3 Sheets—Sheet 1.

F. A. MORLEY.

METHOD OF EVAPORATING SALT WATER AND OTHER LIQUIDS.

No. 107,523. Patented Sept. 20, 1870.

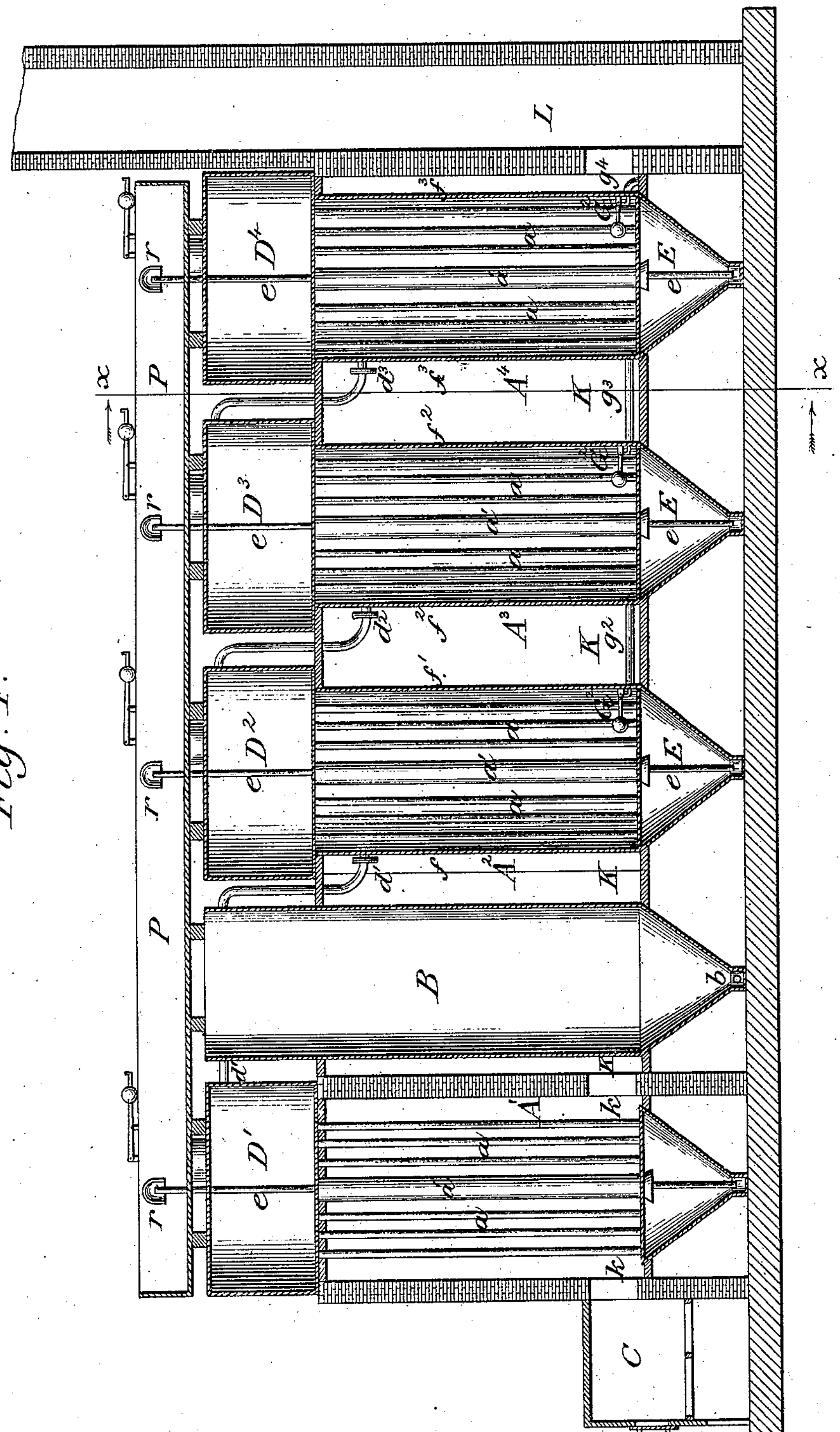

Fig. 1.

Witnesses:

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Inventor.

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3 Sheets—Sheet 2.

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Fig. 2.

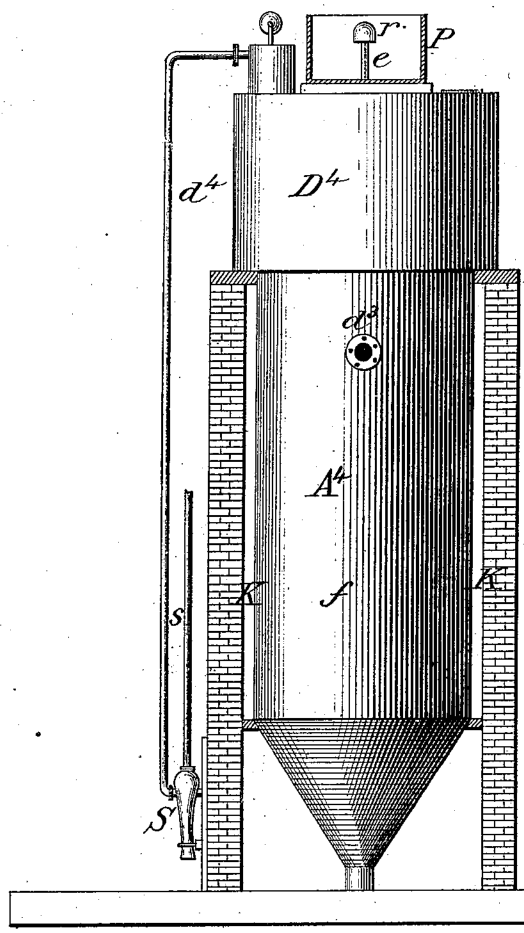


Fig. 5.

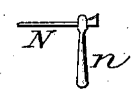


Fig. 6.

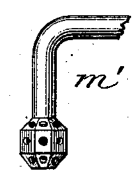


Fig. 3.

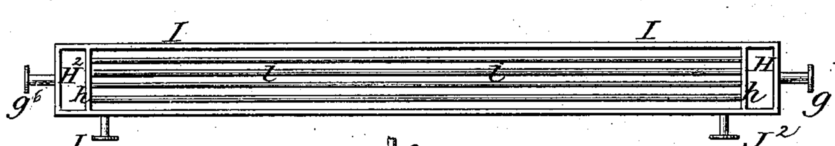
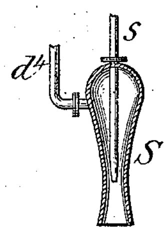


Fig. 4.



Witnesses:

Wm J Dodge
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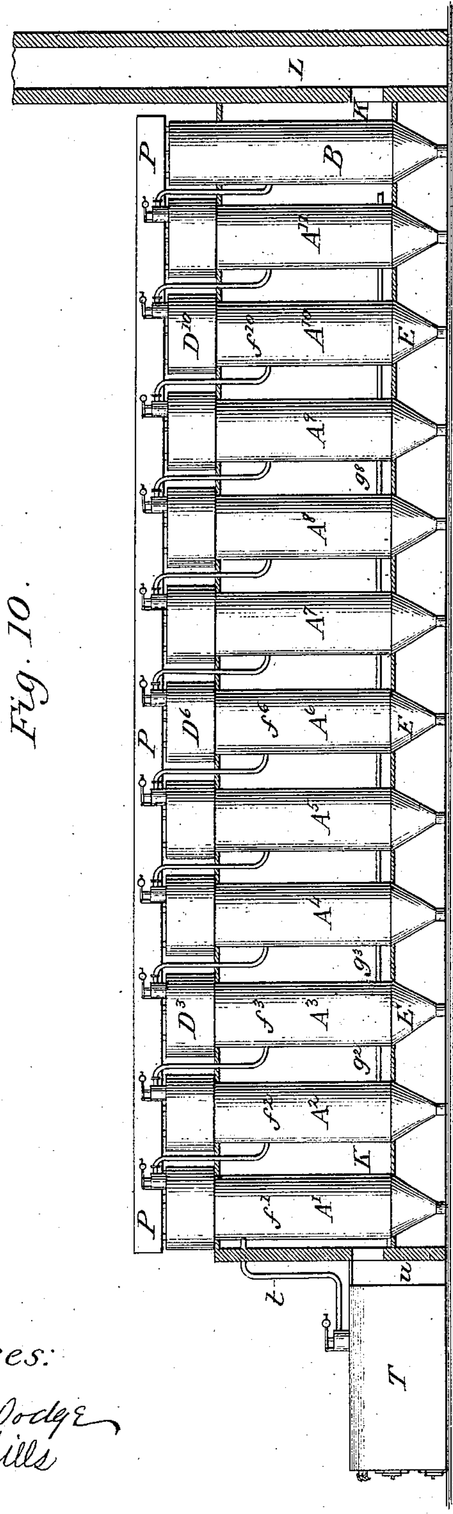

Fig. 10.

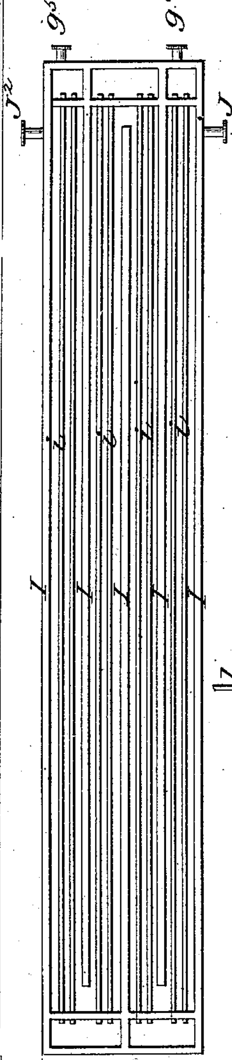

Fig. 7.

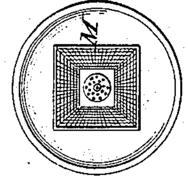

Fig. 9.

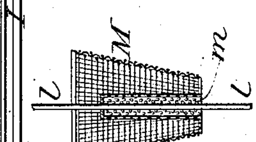

Fig. 8.

Witnesses:

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United States Patent Office.

FRANKLIN A. MORLEY, OF SYRACUSE, NEW YORK.

Letters Patent No. 107,523, *dated September* 20, 1870.

IMPROVEMENT IN EVAPORATING SALT-WATER AND OTHER LIQUIDS.

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, FRANKLIN A. MORLEY, of Syracuse, in the county of Onondaga and State of New York, have invented an Improved Method for Evaporating Salt-Water and Other Liquids; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable those skilled in the art to make and use the same, reference being had to the accompanying drawing forming part of this specification, in which—

Figure 1 is a vertical longitudinal section of my invention.

Figure 2 is a cross-section, enlarged, taken in the line *x x* in fig. 1.

Figures 3, 4, 5, 6, 7, 8, and 9 are detail views.

Figure 10 shows a more full or extended application of the method, with a modification, showing the use of a fresh-water steam-boiler for actuating the series of salt-boilers.

Similar letters of reference indicate like parts in the several figures.

The object of this invention is to apply the heat in such manner that it may be used repeatedly upon the several boilers of a series, efficiently and without loss of evaporative force, as hereinafter explained.

In the accompanying drawing—

A^1 A^2 A^3 A^4 is a series of salt-boilers or evaporating-vessels, and

B shows a vessel for heating and purifying the feed-water.

Each boiler A formed by a nest of flues or tubes, *a a*, that connect an upper chamber, D, with a lower conoidal chamber, E; and each boiler is filled with salt-water, so that its upper chamber D is nearly full, the tubes *a a* and the lower chamber E being entirely full.

The heat from the furnace C flows into the chamber *k k*, and steam is formed above the water in D^1.

This steam flows from D^1 through the pipe d^1 d^1, into a shell or jacket, *f f*, that incloses the flues of the second boiler A^2, and here the steam is condensed on said flues *a a*, and gives up its heat to form steam in chamber D^2.

This new steam in D^2 flows through the pipe d^2, into the jacket *f f* of the third boiler A^3, and is condensed on the flues of said boiler, and, in giving up its heat by condensation, new steam is formed in the chamber D^3, and this steam, passing through pipe d^3, into the jacket of boiler A^4, is condensed on the flues of said boiler, and forms steam in chamber D^4, and this steam from D^4 is allowed to escape into the open air, or is withdrawn by an ejector-condenser, or the steam from this last boiler can be used to heat the feed-water, as hereinafter more fully explained.

In order to repeat the effect in this manner, without loss of evaporative power, I generate the steam in the first boiler A^1 under a pressure of about one hundred and fifty pounds to the square inch, making the temperature of the steam in D^1 about 365° Fahrenheit.

This steam passes into A^2, and, condensing upon its flues, forms steam in D^2 at a temperature of 315°, and with a pressure of seventy-two pounds to the inch; and this new steam flows into jacket A^3, and, condensing on the flues, makes steam in D^3 at a temperature of 265°, with a pressure of thirty pounds; and this steam passes into A^4 and condenses on its tubes, and forms steam in D^4 at atmospheric pressure.

By this means the steam on the outside of each set of flues is kept at a temperature of about 50° above the water within the flues, and this gives a rapid ebullition within all the boilers. One-half of this difference of temperature between the steam outside and the water inside of the flues, or 25°, makes the water in the boilers boil with sufficient energy to give a rapid circulation in said boilers.

It is necessary to have a good circulation in the boilers, to prevent salt from forming on the heating-surfaces.

The circulation is obtained by making the flues or tubes *a a* of different diameters.

A large tube, *a'*, is placed in the center of each nest of tubes, and as this tube holds much more water, in proportion to its heating-surface, than the smaller tubes, the consequence is the smaller tubes always begin to boil first, and the steam-bubbles cause an upward current in said small tubes *a*, and this upward current is compensated by a downward flow through the large pipe *a'*.

When in full operation, the water never boils in the large tubes, as the water, in passing down them, is subjected to a constantly-increased pressure of water above, and although the temperature of the water is increased while passing down the large tubes, the boiling all takes place in the ascending currents or small tubes, when the water has moved nearer to the surface, and a portion of the weight of water above is removed, and, by this means, a strong circulation of water or brine is maintained, and the heating-surfaces are very efficient, as the steam-bubbles are swept rapidly from them.

The downward current in each large flue *a'* takes all of the salt from the upper chamber D, and throws it down in the conoidal chamber E, from which the salt is occasionally removed, by blowing out by steam pressure, into a suitable tank or receiving-vessel.

The waste heat or the gaseous products of combustion from the furnace C pass through the chamber K K K to the chimney L, and said waste heat, in passing to the chimney, passes around all of the jackets *f f* of the boilers, and prevents radiation of heat from said boilers A, and, by this means, the repeating process is kept up with full force from boiler to boiler.

The water formed in the jacket of A^2 from condensation of steam falls to the bottom of the chamber formed by said jacket, and the exit of this water is regulated by a float-valve, G^3. When the water has accumulated sufficiently to float the valve-lever G^2, the water escapes through the pipe g^2 into the jacket of A^3. This water has left A^2 at a temperature of 365°, and enters A^3, where the temperature is only 315°, and the consequence is that, as the water enters A^3, it gives off steam enough to instantly lower its temperature to 315°, and in this manner a portion of the heat from this water of condensation is extracted by furnishing steam to heat the water-tubes of A^3.

The water of condensation passes from one jacket to the next, and in this manner gives off steam all the way through the series, and all of the water of condensation is discharged from the exit-pipe g^4 at a temperature of 212°, and is then thrown away, or is used to heat feed-water.

The condensation water from the pipe g^4 is used to heat the feed-water for the boilers, as follows:

A long shallow tank, I I, fig. 3, is made, and provided with partitions *h h* at each end, so as to form compartments H H^2, and a series of flues, *i*, are then placed in these partitions *h h*, so as to connect the compartments H H^2 with each other.

The hot-water waste-pipe g^4 is then connected with the pipe g^5, and the hot water passes into the compartment H, and from thence flows through all of the flues *i* to the compartment H^2, and out through the pipe g^6. While the hot water is flowing through the flues *i*, the cold salt-water is admitted into the tank by the pipe J, and flows along the flues *i* to the opposite end of the tank, and is discharged at the pipe J^2.

It will be noticed that the cold water flows through the tank in a direction opposite to that taken by the hot water, and by this means the heat is more thoroughly extracted from the hot water; as the cold water first encounters the hot-water pipes, after a large portion of its heat has been given up, and flowing toward J^2, it is constantly coming in contact with water of a higher temperature, until it reaches J^2, where the hot water is at about 212°. In this way a quantity of feed-water, equal to the hot water, can be heated to nearly 200°, while if both the hot and cold water travel in the same direction, the temperatures could only be equalized, and not that in practice, as the hot water would be thrown away at a temperature of 10° or 20° hotter than the feed-water as it left the heater.

The flues *i* are fitted in the partitions *h h* loose enough, so they can be moved endwise, to allow them to be taken out of said partitions for cleaning, when a scale has formed on them. As the heat is a low one, this scale or deposit can be removed with a stiff broom, by merely rolling the flues in their seats, so as to get at their lower sides; but where the scale is more stubborn these flues *i* can be slipped out in a few moments, and a relieving set of flues put in, and the flues that have been removed can be scaled at leisure, or the same set of flues can be scaled and returned to their places, and no relieving flues used.

A modification of this heater is shown by fig. 7, the principle of which is the same as that just explained, only the distance traveled by both the hot and cold water is greater, without increasing the length of the tank, the route taken by the waters doubling upon itself several times. This increasing of the distance through which the waters travel allows them to be exposed to each other for a longer time, and for this reason the heater is more economical or effective, as nearly all of the abnormal heat in the waste water can be extracted and given to the feed-water.

The feed-water, after passing through the heater I, is pumped into a large plain feed-boiler, B, fig. 1, and its temperature is there brought fully up to the boiling-point by waste heat from the furnace C, and the water or brine is then hot enough to supply the boilers A, and is pumped into said boilers at once, if there are no impurities to be first taken from the water. If the brine holds carbonate and sulphate of lime in solution, then it is purified, so as to get a good quality of salt, and to prevent formation of scale in the boilers A.

The brine is purified as follows:

There are two or more of these feed-boilers B used, and they are made to relieve each other, so as to keep up a constant supply of feed-water. A feed-boiler is filled with brine, and salt is blown from one of the boilers A into the feed-water, to fully saturate it with salt, and this, in connection with its temperature, being brought to the boiling-point, causes the carbonate of lime to be thrown down, the water having a greater affinity for salt than for the carbonate of lime, and the increased temperature of the water driving off the carbonic acid, so that the lime becomes insoluble and settles to the bottom of the boiler B. A portion of the sulphate of lime is also precipitated, but it may be found necessary to take a further step for wholly removing this impurity, which will be explained hereafter.

To facilitate the saturation of the feed-water with salt, and not waste the salt, a perforated vessel or wire rack, M, figs. 8 and 9, is provided, and suspended on a shaft, *l l*, fig. 8, the said shaft and rack *l* M being placed within the boiler B in a vertical position, and in such manner as to be rotated by the same power that operates the feed-pumps of the works; and a quantity of salt being blown into this rack, and the rack caused to rotate slowly, a current of water is constantly thrown outward from the center of the rack through the salt and over its surface, and this agitation or current soon brings all of the water in contact with the salt, and saturation is rapidly brought about, and the agitation also facilitates the liberation of the carbonic acid.

The rack M has an open center, *m*, fig. 8, that allows water from below to pass up into the center of the rack, to supply the centrifugal current that is constantly passing out horizontally through the salt in the rack.

Salt can be blown into this rack, when it is in motion or at rest, by suitable conduits or pipes, that lead from the conoidal chambers E and terminate over or in the upper part of the rack M.

To check the discharge of salt from said blow-pipe, and prevent it from being thrown over the rack into the body of the boiler B, by the sudden dispersement of the hot water as it leaves the blow-pipe, the said pipe has a perforated chamber or nozzle, *m'*, fig. 6, at its discharging end.

To get out the remaining portion of the sulphate of lime, after the feed-water has been heated and brought to the boiling-point, a cover is provided for the boiler B, with a large valve or door opening inward, for convenience of access, which will confine the steam that is formed in the boiler, and the temperature of the feed-water is raised to 365°, and the salt-rack M is kept in motion to agitate the water. At this temperature the brine has become purified from the sulphate, and the feed-water is then run off into the boilers without the aid of feed-pumps, the pressure in B being sufficient to balance or overcome the pressure in the boilers A.

The sulphate of lime is totally insoluble in water at a temperature of 300°, and by the time the feed-water has reached the temperature of 365°, the impurities have had time to settle, and the brine is ready for use.

But little scale is formed in the boilers A when the feed-water has only been saturated and heated to to 212°, and the boilers could be run for about sixty days, and then cleaned readily by filling with fresh water until the flues are covered, and adding a moderate portion of chloride of ammonium and hydrochloric acid.

The boilers A are also designed to obviate scaling as much as possible, the loose impurities being withdrawn from the circulation as fast as they are liberated, by falling from the downward current as it leaves the lower end of the large flue a', and settling into the conoidal chamber E, where no steam forms to agitate them, and where they are below the agitation caused by the circulation of the brine; but, as a better quality of salt is made by first purifying the feed-water from the sulphate of lime, the heating of the feed-water to 300° and upward is preferable, with water containing much of this impurity.

Fig. 4 shows a section of the ejector-condenser. The object of this condenser is to make the last one or two boilers of the series boil at a temperature less than 212°, the last boiler operating at a temperature of 150°, or thereabout, so that a greater difference of temperature can be obtained between the first and last boiler of the series, and thereby make the evaporation more active and energetic throughout the series.

The condenser is operated by admitting cold water through the pipe s, and the steam, flowing in through the pipe d^4, condenses so rapidly at the mouth of the cold-water pipe as to eject the condensing water and air, and keep up a vacuum of several pounds in said condenser S and chamber D^4.

The boilers are fed by suitable feed-pumps that are operated by a small engine, the steam to work the engine being taken from some one of the boilers A.

The pumps are so located as to be kept at a hotter temperature than the feed-water, and by this means no salt will form on their inside or working-parts.

To do this each pump has more or less of its body placed within the chamber D of its boiler. The reason for this is that saturated water, if chilled by its contact with the pump, would hold in solution less salt, and deposit a portion; but, if the tendency of the contact is to heat the water, its capacity for salt is increased, and no salt is deposited on the pump as the water is passed through.

The boilers are provided with gauge-cocks, so that the height of water in the chambers D can be known when they have been pumped up to the proper height; and, as the gauge-cocks are liable to become fouled by salt, a follower, N, fig. 5, is used to clear them, as occasion may require. If, on opening a gauge-cock, neither water or steam is ejected from the boiler, the follower N is inserted, and pushed through by a blow with a mallet, the follower having a side handle n, to prevent hot water from being thrown upon the hand of the operator.

The salt-blowing pipes are provided with suitable gates or cocks for opening and closing them at will, and the several boilers are each provided with a safety or escape-valve, similar to those in common use on other steam-boilers.

The salt is drawn from the boilers A into a tank, P, by the salt-blowing pipes e e, figs. 1 and 2.

The water that is blown out into the tank P with the salt is drawn out of said tank by the feed-pumps, and returned to the boilers, and the salt is then shoveled into baskets, or onto racks above said tank, to drain into the tank.

This tank can be placed above the boilers, as shown, or can be placed near the ground by the side of the boilers.

The salt-blowing pipes e e can be conducted upward through the center of the boilers, as shown in fig. 1, or they can make the connection between the salt-chamber E and tank P, outside of the boilers.

Each blowing-pipe e has a cap, r, to catch the discharge, and cause it to drop from the end of the pipe into the tank.

The tubes i in the heater I can have collars of hemp, or rubber rings, for tightening the joints in the partitions h, and these packing-rings can be pressed on the joint by a follower or nut on one end of the pipe, while a fixed shoulder on the pipe will answer for the opposite end. This will allow these flues to be taken out for removing scale from them, or for cleaning out the tank I at any time, although, usually, the loose deposit of lime will be rinsed out through one or more holes in the bottom of the tank, that are closed by plugs when the heater is in use.

Fig. 10 shows a more full application of the method than is shown by fig. 1.

When the works are extended to this extent the condenser is dispensed with, and all of the steam that is generated by the last boiler A^{12} is conducted into the feed-water in B, (after said feed-water has been heated to nearly 200° by the heater I,) to raise its temperature fully up to the boiling-point.

The salt made by the boiler A^{12} is also added to the feed-water, so that the steam thus used does not weaken the brine, and the salt-making work of the boiler A^{12} is sacrificed to give the additional heat to the feed-water, for simplicity of method, and for expediting the preparation of said feed-water. No extra vessels are required, and the heat of the steam is conveyed to the water in B at once as they come in contact.

A fresh-water boiler, T, can be used to actuate the series of boilers A^1 A^2 A^3, &c., and steam from this fresh-water boiler passes through the pipe t into the jacket of boiler A^1, and, as this steam condenses, the water immediately returns to its boiler T by a pipe, u, and in this manner the height of water in the fresh-water boiler regulates itself, and requires little or no care; and, as distilled water is constantly returned to the boiler, no scale can form in it, and it is always in a clean and efficient condition, and there is no danger of overheating the boiler-plate of said boiler.

This boiler will drive a small steam-engine for working the feed-pumps, and for rotating the saturating-racks, and this will take some water from the boiler; but what feed-water that is required to be pumped into the boiler is taken from the waste-pipes g, so that nothing but distilled water will enter the fresh-water boiler. And, as the other boilers A are heated by steam, there is no boiler-plate about the entire works or flues that can be injured by heat, and a good degree of endurance for the apparatus is thereby insured.

The chambers D and E are of cast-iron, made sufficiently strong to bear any pressure that may be brought upon them, and will wear a long time, as the iron is not exposed to overheating.

The jackets or shells f f are wrought-iron plates, and the flues a a are also of wrought-iron.

A much larger number of flues, a, are used than is shown in the drawing, so that a large heating-surface is obtained for the steam.

Where the system is extended so far as shown in fig. 10, the evaporation in each boiler is less rapid as the difference of temperature between the steam on the outside of the flues and the water inside of them is reduced to about 14°, but this is sufficient to give the proper circulation in the boilers A, but it is about the practical limit of the process.

No more heat is required to evaporate the water under pressure than in an open vessel.

The method generally in use is the kettle method, the evaporative efficiency of which is 5.5 pounds of water to the pound of coal.

The best steam-boilers are capable of converting twelve pounds of water, from the boiling-point, into steam, for each pound of fuel. A good fresh-water boiler, T, is capable of making twice as much steam per pound of fuel as is made by the kettle system now in use, and the effect of steam from the boiler T is increased tenfold by the series of boilers A; consequently, the evaporative power of this method is about twenty times that of the ordinary method.

Having thus described my invention,

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

1. A series of evaporators, A^1 A^2 A^3, the steam of the preceding one boiling the next, as described, when arranged in a chamber, K K, between the furnace C and chimney or outlet L, so that the waste heat from the furnace shall pass around the series of evaporators, and prevent radiation or loss of heat from said evaporators or steam-jackets *f f*.

2. The pipes g^1, to convey the water of condensation from the jacket of one evaporator of a higher temperature to that of the next evaporater, so that more heat can be extracted from the condensation water and applied to the evaporating-surfaces, substantially as described.

3. The salt-boilers A, when made with an upper chamber D and lower chamber E, and said chambers connected with each other by flues *a a*, and having a steam-jacket, *f f*, as herein described.

4. The ejector-condenser S, in combination with the last boiler of a series, A^1 A^2 A^3, as herein specified.

5. The combination of the tank or salt-receptacle P with the salt-pipes *e e*, for the purpose specified.

6. In combination with the salt-blowing pipes *e*, the caps *r*, for the purpose herein described.

The above specification of my invention signed by me this 16th day of May, 1870.

F. A. MORLEY.

Witnesses:

WM. J. DODGE,

E. H. MILLS.