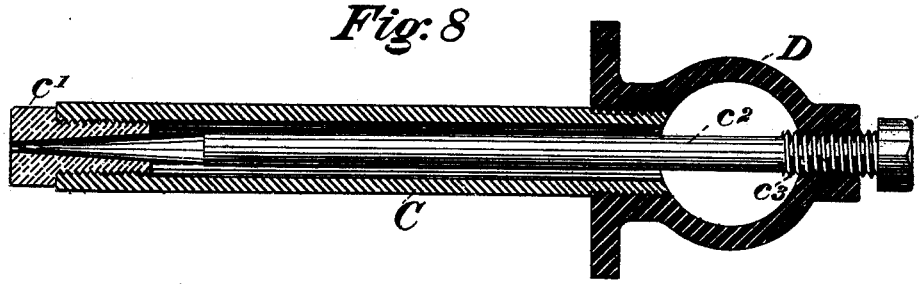


Fig: 8



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UNITED STATES PATENT OFFICE.

JOHN EVERDING, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF HIS RIGHT TO ABRAHAM S. JENKS, OF SAME PLACE.

IMPROVEMENT IN STEAM-GENERATORS.

Specification forming part of Letters Patent No. **213,556**, dated March 25, 1879; application filed September 11, 1878.

To all whom it may concern:

Be it known that I, JOHN EVERDING, of the city and county of Philadelphia, in the State of Pennsylvania, have invented certain new and useful Improvements in Steam-Generators, of which Improvements the following is a specification:

My invention relates to the class of steam-generators technically termed "instantaneous" or "injection," the distinguishing feature of which type is that they contain no appreciable quantity of unvaporized water, the feed-water being supplied in such relation to the requirements of steam-generation as to be, instantly upon its entrance into the generator, converted into steam of high expansive force and of a temperature greatly in excess of that due to saturated steam.

The object of my invention is to provide an instantaneous steam-generator, of simple, compact, and durable form, which shall be exempt from danger of explosion, and be reliable in its action and capable of easy operation and control, and which will, further, both enable a material reduction of the dimensions of a structure required to furnish a given amount of power to be made, and effect, when in service, a substantial economy in consumption of fuel as compared with steam-boilers of the ordinary description.

To these ends my improvements consist in the combination of a furnace, a series of generating-chambers placed therein above the surface of the grate, and a series of injection-nozzles of special construction, each fitted to a supply-pipe within one of the generating-chambers, and having a discharge-area in direct proportion to the heating-surface of said chamber.

My improvements further consist in the combination, with the generating-chambers and their injection-nozzles, of a coiled pipe steam receiver or reservoir having a volume equal to or greater than that of the engine-cylinder.

My improvements further consist in the combination, with an instantaneous generator, as above described, of a double-acting force-pump, by which a continuous supply of water is forced through the nozzles into the heated vessels to maintain a uniform temperature therein and prevent an accumulation of back-pressure or the overheating of the vessels through neglect, all as hereinafter more fully set forth.

In the accompanying drawings, Figure 1 is a vertical section through a generator embodying my improvements; Fig. 2, a horizontal section through the same at the line $x\,x$ of Fig. 1; Fig. 3, a plan or top view of the steam-receiver; Fig. 4, a central section on an enlarged scale through one of the injection-nozzles; Figs. 5, 6, and 7, sectional views, respectively, showing different forms of generating-vessels; and Fig. 8, a section, on an enlarged scale, showing a device for varying the area of the injection-nozzle when desired.

The furnace A of the generator may be formed of brick, or of cast or wrought iron, lined with fire-brick, and cased with a suitable non-conducting covering, and is provided with a suitable grate, A^1, fire-door A^2, and exit flue or chimney A^3. A series of generating-vessels, B, are arranged in a horizontal plane within the furnace at a sufficient height above the grate to admit of the proper combustion of the fuel placed thereon.

The generating-vessels are steel castings, and are, by preference, made in the form shown in Figs. 1 and 2—to wit, that of hollow spherical chambers, connected together in groups or sections by short narrow necks; but other forms may be adopted, if preferred—as, for example, the chambers may depend from an upper tubular connection, as shown in Figs. 5 and 6, or each chamber may be a horizontal cylinder of small diameter, as shown in Fig. 7.

The dimensions of the generating-chambers may be varied, as desired; but, for obvious reasons, large diameters are impracticable, and I prefer to make them no greater than such as, with a thickness of one-half an inch of metal, will admit of the chambers sustaining a bursting-pressure of at least four times the ordinary working-pressure, which working-pressure cannot with advantage be made to exceed one thousand pounds to the square inch. A chamber of six inches internal diameter and one-half an inch thick would safely sustain such working-pressure if composed of

metal having a tensile strength of twenty-four thousand pounds to the square inch, and the steel castings which I employ have a tensile strength of from thirty thousand to forty thousand pounds, and are tested by hydraulic pressure to four thousand pounds. A removable plate or door, A^4, in the side of the furnace admits of the insertion and removal of the vessels as required. Each of the generating-vessels is provided with an internal water-supply pipe, C, closed at its inner end, and having an outlet in line with the center of each of the several chambers of which it is composed. An injection-nozzle, *c*, is fitted to each of the outlets of the supply-pipes, said nozzle being a short hollow cylinder, formed of nickel, German silver, or other metal suitable to withstand the action of heat, and not liable to corrosion, and having a conical end projecting into the supply-pipe, and perforated with an opening of smaller diameter than that in the body of the nozzle, as shown in Fig. 4.

The object of this construction is to prevent the entrance of foreign matters into the nozzles from the supply-pipes, and to avoid the clogging of the nozzles in the use of salt or saline matter.

The smaller diameter of the bore of the nozzle must bear such a ratio to the area of heating-surface in the generating-chamber which said nozzle supplies as to admit of the introduction of such a quantity of water in the ordinary working of the apparatus, and no more, as will be immediately vaporized by contact with the heated walls of the chamber; and while, for the reason that this ratio will necessarily vary under different circumstances, and must, to a certain extent, be left to the judgment of the constructer, it is impracticable to lay down a rule for its accurate ascertainment in every case, I indicate, as a guide, that I have found by experiment that the inlet or smaller diameter of a nozzle suitable for a generating-chamber of six inches internal diameter and one-half inch thick should be about one-sixteenth of an inch.

The water-supply pipes C are connected at their outer ends to necks upon a common pipe or manifold, D, said necks having flanges *d*, to which corresponding flanges *b* on the outer ends of the generating-vessels B are bolted, forming permanent joints to close the ends of the generating-vessels, as best seen in Fig. 6.

An induction-nozzle, d^1, on the manifold D is connected by a feed-pipe, d^2, having a check-valve, d^3, with a double-acting force-pump, G, which may be operated either by steam or by hand, as circumstances may require. A blow-off cock, d^4, is secured to one end of the manifold D to admit of the removal of sediment or deposit, and to carry off the surplus water when a circulation is maintained through the generating-chambers for the purpose of cooling the same during stoppages of the engine.

The several series or groups of generating-chambers are connected at their ends farthest from the manifold D by short pipes B′, and by a vertical connection, *b*′, with a steam reservoir or receiver, E, having a capacity equal to or greater than that of the volume of the engine-cylinder, and formed of a coil of heavy pipe, preferably as shown in Figs. 1 and 3, from the top of which a steam-supply pipe, E′, having a pressure-gage, *c*′, leads to the engine. The coil E may be made in various forms, and be set either horizontally, as shown, or vertically; and, if desired, the fittings *e*, connecting the several pipes, may be dispensed with, and a single bent or curved pipe be substituted; but I consider the arrangement shown as more desirable and practicable.

Fig. 7 shows a series of generating-vessels, each of which is a single chamber of cylindrical form, provided with an adjustable nozzle, c^1, the construction of which will more clearly appear by reference to Fig. 8. The nozzle c^1 is screwed into the end of the water-supply pipe C, and has a conical central opening, the larger diameter of which is toward the inside of the pipe. An adjusting-stem, c^2, having a conical end corresponding with the bore of the nozzle and projecting thereinto, is arranged within the water-supply C, and has a screw-thread, c^3, upon its outer end, which passes through the manifold D and engages a corresponding female thread therein. The stem c^2 may be rotated, and thereby adjusted longitudinally in the pipe C, so as to increase or diminish the area of the annular opening between its conical end and the bore of the injection-nozzle, as may be required, to afford a greater or less supply of water to the generating-chamber.

In the operation of the generator, fire being made upon the grate, and the generating-vessels being heated thereby to a proper degree, water is forced through the injection-nozzles by the feed-pump, which can be operated by hand until the pressure is sufficiently great to permit the use of steam, when the process becomes automatic, the working of the pump being regulated to afford the proper supply of steam required for the operation of the engine. The injected water will be instantaneously converted into steam of exceptionally high pressure, and the degree of dryness of the same may be regulated, as required, by the quantity of water injected, so that no difficulty need be encountered in lubricating the cylinder of the engine operated by the generator.

In order to prevent overheating of the apparatus and accumulation of pressure during the stoppage of the engine, the force-pump is kept continuously working at a slow speed, regulated by the indications of the pressure-gage, and the surplus water is allowed to escape through the blow-off cock.

I am aware that numerous devices for the instantaneous generation of steam by the injection or spraying of water into heated vessels have been proposed and made the subject of Letters Patent both in the United States and in foreign countries; and I do not therefore broadly claim a series of generating-vessels

heated in a furnace and provided with water-injection pipes. So far, however, as my knowledge and information extend, none of said generators have been sufficiently successful in practice to warrant their continued use, and I limit my claims herein to the specific devices and combinations which, from my experimental researches with a generator embodying the same, are in my judgment practically useful and beneficial.

I claim as my invention and desire to secure by Letters Patent—

1. The combination, in an instantaneous steam-generator, of a furnace, a series of generating-chambers located in and heated by said furnace, and a series of water-injection nozzles, each fitted to a separate supply-pipe within one of the generating-chambers, arranged substantially as set forth.

2. The combination, in an instantaneous steam-generator, of a furnace, a series of generating-chambers, each provided with an injection-nozzle, and a coiled pipe steam receiver or reservoir, substantially as set forth.

3. The combination, with an instantaneous steam-generator, substantially as described, of a double-acting force-pump and a blow-off cock, to maintain a continuous supply of water to the generating-vessels and prevent overheating and excess of pressure during the stoppage of the engine, substantially as set forth.

4. The combination, in an instantaneous steam-generator, of a water-supply pipe and an injection-nozzle having a hollow cylindrical body fitted with an external screw-thread to engage a corresponding thread in the supply-pipe, and a conical end projecting into said pipe, and having an opening of less diameter than that of the body of the nozzle, substantially as set forth.

5. The combination, in an instantaneous steam-generator, of a water-supply pipe, an injection-nozzle, and a device for varying the discharge-opening of said nozzle, substantially as set forth.

6. The combination of the feed-pipe, the manifold, the water-supply pipes, and a series of generating-vessels, arranged substantially as set forth.

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Witnesses:

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GEO. A. VAILLANT.