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E. Danford,

Steam-Boiler Flasher.

No. 51,026. Patented Nov. 21, 1865.

Fig. 1

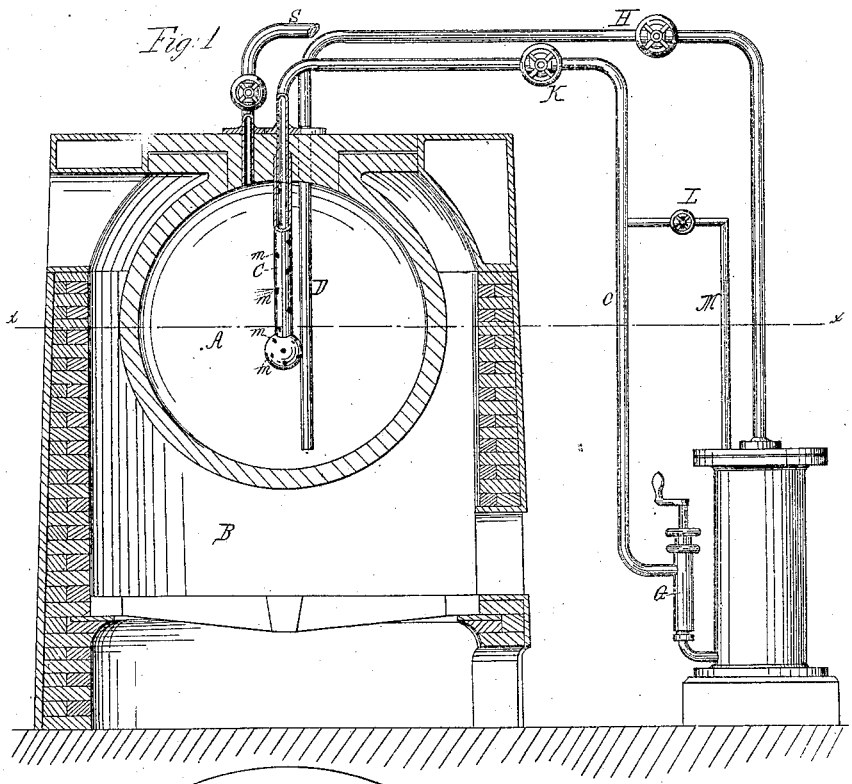
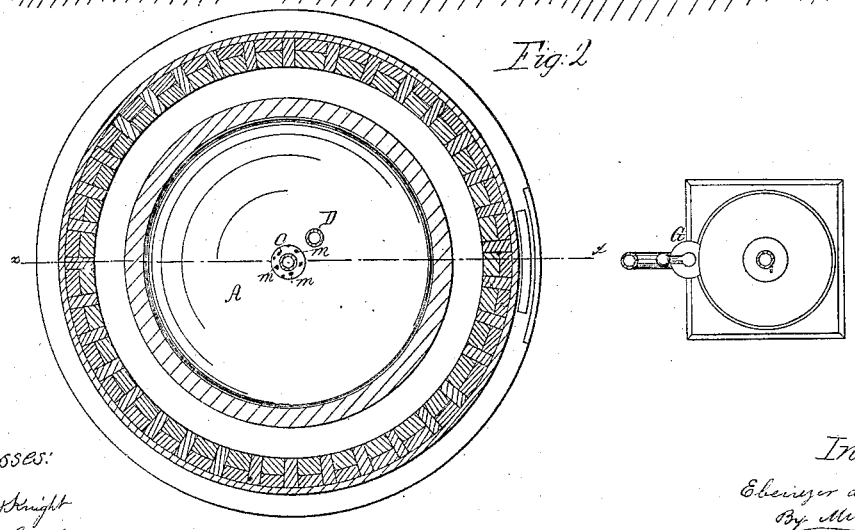


Fig. 2



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2 Sheets-Sheet 2.

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Fig: 3

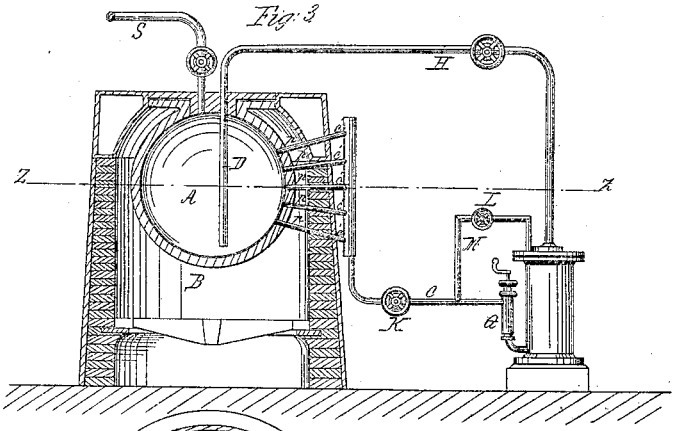


Fig: 4

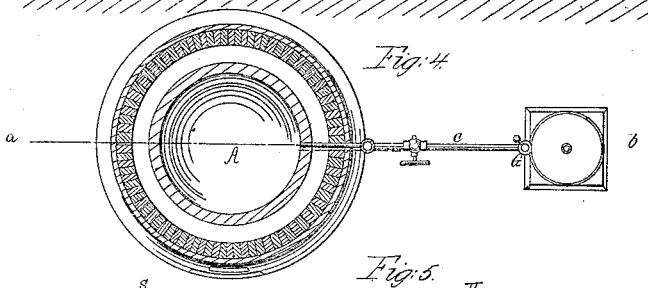


Fig: 5.

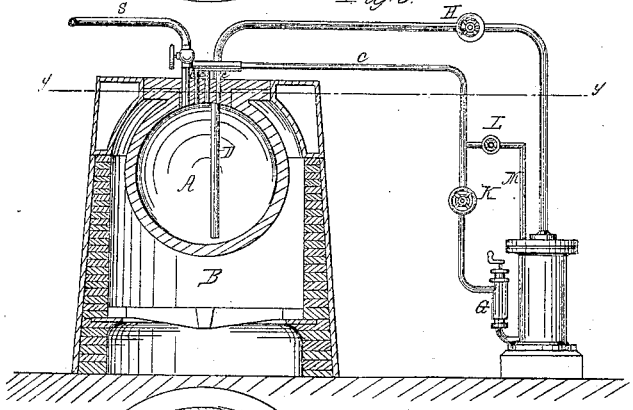
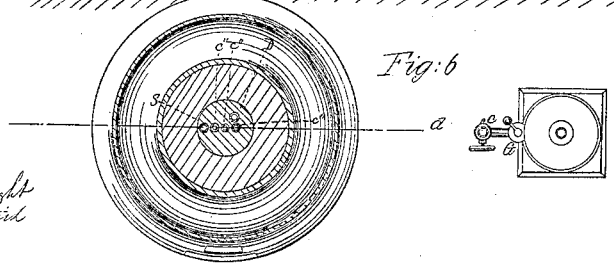


Fig: 6



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UNITED STATES PATENT OFFICE.

EBENEZER DANFORD, OF GENEVA, ILLINOIS.

IMPROVEMENT IN STEAM-GENERATORS.

Specification formingpart of Letters Patent No. **51,026**, dated November 21, 1865.

To all whom it may concern:

Be it known that I, EBENEZER DANFORD, of Geneva, in the county of Kane and State of Illinois, have invented new and useful Improvements in the Generation of Superheated Steam; and I do hereby declare the following to be a full, clear, and exact description of the nature, construction, and operation of the same, sufficient to enable one skilled in the art to which it appertains to construct and use the same, reference being had to the accompanying drawings, which make part of this specification.

In the usual mode of making steam there intervenes between the metallic surface on which the fire acts and the volume of steam in the boiler a body of water which receives the heat transmitted; and when steam is made under these circumstances it is, when of the same pressure, always of the same temperature. Thus steam of fifty pounds pressure is always of 281° temperature, and steam of one hundred pounds pressure is always of 327.8° temperature, (Regnault, Bourne's Steam-Engine,) and tables prepared for the purpose state what are the temperatures of steam of various pressures when so made. Steam so formed may be called "natural steam." Steam so formed admits of being heated by being subjected to the action of heat of adequate temperature without the presence of water to take up the heat. Steam so heated is superheated, and is called "superheated steam."

In all the processes for producing superheated steam heretofore made use of, so far as known to me, natural steam is first made, and then that steam is made superheated steam by being subjected by itself to the action of heat, as in the use of steam-chimneys and similar combinations, whereby natural steam is subjected to the action of heat after it has passed from the chamber or coil in which it is generated, or after it has passed the point at which the water was converted into steam.

There have been attempts made to produce steam instantaneously by injecting water on the inside surface of a "heated generator," (so called,) the object being the production of natural steam intermittently, as required by the engine, all of which, as far as known to me, have been failures. Another attempt to produce an economical effect in this direction, consisted in the injection of water into superheated steam of such a volume that a saturated or wet steam was the product, which was afterward conducted over a heated surface to produce superheated steam.

In my invention the relation between the volume of superheated steam and the injected water is such that the incoming water is converted into superheated steam. The combinations which I have invented for this purpose are represented in drawings hereto annexed, and marked Figures 1, 2, 3, 4, 5, and 6, and consist of, first, the vessel A, which I term "generator;" second, the pipe or coil $c\,c'\,c''$; third, the injector or force-pump G; fourth, the discharge-pipe D; fifth, the steam-pipe S, whose character, operations and purposes are fully and correctly described as follows:

Figure 1 is a vertical central section on the line $x\,x$, Fig. 2. Fig. 2 is a horizontal central section on the line $x\,x$, Fig. 1. Fig. 3 is a vertical central section on the line $a\,b$, Fig. 4. Fig. 4 is a horizontal central section on the line $z\,z$, Fig. 3. Fig. 5 is a vertical central section on the line $c\,d$, Fig. 6. Fig. 6 is a horizontal section on the line $y\,y$, Fig. 5.

A is a spherical vessel, of such thickness of sides as will furnish adequate strength, and such internal diameter as will furnish the volume of superheated steam required, as hereinafter set forth. This vessel is placed in a suitable furnace, B, the fire and heat of which act on the exterior surface of the vessel. A small quantity of water, being placed in the vessel A when it is under the action of heat, will yield as much natural steam as the capacity of the vessel will permit at a determinate temperature. The water not converted into natural steam (because there is no room for any more natural steam of that pressure) is to be blown out of the vessel through the discharge-pipe D by opening the cock H. The continued application of heat to the natural steam so made will convert it into superheated steam, and the vessel will be full of superheated steam, and the volume of superheated steam will be the means of converting water into superheated steam, when water is forced into it in the manner hereinafter described.

C, Figs. 1 and 2, is a pipe or pipes, or coil of pipes, which (in combination, as represented by Figs. 1 and 2) extend to about the central part of the generator A, and having on it numerous orifices, the greater number being near

the end of the pipes or coil. Through this pipe or coil, and out of these orifices *m m m*, water is forced in jets into the superheated steam. The pipe or coil C, being surrounded by superheated steam, will partake of its heat, and the water in the pipe or coil will thereby be heated, and the length of the pipe or coil C is such that by the time the water issues from the pipe into the superheated steam it is of nearly the same temperature as that of the superheated steam. Under these circumstances the entering water, regulated in quantity by the engineer, is converted into superheated steam immediately.

C′ C′ C′, Figs. 3 and 4, are pipes which (in combination represented in Figs. 3 and 4)enter the vessel after passing through a part of the furnace. Out of the ends of these pipes the water is forced into the superheated steam in the generator A. The length *p p p p p p* in the furnace should be such as to afford time for the heat passing over the pipe to raise the temperature of the water in it nearly to the temperature of the superheated steam in the vessel A. Under these circumstances the entering water, regulated in quantity by the engineer, is converted into superheated steam immediately.

C″ C″ C″, Figs. 5 and 6, are pipes which (in combination represented in Figs. 5 and 6) enter the plate which closes the vessel A. They are in number such that each stream or jet is small, or the water issues from the ends through orifices that produce jets adequately small. Water forced by the action of the injector through these orifices will penetrate the superheated steam and, being regulated in quantity by the engineer, will be converted into superheated steam.

G is a Giffard injector or some form of force-pump by means of which water is forced through the pipe or coil C. A branch, M, from this pipe leads to the water-reservoir, and by means of a cock, L, on it such part of the water delivered by the injector or force-pump is thrown back into the reservoir as may be found advisable.

D is a discharge-pipe which extends to near the bottom of the vessel A, by means of which any accumulation of water is blown out when desired.

S is a steam-pipe which conveys the superheated steam from the vessel A to the place and parts where it is to be used.

In the use of these combinations their satisfactory operation will depend on the proper adjustment of the supply of water by pipes C C′ C″, to the state of the fires, and the rate at which superheated steam is taken away by pipes. It will be seen that in either case it is not intended that water be injected onto the surface of the vessel, but that the volume of "superheated steam" is the material (so to designate it) which receives the entering jets and supplies, as far as any additional heat is necessary, the heat which converts the entering water into superheated steam. It is this part of the combination and its operation which distinguishes it from attempts to make steam continuously and satisfactorily by injecting water on the inner surfaces of heated vessels. The hot surface of the vessel was the part provided to convert the water thrown upon it in spray or jets into steam. Various as these attempts have been, they have all had this common feature—viz., that the hot surface was to receive the water, whereas in my combination I take special care to provide such depth of volume of superheated steam to receive the water as will cause the water to pass into a state of superheated steam before it reaches the surface. And it is in this feature that we find explanation of the fact that my invention, having been thoroughly tried, is perfectly successful, working with a regularity, steadiness, and practical character which leaves nothing to be desired, except a knowledge of the durability of the vessel used under such circumstances.

Three elements enter into the production of superheated steam by the use of these combinations, viz: First, surface of generator exposed to the action of fire and heat; second, cubic contents of generator, which determines the volume of superheated steam which provides the heat by which the entering water is converted into superheated steam; third, quantity of water forced into the superheated steam in a given time.

It will be seen that with any vessel of known cubic content and surface there is a certain quantity of water which, with that cubic content of superheated steam and surface, under the action of a certain amount of heat, will be continuously and satisfactorily converted into superheated steam; and therefore it will be seen that by regulating the quantity of water entering, vessels of any relative surface and content can be used, and as the quantity of water is a matter of regulation it is only necessary to provide ample means of supply and regulation, leaving to the engineer the adaptation of these means to the proportion of the other elements. Continued use of these combinations will define, as cannot be done beforehand, the exact quantity of water which should be injected under known circumstances.

In practice it has been found that a spherical vessel (same as represented in the drawings annexed) of thirty inches internal diameter, placed in a furnace having three square feet of grate-surface, into which vessel, when filled with superheated steam of one hundred to one hundred and twenty pounds pressure, and 500° to 600° temperature, there was supplied twelve cubic inches of water per minute through about forty orifices of about one-tenth of an inch diameter, ran an engine having a cylinder five inches diameter, eight inches stroke, at a pressure of eighty pounds per square inch, and two hundred revolutions per minute.

In determining the plan and proportions of the elements of these combinations it is to be remarked, for the guidance of those interested, first, that a body of superheated steam of 500°

to 600° temperature, and one hundred and twenty to one hundred and fifty pounds pressure is a density, and heat not readily penetrated by jets of water without a communication of heat that will convert the water into superheated steam, but that, second, it is advisable to have a considerable depth of superheated steam in advance of the entering jets, and that it is not advisable to have less than ten inches, though less depth would answer with less efficiency; third, that orifices of one-sixteenth to one-eighth of an inch diameter permit jets which operate well in practice.

The form of vessel or generator represented in the drawings is spherical, selected as the one of greatest strength and capacity with a given amount of material; but any form of vessel of adequate thickness of parts in relation to its form and sustained pressure can be used.

To secure the most efficient generator with given weight of parts, regard must be had to the practical suggestions herein contained.

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

The combination of the heated generator A, filled with superheated steam, with water-injecting pipe C or C′ or C″, and force-pump G, when so adjusted that water injected into the superheated steam in quantity regulated to the action of the fire, and surface, and content of the generator is immediately converted into superheated steam, all substantially as herein described.

To the above specification of my superheated-steam generator I have signed my hand this 25th day of September, 1865.

EBENEZER DANFORD.

Witnesses:
EDWARD H. KNIGHT,
W. F. HALL.