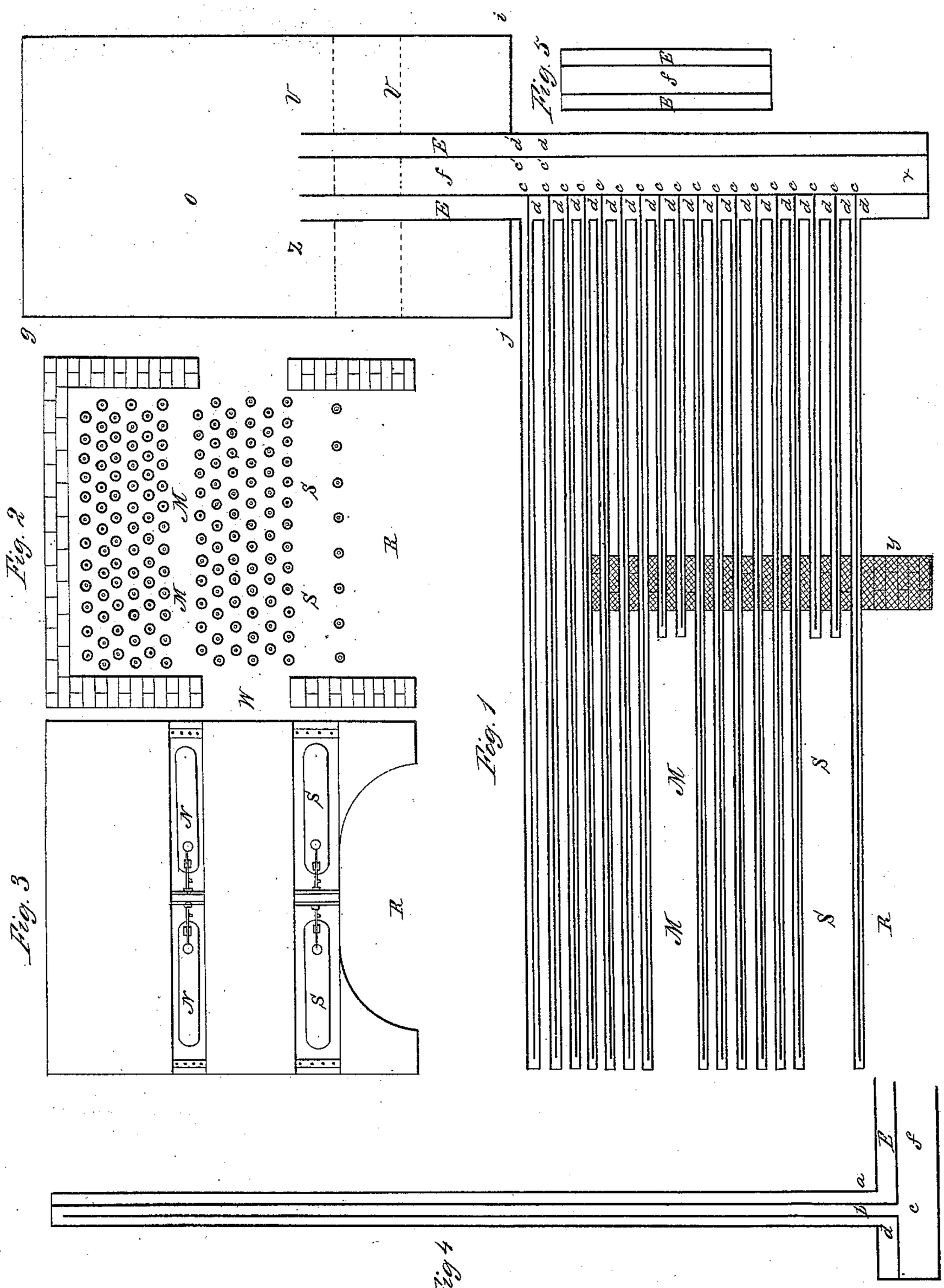
E. Thayer,

Steam-Boiler Furnace,

No. 61,031. Patented Jan. 8. 1867.



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ELI THAYER, OF NEW YORK, N. Y.

Letters Patent No. 61,031, *dated January* 8, 1867.

IMPROVEMENT IN STEAM GENERATORS.

The Schedule referred to in these Letters Patent and making part of the same.

TO ALL WHOM IT MAY CONCERN:

Be it known that I, ELI THAYER, of the city, county, and State of New York, have invented a new and improved Mode of Generating Steam; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The nature of my invention consists in so constructing and arranging the different parts of a steam generator, that, while the fire surface may be very great and exposed to the highest possble heat, there shall be a constant and rapid circulation of water and steam over every part of it, preventing the injurious heating of the metal of the generator, and the formation or adhesion of steam globules upon its inner surface. This mode of construction (as will be shown hereafter) will also secure cheapness, simplicity, and compactness of form, with the greatest possible safety, efficiency, and economy in use.

To enable others skilled in the art to make and use my invention, I proceed to give a description of its construction and mode of operation.

Figure 1 represents a longitudinal vertical section.

Figure 2 represents a transverse vertical section in front of the bridge wall and through the furnace.

Figure 3 represents the furnace front.

Figure 4 represents a single tube of the generator on a larger scale than shown in the other figures, for the purpose of exhibiting more clearly its construction and connection with the supply and discharge-chambers of the boiler. As these tubes are all constructed and attached in the same way, and differ only in length and size, a description of one will be a description of all.

In this figure, *a* represents a pipe or tube of metal, one and a half inches internal diameter, one end of which is closed by being welded together, filled with a plug, or covered by a cap. The other end is open and securely screwed into the side of the discharge-chamber *e*, at the point *d*. *b* represents a metallic pipe or tube, whose external diameter is less than the internal diameter of the pipe *a*, and lying within *a*. This pipe, *b*, is open at both ends, one end being securely screwed into the supply chamber of the boiler, at the point *c*. The pipe *b* may properly be called a supply pipe, and the pipe *a* a discharge pipe. Suppose now that water is poured into the supply-chamber *f* until it rises several inches above the point *c;* the water will flow through the supply pipe *b*, and back through the space between the outer surface of *b* and the inner surface of *a*, into the discharge-chamber *e*, until it rises in the discharge-chamber to the same height as in the supply-chamber. Now if the supply-chamber *f*, and the discharge-chamber *e*, have no communication with each other, except as above described, below the surface of the water, and if the capacity of the discharge-chamber *e* be not very much greater than the capacity of the space between the pipes *a* and *b*, then when sufficient heat is applied to the pipe *a*, (which is horizontal or nearly so,) there will be formed a rapid circulation of water through the pipe *b*, and of water and steam through the space between the two pipes into and through the discharge-chamber *e*. If the water in the supply-chamber *f* stands three feet above the point *c*, and the tubes *a* and *b* be respectively one and a half and three-fourths inch internal diameter, and not exceeding twelve feet in length, they may be embedded in the burning coal of a powerful furnace throughout their entire length, without injury, so rapid is the circulation of water and steam through and between them, and so swiftly is the heat of the metal carried away in steam. If now, instead of this single combination of *a* and *b*, we suppose several hundred such, with a corresponding increase of the size of the chambers *e* and *f*, the first connected above with a steam-chamber into which it discharges, and the other connected with a water-chamber from which it receives its supply, we shall have a very correct idea of the steam generator represented by figs. 1, 2, and 3.

Figure 5 represents a horizontal section of the supply-chamber *f*, (fig. 1,) and of the discharge-chambers *e* and *e'*. The chamber *e'* is inserted for the purpose of showing how the power of a steam generator of this kind can be doubled by having a furnace and tubes, *c' c' d' d'*, (fig. 1,) on each side of the supply-chamber *f*.

We proceed now to a more full description of the construction and mode of operation of this steam generator, and for this purpose will use the section represented by fig. 1. *g h i j* is a plain cylinder to be made of sufficient strength to sustain any required pressure, and of capacity in proportion to the extent of the fire surface of tubes connected with it by means of the chambers *e e'* and *f*. These chambers together form a sur-

face of the four sides, and one end of a rectangular parallelopipedon, excepting that, inside the cylinder that portion of the two sides between the chambers *e* and *e'* is wanting. The width of these chambers is most conveniently made less than the diameter of the cylinder, so that the water may flow around the discharge-chambers *e* and *e'*, into the supply-chamber *f*, so long as any water may remain in the cylinder. The supply-chamber only extends as high as the bottom *i j* of the cylinder, but the discharge-chambers *e* and *e'* extend up into the cylinder above the high-water line *u*, or perhaps one-third of the length of the cylinder. These chambers have their bases in the same horizontal plane, which is so much below the lowest tier of the steam and water pipes, that the adjacent portion of the chambers becomes the sediment extractor of the boiler, and should be supplied with blow-off cocks at or near *x*, (fig. 1.) *y* represents the bridge wall, built of solid masonry from the bottom of the ash-pit R, and extends entirely across the furnace and as high as needed, at least several inches above the top of the feed-chamber *m m*. This wall should be built at the same time that the pipes passing through it are inserted in their places so as to make the work perfectly tight and compact about them. *s s* represent the furnace, and *m m* the feed-chamber. Between this chamber and the furnace, each of which has doors opening the entire width of the furnace front, as shown in fig. 3, there are several tiers of pipes as seen in figs. 1 and 2. The number and size of the pipes of this generator must vary according to the power required. For a boiler of one hundred horse power, I use pipes, for the outside, of extra strong iron, and of one and a half inch internal diameter. The inner pipes are of ordinary thickness and three-fourths of an inch internal diameter. In a boiler of the power above named, there would be about one hundred and sixty double pipes, of the kind just named, each twelve feet long, and placed in the furnace as shown in fig. 2. The lower tier of these pipes, *i. e.*, those between the ash-pit and the furnace *s s*, are six inches apart, between centres, and having the welded ends resting on a bearing bar in front, serve as the "tubular supporters of grates," as described in my patent of August 1, 1865. The welded ends of the other long pipes pass through a cast-iron plate securely built into the mason work three or four inches back of the furnace front, (fig. 3,) and are therefore free to move backward and forward as the pipes may expand or contract, without in any degree straining the threads by which the pipes are attached to the discharge-chamber *e*. The welded ends of the short pipes, viz, those back of the furnace and feed-chamber, are sustained by the bridge wall. The number of these will of course depend upon the height of the furnace and feed-chamber, but in the present plan, as seen in fig. 2, there would be two tiers back of the furnace *s s*, and one tier back of the feed-chamber *m m*, about thirty-six in all. As the external diameter of the outside pipes is about two inches, we should have as the fire surface in the steam generator, above described, one thousand and sixty-eight square feet. This estimate does not include the surface of the chambers *e f* and *e'*, around which the draught should be made to pass. The depth of the furnace, from the bottom of the pipes over it to the grates, is eight inches; of the feed-chamber, which has pipes for grates, five inches. No two pipes are nearer to each other than the length of their external diameter. Suppose now that the cylinder of which a vertical section, through its axis, is represented by *g h i j*, (fig. 1,) is filled with water to some point between *u* and *v*, the high and low-water lines, having the upper part of the cylinder, marked *o*, as the steam space. The water flows through the inner pipes, entering at the points *c c c*, and returns between the two pipes, entering the discharge-chamber *e*, at all the points *d d d*. The water will then stand on the same level in *e* as in *f*. (In case the second discharge-chamber *e'* is constructed in a boiler for future use, when it may be needed, it should, until such use, have a communication with *f*, so as to be a part of the supply-chamber.) We now fill the furnace with a wood fire; the immediate effect is to produce steam in the spaces between the outer and inner pipes; this steam presses equally towards the supply apertures *c c c*, and the discharge apertures *d d d*, and a part escapes through both or is condensed, but very soon the force of the steam drives the water entirely out of the discharge-chamber *e*, and there is established a constant and rapid current through the pipes and between them, from *c* to *d*, the motive power of which is the difference in weight between the column of water and the column of steam. After the wood in the furnace has become thoroughly ignited, coal should be shovelled into the feed-chamber and allowed to fall among the pipes till the spaces between them are full. The pipes make the coal easily permeated by the heat and gases from the fire below, by partly sustaining its weight and thus preventing its massing together or "clogging." In this way the coal is burned in actual contact with the fire surface of the boiler to any extent that may be desired. As soon as the fire needs cleaning the furnace is opened and the ashes sifted through the grate. The coal in this furnace will consume much sooner than that lying among the pipes above the furnace. Hence the furnace may be nearly empty while the space above it is full of partly consumed coal. In this case the furnace should be replenished with fresh coal. The combustible gases arising from this must traverse and permeate the already ignited coal above, thus securing the most perfect combustion. For the purpose of removing any cinder or other obstruction which may get among the pipes lying between the furnace and feed-chamber, I have provided the doors *w w*, in the walls of the generator, as seen in fig. 2, through which, with a common slash-bar, every point in the many tiers of pipes can be reached. It may in some cases be desirable to have even a second feed-chamber above *m m*, or a feeding door, even in the top of the structure, above all the pipes, for the purpose of throwing down coal to be consumed in contact with the pipes, but the plan above given is probably the best for ordinary use. Instead, also, of the discharge-chamber *e*, which all the pipes have in common, (figs. 1 and 5,) there might be a separate discharge pipe for each double pipe, *a b*, (fig. 1,) or one discharge-pipe for several of the double pipes, but this plan would be more complicated and expensive than the one above described, of having a common discharge-chamber for all the pipes in which steam is formed. It will be observed that the supply aperture for each double pipe, *a b*, is *c*, (fig. 1,) while the discharge aperture for each and all of the double pipes is *z*, the upper end of the discharge-chamber *e*.

We have thus far described the steam generator without dwelling particularly upon its most important feature, namely, the several pipes or tiers of pipes between the feed-chamber *m m*, and the furnace *s s*. While these pipes constitute the most effective part of the generator in the production of steam, on account of their

contact with the incandescent coal, they also subserve another very important purpose to which we now invite attention. When the coal is shovelled into the feed-chamber and allowed to fall among these pipes, it does not occupy or fill all the space between them; under each pipe there will be left an air-space as long as the pipe and as wide as its diameter, averaging about one inch in depth, while between the pipes in the same horizontal tier the coal lies very lightly, as its weight is mainly or entirely sustained by the adjacent pipes. It is obvious, then, that this minute division of the coal by the supporting tubes greatly facilitates the passage of air through the fuel for the support of combustion. If, however, the coal should be of very great depth, for the purpose of containing or covering a large number of tubes, it might be necessary to admit air from the furnace front directly under a part or all of the pipes so embedded in the coal. We see, then, that these pipes between the feed-chamber and the furnace, or, (if the furnace be also filled with them,) between the feed-chamber and the grate, serve to support the coal, to increase air-spaces in it, thereby promoting combustion, and to generate steam. They also effectually prevent the formation of "clinker," for the heat of the fire is so rapidly carried away by the passing water and steam, that the coal and ashes among the pipes cannot be melted. With reference therefore, to the mechanical effect of these pipes, as above described, embedded in the coal, whether one tier or more, I give them the name of the "upper grate." This grate may be used in connection with my steam grate, patented March 28th, April 11th, and August 1st, 1865, or in connection with any other grate. It may be used with such a steam generator as above described or with any other, of which, as of the above, it may form a part. It may be made either of double pipes, as above described, or it may be made of ordinary single pipes. The circulation of water and steam through the pipes composing it may be effected by a discharge-chamber, as set forth, or by any other contrivance; they may constitute the whole of a steam generator or only a part of it, and may be used in stoves, ranges, grates, or fire-places in dwelling-houses, for heating, or in furnaces for the production of steam. It may not be necessary, though it is pertinent, to say here that this invention is based upon new views of radiant heat, and is a reduction of such views to practice. In accordance with this new theory I find that the steam generated in these embedded pipes constituting the upper grate is made by heat which would otherwise be of little or no use, and does not, therefore, materially diminish the power of the fire for accomplishing other work. In the drawings and description above given, I have represented a vertical boiler for containing the steam and water, but a horizontal one could, perhaps, in many locations, be used with better economy. I have also represented a bridge wall, but this may be dispensed with by bringing the discharge-chamber forward to the back end of the furnace. This method would be preferable with a horizontal boiler lying above the pipes and parallel with them.

Having now described its construction and mode of operation, what I claim as my invention, and desire to secure by Letters Patent, is—

1. The discharge-chamber *e*, in combination with a tubular steam generator, substantially as set forth.

2. The arrangement of the several doors *n n*, *w w*, for feeding the fuel among the pipes constituting the upper grate, and for clearing them of cinder or other obstructions, substantially as set forth.

3. The feeding-chamber *m m*, substantially as set forth.

4. The upper grate, substantially as set forth.

ELI THAYER.

Witnesses:

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