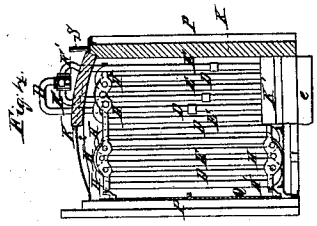
2 Sheets—Sheet 1.

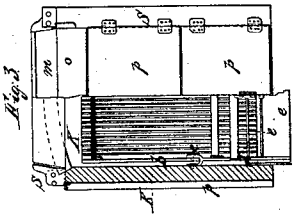
J. F. BELLEVILLE.

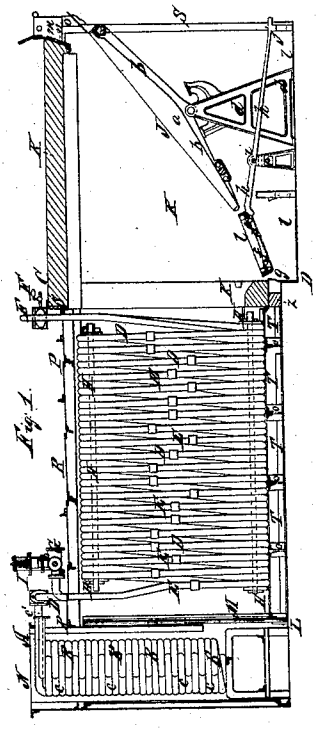
STEAM GENERATOR.

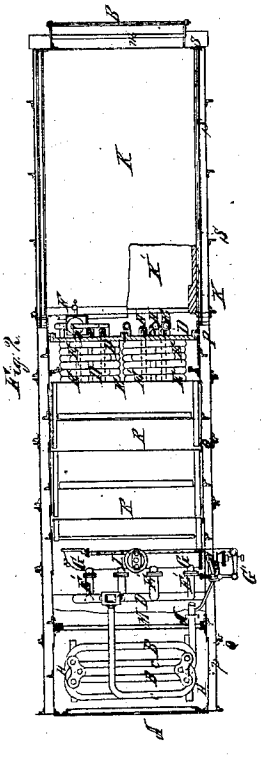
No. 18,319.

Patented Oct. 6, 1857.









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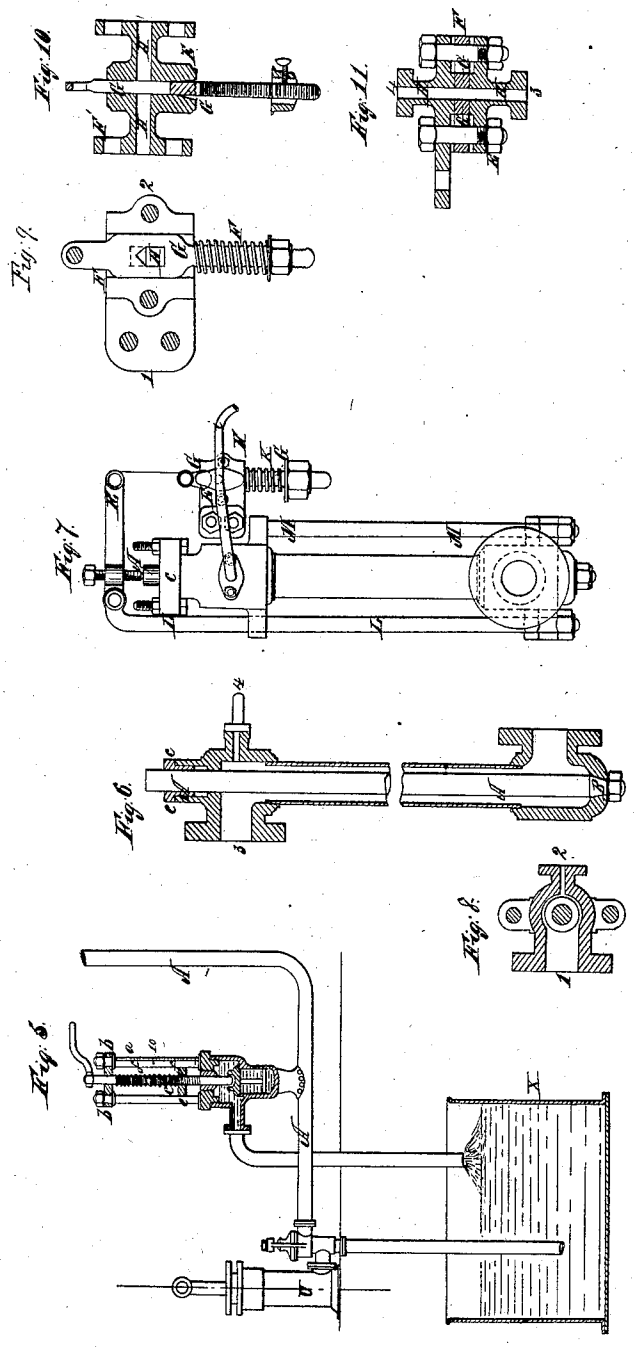

UNITED STATES PATENT OFFICE.

JULIEN F. BELLEVILLE, OF NANCY, FRANCE, ASSIGNOR TO ROBERT MURPHY.

STEAM-GENERATOR.

Specification of Letters Patent No. 18,319, dated October 6, 1857.

To all whom it may concern:

Be it known that I, JULIEN FRANCOIS BELLEVILLE, of Nancy, in the Empire of France, have invented certain new and useful Improvements in Steam-Generators; and I hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings.

My improvements relate to generators evaporating water or any other liquids without danger of explosion, at a pressure which can be varied at pleasure.

The chief peculiarity of my improvement consists in the arrangement of tubes for generating steam. I arrange them in a horizontal position with respect to the furnace.

The generator consists of tubes or coiled pipes in any suitable number, bent into any desired form, and having a greater or less number of cylindrical, elliptical or other convolutions and they may be either horizontal or vertical or inclined.

My present invention is applicable to stationary, marine and locomotive engines, also for heating, evaporating, distilling or other purposes for which steam is or may be employed.

I employ in connection with my present arrangement of generating tubes, grates of a peculiar disposition and a smoke consuming apparatus whereby I derive great advantages: The temperature is more regular and variations of pressure resulting from variations of temperature are avoided. In this arrangement also the heat is more fully utilized and more equally diffused throughout the firebox and the production of steam better regulated. The steam generator may be of less dimension and the parts so arranged as to be easily cleaned and the deposit of cinders on the pipes prevented.

My improved method of generating steam is based on the principle of maintaining the equilibrium of internal and external pressures while producing equal evaporation of liquids. In order to obtain steam at any desired pressure I employ a valve for regulating the pressure and feed.

A peculiarity of my arrangement consists in the considerable circulating action carried on in the tubes the surface of which are in proportion to the force to be produced.

I shall now proceed with a detailed description of my invention and the manner in which the same is carried into effect.

Figure 5 shows a regulating pressure and feeding valve. The pipe A conveys the water from the reservoir to the generator by means of a pump V worked by the engine. The valve V is mounted upon the feed pipe and consists of the following parts: A column *a* having atmospheric graduations is connected with a crossbar *b*. A helical spring *c* on a screw shaft *d*, move by means of a wrench to screw into a movable crossbar *e* serving as an indicator of pressure. By turning the screwshaft *d*, the cross bar *e* will be moved along the division of the column *a* and compress the spring *c*. This last, thus strained increases in the same degree the pressure on the valve V and also regulates the pressure in the reservoir (if closed,) and of course that in the generator.

This valve will serve the purpose of a safety valve. The equilibrium of pressure is maintained continually by the 1° by a a flap-valve, which is raised by the pressure coming from the pump and closes when the pressure from the generator exceeds that of the pump, and the water from the generator escapes through the regulating valves into the reservoir until the equilibrium of pressures is again established.

Fig. 1, is a sectional side elevation of an arrangement of apparatus for the generating of steam constructed according to my present invention. Fig. 2, a plan view with a portion of the casing of the apparatus removed. Fig. 3 a front view partly in section. Fig. 4 a section through C—D of Fig. 1, and an elevation partly in section showing the valve and appurtenances for regulating the feed.

The steam generator is fed with water from a feed pump worked by the engine 1 through a feed or supply pipe in direct communication with the above described valve for regulating pressure. The feed pipe is in communication with a force pump which may be worked by hand in order to bring the pressure to the proper starting point. To the feed pipe between the regulating valve and the generator is a valve which is opened by the pressure from the pump and closed by that from the generator and also a feed cock. The valve joint referred to.

prevents the escape of the water in the generator through the regulating valve if the pressure of steam happens to undergo slight increase as when stoppage takes place.

The generator tubes are divided into two general sets one in the firebox and the other in the smoke box. The coils of pipes in the firebox are shown arranged in an oblong form as at D, E, E′. The side coils are interlaced with the central coils and arranged in two sets, a common channel being left between them.

H H H are rods at top and at bottom which are bolted at each of their ends to cross plates H′, transverse the sets of coils, connect them and hold them in their proper positions in such a manner that on looking at the front of one of the sets six vertical tubes and five spaces or flues would be seen in a straight line throughout the length of the firebox. The smokebox is behind the firebox in a compartment at the bottom or foot of the chimney. These two parts of the generator are separated by a partition M. The smoke box is shown as consisting of 2 sets of coils B and C of the same form as those of the firebox, their coils are interlaced in such a manner as to leave equal spaces for the passage of the heating gases, between their straight portions. These pipes are connected by tie rods.

When the water from the feed pump enters the smoke box at A it circulates first in the coils B and C then from back to front in the coils D in the central portion of each constituent part, then returns from front to back in the side coils E E′ (which are connected with the central coil by a T or branch pipe F); the steam then passes out at E E′ into a delivery pipe G placed near the chimney. On tne T pipe F is fitted a gage tap F′ for testing the state of the steam when desired and thence regulating the fire.

The velocity of circulation in the coils is in inverse ratio with the density of steam whence it results that the current acquires an invariably increasing velocity as it approaches the coil—therefore in order to increase the velocity of the current in those portions of the tubes which contain water and watery steam or steam combined with water their section should be less than that considered necessary for the obtaining of a flow of anhydrous steam sufficient for a given force. In its course the water is heated in the coils B, C, of the smoke box is next nearly converted into vapor in the central coils D and is finally rendered anhydrous or deprived of its watery particles and converted into gas or gaseous steam in the coils E, E′. In this arrangement the course of the water and the watery steam is in a reverse direction to that of the heat; for the former are carried toward the furnace, while the steam as it becomes anhydrous or deprived of its watery particles is carried away from the furnace in such manner that the portion of pipes which is considered as a reverse surface cannot attain a very high temperature for not only is it distant from the furnace but it is moreover in direct contact with the central course of circulation in which water or watery steam circulates. Proportional equilibrium of temperature is thus established between the 3 courses of circulation whence the last of the coils E E′ (representing nearly all the reserve surface) will not be raised above the range of a suitable temperature. In no case can the steam leave the generator at an unduly elevated temperature because the coils which from their position are exposed to a progressive increase of temperature are interlaced and in contact into coils, the temperature of which is diminished inversely. This constitutes one of the principal features of my new arrangement.

I now proceed to describe the apparatus or contrivance for regulating temperature. In the pipe G or in any other part of the delivery I insert an expanding rod or tube immersed in the current of steam this rod or tube is fixed at one end to the interior of the delivery tube and at the other passes through a stuffing box to the outside where it acts through a screw or threaded stem on a lever which works the key plug or valve of an injection tap, the fluidway of which communicates on one side with the feed pipe and on the other with the steam outlet; the valve or plug is kept closed by means of a spring and is moved by means of the lever in the direction of its axis in order to open the fluid way of the tap. This rod or tube expands or lengthens as the temperature increases. Its acts is as follows: The distance between the tube and the stem of the lever having been previously regulated, then when the steam reaches a particular point the tube or rod comes in contact with the screw or stem of the lever when the steam goes beyond that point the expanding tube becoming lengthened or expanded in direct proportion with the increase of temperature gradually lifts the lever and thence the key or plug of the injection tap, when a thin stream of water will penetrate into the current of steam corresponding to the difference between the pressure in the feed pipe and that in the steam outlet pipe which difference results from the loss due to the friction occasioned by the rapid circulation of steam in the numerous convolutions of the coils. The water thus injected becomes vaporized, absorbing the excess of heat of the steam and the stream continues to enter until the temperature descends sufficiently to contract the expanding tube and remove it from the lever on which it will then cease to act and

and circulate around along and among all the tubes and after having yielded the greater portion of their heat among the fire-box pipes the gases pass from the bottom to the top part of the smoke box pipes in contact with which they abandon all their practically serviceable caloric. The heat radiating from the furnace reaches all the coils but diminishes in intensity in proportion to its distance from the furnace.

The action of the apparatus is as follows: The fire having been lighted and the valve V properly regulated, the feed pump is set to work when the water will be fed into the generator tubes becomes heated and converted into vapor as it passes through the coils until the tension acquired by the steam so produced is in equilibrium with the maximum pressure to which the regulating valve is weighted, and when a little beyond that point then the water ceases to flow into the generator and the regulating valve is opened by the excess of pressure from the steam whereby equilibrium is restored and all the water supplied by the pump returns into the cistern X (Fig. 5) from which the feed pump is supplied with water. The steam is thus kept at the proper pressure. If a volume of steam should have been expanded for any purpose, the tension of the steam becomes diminished to a like degree and the equilibrium would be disturbed but at the same time the pressure of the valve being then greater than that of the steam the valve would fall; water would again flow into the generator until a fresh volume of steam equal to that expended had been produced and equilibrium thus restored. The feed is exceedingly rapid and the quantity of water which enters the generator is exactly the equivalent of the weight of steam which is given off in the same time so that the quantity of water fed into the generator is in proportion with the quantity of steam expended. The quantity of water returned into the cistern X through the valve V is in inverse ratio with the quantity of steam expended. When the engine is put in action it sets the feed pump to work which keeps up a continuous pressure in the feed pipe, and supplies a greater quantity of water than needful for the generator. The excess of water supplied by the pump jerks or lifts the valve at every stroke of the piston which indicates that the pressure in the supply pipe is at least equal to the weight of the valve and the pump is in good order. To stop the engine the steam tap must be turned.

This new construction of generator is particularly secure on account of its not retaining any reserve of water or steam (water can only penetrate therein in proportion to the copenitative of steam). Any reserve of steam is quite useless as the generator instantly produces at any pressure and in any quantity the required volumes of steam up to the maximum point of vaporization.

If accidentally one of the generator tubes should happen to rend the current of steam in it at the time would pass through the leak instead of going on through the pipe and would escape through the chimney and if the escape were very considerable all that would happen would be a stoppage of the engine. There being no reserve of water to heat, as soon as the fire is lighted the engine can be set in action. Economy of fuel results from these points. The steam produced is gaseous and contains less latent caloric than saturated steam does. Steam is employed at a high pressure so as to have a great elasticity. The conductibility of the metal which the generator is made of is better utilized and the particles of water being rapidly rendered against the inner sides of the tubes, the caloric is absorbed by their conversion into steam almost as fast as it is transmitted through the metal.

In ordinary steam boilers, the nearly stagnant body of water which presses against all the surfaces in contact with the heating gases is bad conductor of heat so that in such boilers a very small portion of the conducting property of the metal is turned to good account.

In my improved generator steam may be obtained at various pressures by regulating the weight of the regulating valve and at a higher temperature than those which correspond to its tensile force on account of its not being produced in contact with an excess of liquid. Saturated steam instead of gaseous steam, may, if preferred, be obtained in my generator but the latter is the more advantageous.

This invention is characterized by the improbability of explosions, the great economy of fuel reduced weight and dimensions, rapid production of steam after the furnace has been ignited, production of "dry" or anhydrous steam at any pressure, also by the means afforded of immediately increasing or decreasing the pressure by allowing the charge of the feed regulating valve and of considerably augmenting the work of the engine if required in case of an increased resistance, by the regularity of feed and consumption of smoke. Ready means of managing the fire, little need and easy mode of repairs.

The generator is especially applicable for marine purposes, not only on account of its safeness, but also of the means it affords for employing high pressure and very expansive steam, whereby fuel is considerably economized and a given quantity of fuel would thus be sufficient for much longer voyages than at present.

Having now described my improvements,

the injection tap will be closed by the pressure of the spring on the plug. The opening and closing of the injection orifice are thus regulated according to the rise and fall of the temperature of the steam. To regulate the time for the injection of water into the steam the expanding tube should be brought nearer to or farther from the lever.

Fig. 6 is a front elevation of line contrivance. Fig. 7, a vertical section. Fig. 8, section through line 3—4 of Fig. 7. Fig. 9, view of tap detached. Fig. 10, section through line 1—2 of Fig. 9. Fig. 11, section through line 3—4 of Fig. 10.

A is the expanding rod fixed at B to the delivery pipe and passing through the stuffing box C to the outside.

E is the lever; D screw for regulating position of rod and lever F injection tap *g* its plug or valve. The lever and tap are mounted in standard L L parallel to and outside of the steam delivery pipe. These standards are not very liable to expansion on account of their position but they should be at least equal in length to the expanding tube; they are fixed at one end to the tube G.

I is a steam valve on the delivery pipe, weighted to some atmospheres exceeding the maximum pressure of the feed regulation valve.

The generator is shown in the drawings as provided with an inner and outer casing. The inner casing may be made of sheet iron with angle pieces P solidly secured but allowing for expansion. The space Q between the inner and outer casings is filled in with cinders or other nonconducting media to prevent outward radiation of heat. The top R of this casing is composed of arched or convex plates of cast or sheet iron bound with angle iron and covered with cinders or any other nonconductor of heat—or the casing may be of brickwork and the top or dome of iron bound with angle iron.

The generator is mounted on feet *o o* of angle iron, between which space T T are left in which the cinders drawn in by the gases drop and whence they may easily be withdrawn; the passages L under the bridge *f* register, having to be opened for the purpose, or the sides, domes and bridge are made in firebrick and constitute the inner casing as at K, having an outer casing of sheet iron bound with cast iron at the sides and with angle iron at the top.

I employ in connection with my arrangement of steam generator a furnace or smoke consuming apparatus, as shown in Figs. 1, 2, 3.

a is a grate consisting of firebars fitted in a frame *b* mounted on pivots *c* and free to move thereon by which means the firebars may be inclined as required. The pivots *c* are in a bracket or framework *d* or instead of the frame crosspiece may be used resting at their ends on the sides of the ashpit *e* is a smaller grate at the bottom of the larger grate and having firebars mounted in a frame *f* free to move on a pivot *g* in such a manner that the highest part of the two grates sufficiently large for the removal of cinders, scona, &c. The lever *h* is centered at *i*.

j is a hook in which the end of the lever *h* catches when the smaller grate is raised.

k is a plate for carrying the small grate when lowered and at the same time for stopping the fall of the fuel into the ashpit.

l is the ashpit through which a stream of water should be kept continuously flowing, *m* hopper or feed mouth, the back of which as seen in Fig. 1 is sharply inclined in the direction of the grate for the regular descent of the fuel.

n is a movable register at the back part of the hopper, by means of raising or lowering which the thickness of the layer of fuel may be regulated.

o is a movable feed plate at the top of the grate *a* and below the hopper this plate is more sharply inclined than the grate. Between the bottom of the hopper and this feed plate a space is left for testing the regularity of the descent of the fuel.

p, *p*, are doors at the front of the ashpit opened or closed to any desired extent by means of a rack. These doors prevent the radiation of heat from the grate in that direction.

The fuel falls down the grate, piece by piece and as each fragment becomes consumed and diminished in volume it gives place to the next piece resting on it, which drops down and so on until all the fuel descends gradually down the incline; the more active the combustion, the faster the descent. As the fuel leaves the hopper it becomes gradually heated and liberates the gases which it contains little by little these gases ignite and combine with fresh air which has only come in contact with fuel that has not ignited. The fuel becomes ignited as it descends and converted into coke being diminished in volume until at length only the residuum remains in the lower grate *e*. When the furnace is first in action the heap of fuel is thicker at bottom than at top increases widening out toward the bottom.

I do not confine myself to the angle of inclination shown, nor to the particular arrangement of firebars described provided the furnace be constructed on the plan hereinabove described, in which the fuel is made to fall gradually down an inclined plane, becoming consumed as it falls and so feeding the fire in the manner explained.

The heated gases on leaving the furnace pass in streams into the small flues or passages between the coils of the firebox pipes

what I claim and desire to secure by Letters Patent is—

The general disposition and arrangement of the steam generator and the parts connected therewith herein described, consisting of tubes in which water or other liquids are converted into steam substantially as specified.

In testimony whereof I have signed my name to this specification before two subscribing witnesses.

JULIEN FRANCOIS BELLEVILLE.

Witnesses:
EMIL BARRAULT,
GEO. HUTTON.