(No Model.)

A. A. DENTON.

APPARATUS FOR EVAPORATING LIQUIDS BY AIR.

No. 339,388. Patented Apr. 6, 1886.

Fig. 1.

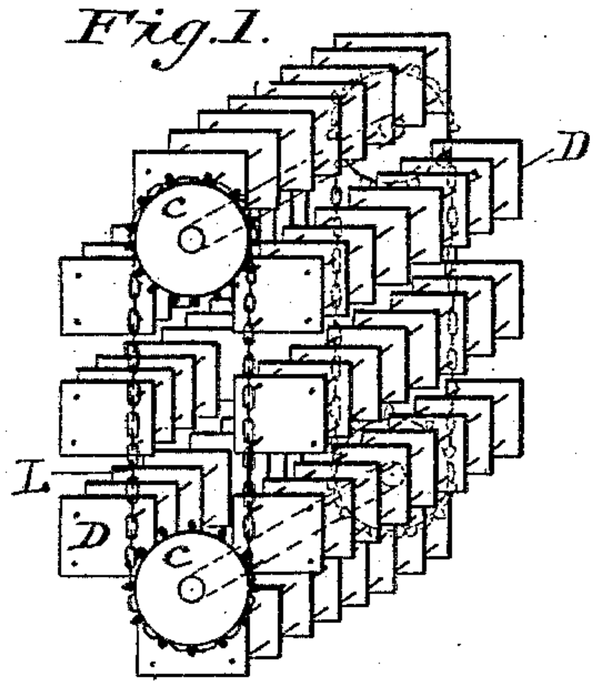


Fig. 2.

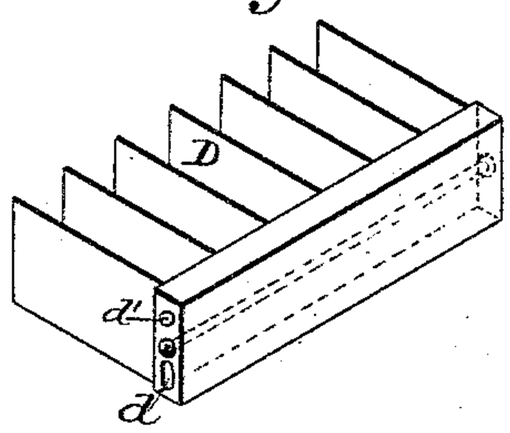


Fig. 3.

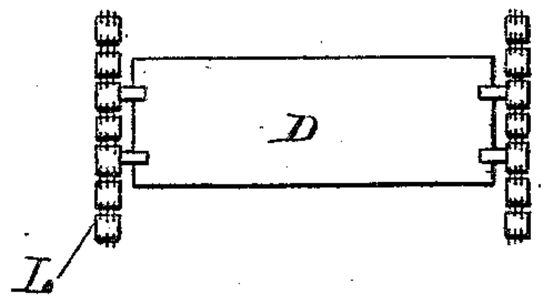


Fig. 4.

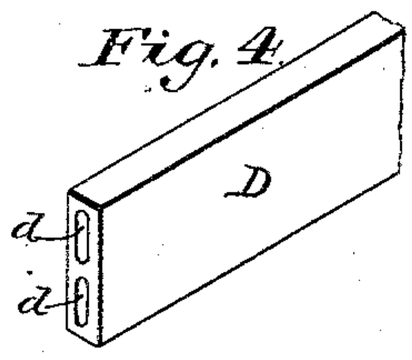


Fig. 5.

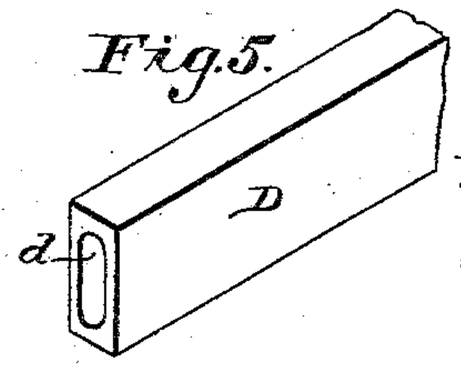


Fig. 7.

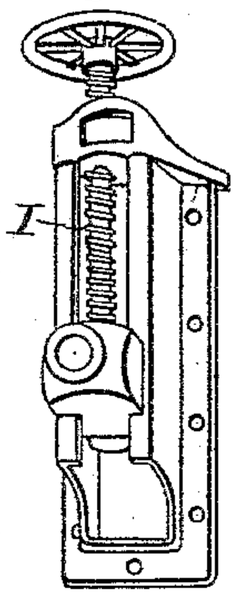


Fig. 6.

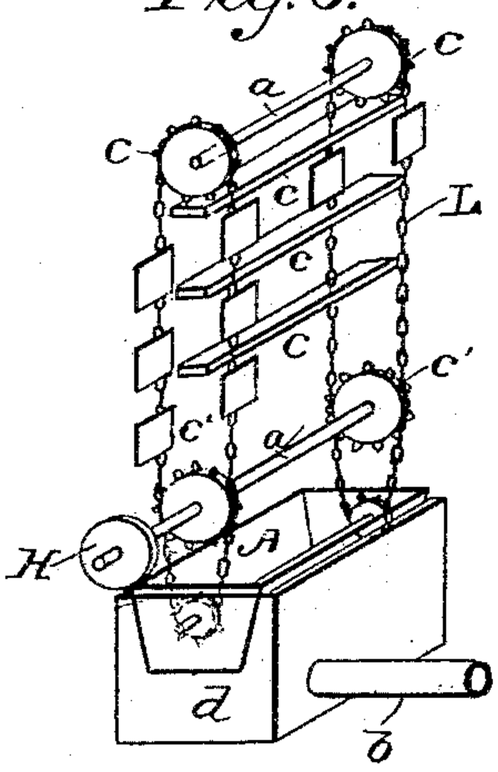


Fig. 8.

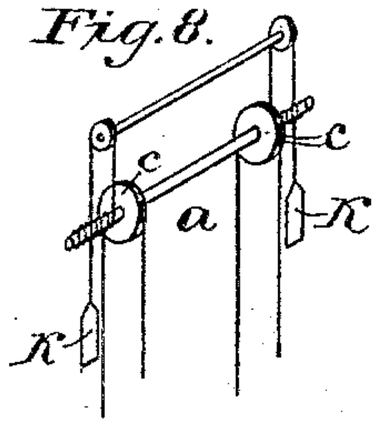


Fig. 13.

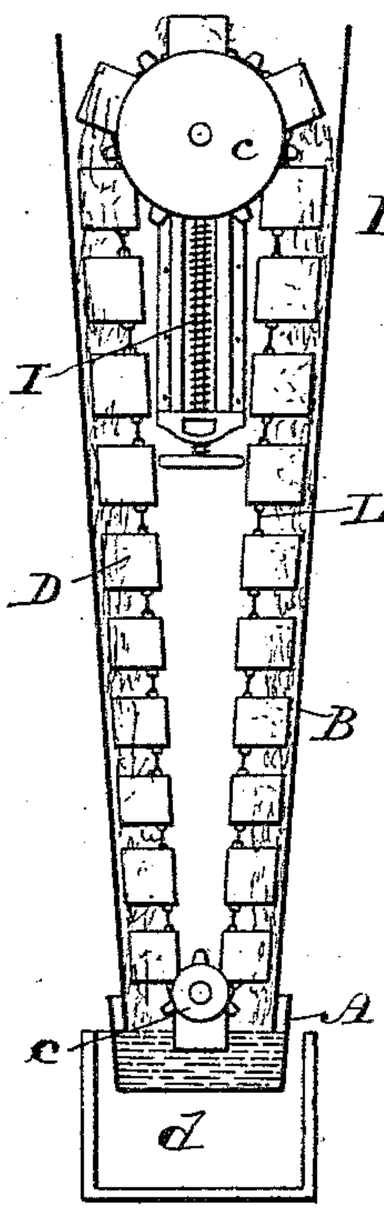


Fig. 10.

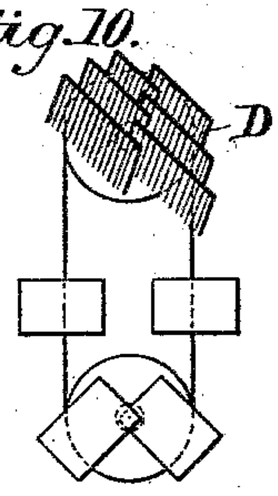


Fig. 14.

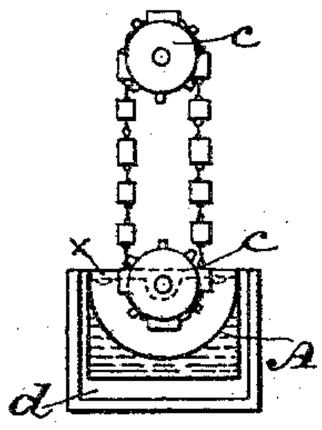


Fig. 11.

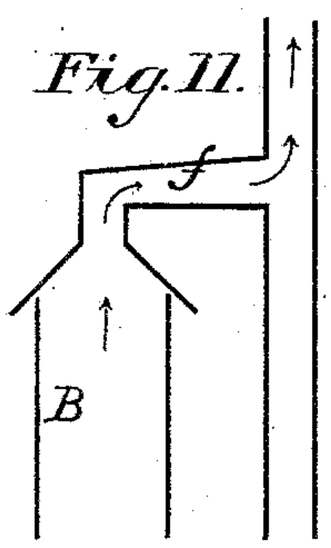


Fig. 15

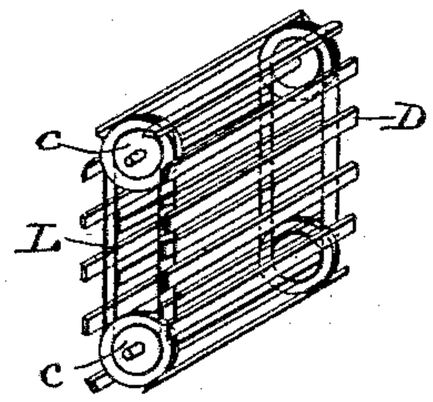


Fig. 12.

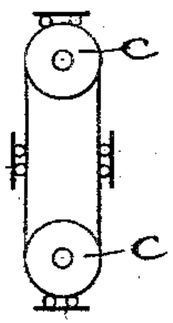
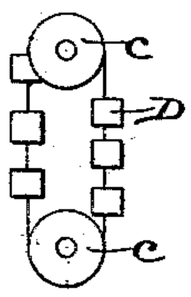


Fig. 9.



WITNESSES.

H. W. Elmore.

Wm J. Tanner.

INVENTOR

Albert A. Denton.

By his Attorney. L. Deane

UNITED STATES PATENT OFFICE.

ALBERT A. DENTON, OF BAVARIA, KANSAS.

APPARATUS FOR EVAPORATING LIQUID BY AIR.

SPECIFICATION forming part of Letters Patent No. 339,388, dated April 6, 1886.

Application filed April 23, 1885. Serial No. 163,198. (No model.)

To all whom it may concern:

Be it known that I, ALBERT A. DENTON, a citizen of the United States, residing at Bavaria, in the county of Saline and State of Kansas, have invented certain new and useful Improvements in Apparatus for Evaporating Liquids by Air and in Apparatus for Exposing Large Surfaces of Liquid to Air or Vapor or Gas, of which the following is a specification, reference being had therein to the accompanying drawings.

The object of this invention is to improve an apparatus for evaporating liquids by air for which Letters Patent were granted me December 23, 1884, No. 309,775, and also an apparatus for exposing large surfaces of liquid to air or vapor or gas, for which my application for a patent is now pending, and which was filed February 28, 1885.

The nature of the improvement consists, first, in changing the construction of the liquid-conveyers; second, in changing the construction of the compound slats; third, in changing the method of attaching the compound slats to the chains or belts; fourth, in using a special driving-shaft carrying special driving-wheels and giving motion to the liquid-conveyers; fifth, in using chain or belt tighteners; sixth, in first admitting the heated air under the basin containing the liquid instead of directly into the air-chamber; seventh, in admitting the hot air to the air-chamber after it has passed under the basin into a central vacant space between the ascending and the descending sides of the liquid-conveyer; eighth, in using deflectors to prevent the hot air from passing uselessly up through the central space between the ascending and the descending sides of the liquid-conveyer; ninth, it also consists in multiplying the evaporating surface by placing one liquid-conveyer over another, when desired, thus forming compound liquid-conveyers having large aggregate evaporating-surface, and, when it is desired, still further to multiply the surface connecting two or more of these compound liquid-conveyers by suitable gear-wheels, so that all move together; tenth, in diminishing the size of the basin, and thus the quantity of liquid operated on, by using smaller wheels in the basin than the upper wheels and than the special driving-wheels; eleventh, in connecting the cover of the air-chamber with the chimney of the heater for the air or for the liquid to increase the current of air through the apparatus, all of which is more fully set forth in the following specification. I accomplish these objects by the following methods:

First. Instead of using an upper and a lower shaft passing through the upper and the lower wheels of the liquid-conveyer to support the wheels, it is sometimes desirable to support the wheels on short journal pins or bearings, instead of shafts, thus allowing the air-chamber to be more completely filled with wet and moving slats than can be done when the shafts previously described are liable to interfere with the motion of the slats. This is more particularly an advantage when the slats are large or are rigidly attached to the chains by two pivot attachments, which are a considerable distance apart, as is shown in Fig. 1, and as hereinafter described.

Second. I make the compound slats more efficient, and they can be placed more closely together on the chains or belts, and they present less resistance to the free outlet of air from the air-chamber, and they pass through the liquid with less trouble by changing the direction of the slats and of the spaces between the slats with reference to the chains or belts—that is, by placing the single slats which compose the compound slats parallel with the chains or belts, instead of crosswise, as I have previously done, and as shown in Fig. 1.

In constructing the compound slats I use a cross-bar or a double cross-bar, Fig. 2, which has suitable attachments to engage with the chains or belts. To this cross-bar or double bar I rigidly attach the single strips, by any suitable method, so that the single slats and also the spaces between the slats, are parallel with the chains or belts. These single strips or slats are kept a proper distance apart to allow air to circulate freely between the single strips by collars or by blocks, and the whole is fastened together by bolts or rivets, as shown in Fig. 2, thus forming a compound slat having large surfaces, through which air can freely circulate.

It will be readily seen by an inspection of

Fig. 1 that when the compound slat thus constructed of single strips placed parallel to the chains or belts is passing over the upper wheels it offers little resistance to the passage of the saturated air out of the air-chamber, for the compound slat is in an edgewise position while passing over the upper wheel. It will also be readily seen that when the compound slat thus constructed is passing under the lower wheels it offers little resistance to the liquid, for it passes through the liquid edgewise. In dense and viscid liquids or semi-liquids—as, for instance, in reducing sirup to sugar—the compound slats move with great difficulty through the liquid in any other position than endwise or edgewise.

Third. I also modify the method of attaching the compound slats to the chains or belts. In my patent dated December 23, 1884, I used a single rigid attachment. The difficulty of this method is that when broad slats having large surfaces are used the weight and the strain of the slat are borne by a single link or by a single point of attachment to the chain or belt. This gives the slat a rocking and unsteady motion and is hard on the attachment.

In the apparatus for exposing large surfaces of liquid to air or vapor or gas for which my application for a patent is now pending I used a single pivot attachment for the slat to the chains or belts. The difficulty of this method is that then the compound slats frequently enter the liquid in a wrong position and turn upside down. This is more particularly the case when the slats are constructed of wood, for their buoyancy in dense liquids increases the difficulty. I overcome these difficulties by using two pivot attachments placed a suitable distance apart, according to the width and weight of the compound slat, as is shown in Fig. 3. I also make one or both of the sockets or bearings for these pivot attachments a slot or an elongated circle, *d*, as is shown in Figs. 2 and 4.

The object of the slot or of the slots is to allow the pivots to accommodate themselves to the curves of the wheels as the compound slats pass over the upper and lower wheels. It will be seen by an inspection of Fig. 1 that the chains or belts pass over the wheels a greater distance than the distance the slats travel, because, as the slats have two points of attachment to the chains or belts, the slat travels partly across the curves of the wheels, while the chains or belts travel a greater distance around the curves of the wheels. This in effect shortens the chains or belts, and the object of the slots is to allow the pivots to come closer together, and thus allow the chain or belt to shorten between the points of attachment to the compound slat. It is evident that one pivot may have a round socket or bearing, *d'*, and the other may have a slot, *d*, sufficient in length to allow the necessary shortening of the chain, as is shown in Fig. 2; or the bearings for both pivots may be slots, as is shown in Fig. 4; or the two pivots may both work in one slot, as shown in Fig. 5.

The length of the slot or slots will depend on the diameter of the wheels used, and also on the distance between the two pivot attachments.

The compound slat, when constructed as thus described, has many advantages over the compound slat previously described.

The compound slat, when attached to the chains or belts L as thus described, has many advantages over the compound slats attached as before described in my previous applications. The compound slats may thus be easily removed from the chains or belts for the purpose of cleaning or repair, or for shipping, and are easily replaced. They have a broad and a strong bearing on the chains or belts, and they are at all times held in their proper position edgewise to the currents of air passing through the air-chamber, and also edgewise to the liquid in the basin.

Fourth. When the upper and the lower shafts which pass through the upper and the lower wheels are dispensed with, and when short journal pins or bearings are used instead, then it is necessary to attach the pulley H, which gives motion to the liquid-conveyer, to a driving-shaft, *a*, Fig. 6, which carries wheels which give motion to both chains or belts of the liquid-conveyer, as shown in Fig. 6. This driving shaft may be placed in any suitable position; but I prefer to place it at the bottom of the air-chamber B, and near the top of the basin A, and I prefer to have the driving-wheels of the same diameter as the upper wheels, C C, and larger than the lower wheels, C' C'. This construction keeps the chains or belts tight on the driving-wheels of the driving-shaft, so that the wheels do not slip on the chains or belts, and it also allows the basin A to be made smaller, and thus reduces the quantity of liquid necessary to immerse the slats, and it also allows a vacant central space above the basin A, into which the hot entering air may first be admitted to the air-chamber, as is shown in Fig. 6 at *b*.

Fifth. When the chains or belts stretch by wear, or expand by heat or contract when wet, it is necessary to adjust their tension to enable them to work properly. I accomplish this by using belt-tighteners I, as shown in Fig. 7. These belt-tighteners may be of any suitable construction. In some cases, particularly when ropes or belts of fibrous material are used, which have considerable stretch and also contraction, it is advisable to overbalance the weight of the liquid-conveyer by weights and cords passing over pulleys at the top of the shaft to give proper tension, as is shown in Fig. 8. This construction allows the belts to contract in length when they raise the weights, and also allows them to stretch or expand in length when the weights descend, and thus always maintains the desired tension,

which may be regulated by increasing or diminishing the weights.

Sixth. I have found that the air entering the air-chamber is sometimes overheated, and when this is the case it sometimes burns the dry residues of the liquid which has dripped from the slats on the walls of the chamber. I also find that it is advisable to warm cold dense and viscid liquids, so that the compound slats may better pass through the liquid. When the overheated air passes first under the body of liquid in the basin A, which has a metallic bottom, the air parts with its excess of heat to the liquid, thus warming the liquid, and the air is not then so liable to burn the films of liquid in the air-chamber. I accomplish this by forming a hot-air chamber, *d*, Fig. 6, under the basin A, fitting closely to the two sides of the basin, so that air cannot pass into the air-chamber at the sides, but only at the ends of the basin A, and into a central space, *b*, Fig. 6, between the ascending and the descending sides of the liquid-conveyer. I also construct the basin A with a metallic bottom. By this construction the hot-air chamber mixes unequally-heated currents of air, giving a more uniform temperature. The hot air warms the liquid in the basin A first, thus parting with any excess of heat, and then the hot air is admitted to the air-chamber and directed first upon the freshly-wet surfaces of the liquid-conveyer before coming in contact with the dry residues of evaporation adhering to the walls of the air-chamber B, which are much more liable to burn than the freshly-wet surfaces of the liquid-conveyer.

Seventh. In order to prevent the hot air from passing uselessly through the vacant central space between the ascending and the descending sides of the liquid-conveyer, and in order to deflect and direct the hot air upon the wet-surfaces of the liquid-conveyer, I use deflectors *c c c*, Fig. 6, to cl se the central space above the place where air is admitted.

Eighth. The efficiency of air-evaporation is dependent largely on the extent of surface of liquid which is exposed to air. The evaporation can be greatly increased by using single-slat liquid-conveyers passing through liquid and through air in or out of a chamber. It can be still more increased by composing the liquid-conveyers of surface-multiplying compound slats. The surface and the evaporation can be further increased by connecting two or more single-slat or compound-slat liquid conveyers by gear-wheels, so that they all move alike through the liquid and through the air. The surface may also be still further increased in compact space by placing one single-slat or compound slat liquid-conveyer over or around another-liquid-conveyer, each liquid conveyer moving on its own wheels, of suitable diameter, to avoid interference between the liquid-conveyers, and these several wheels supporting the several liquid-conveyers all moving upon the same upper and lower axes or centers, which are shafts or journal-pins, as is shown in Fig. 15, and two or more of these compound liquid-conveyers composed of two or more single-slat or compound-slat liquid-conveyers may also be connected together by gear-wheels, thus obtaining very large aggregate evaporating-surface. When motion is given to the driving-pulley H, each compound liquid-conveyer travels around its two centers of motion, and each single liquid-conveyer travels upon its own wheels upon the axes of the compound liquid-conveyer.

Ninth. In constructing the liquid conveyers having compound slats the compound slats may be so attached to the chains or belts as to hang outside the chains, as shown in Fig. 1. The compound slats may also be so attached to the chains or belts as to hang centrally upon the chains or belts, as shown in Fig. 9. The compound slats may also be so attached to the chains or belts as to hang mainly outside the chains and partly between the chains. In some forms of the apparatus, and with some sizes of compound slats, I prefer the construction shown in Fig. 1; but I do not limit myself to this construction.

Tenth. The compound slats may be so attached to the chains or belts that the inner arms overlap each other or interlace or pass between each other when passing over the upper wheels or under the lower wheels, as shown in Fig. 10. In order to successfully accomplish this, it is necessary to "stagger" or to space differently the single strips which compose each alternate compound slat, so that when the compound slats pass over the wheels the single strips composing one compound slat will pass through the spaces between the single strips composing the next compound slat. This will be readily understood by inspection of Fig. 10.

Eleventh. I also connect the cap or cover of the air-chamber B by a pipe or flue, *f*, as shown in Fig. 11, with the chimney of the air-heater or of the liquid-heater. By this method of construction the hot gases of combustion passing up the chimney of the heater cause an increased draft of air through the air-chamber, which increases the rapidity of the evaporation in the air chamber.

Twelfth. In the air-evaporating apparatus constructed as described it is evident the air entering the chamber may be previously heated in an air-heater of any suitable form; or the air may be heated by contact with the liquid-conveyers which pass through the liquid to which heat is applied in any convenient way; or the air and the liquid may both be heated, combining both methods, so as to heat quantities of air easily, as was described in my application for a patent for apparatus for exposing large surfaces of liquid to air or vapor or gas which is now pending.

Thirteenth. It is apparent that the single slats in a single-slat liquid-conveyer can also have its slats attached to the chains or belts

by the double pivot attachment, as shown in Fig. 12.

In constructing the double pivot attachment working in slot-bearings and described above I prefer what is known as "Ewart attachment links D^3 or D^5 or M," or their substantial equivalent.

In order also to aid in preventing the dry residues on the walls of the air-chamber where the hot air enters, and also to increase the wet evaporating-surfaces, the air-chamber may be built wider at the top than at the bottom, as shown in Fig. 13, and larger wheels may be used at the top of the air-chamber than the lower wheels. In this method of construction the liquid dripping from the slats as they pass through the chamber falls partly on the walls of the air-chamber, as shown by dotted lines in Fig. 13, and descends thence into the basin A. The formation of dry residues of evaporation of scattering drops of liquid on the walls of the air-chamber, which are much more liable to burn than freshly-wet surfaces when the air is accidentally overheated, is prevented, and the surfaces of the walls of the air-chamber are thus also partly utilized as additional wet evaporating-surfaces.

I may, if desired, suspend the basin A, containing the liquid, from the lower wheels of the conveyer, as now generally indicated in Fig. 14, so that the weight of the basin and its contents will give suitable tension to the chains or belts carrying the slats D. I may confine the basin A to the shaft of the lower wheel by means of straps *x*, or by any suitable mechanical contrivance accomplish the same end, or the end of the journals of the wheel may pass through the sides of the basin. I also construct the basin and so confine it by guide-strips or by side walls that it may have sufficient vertical movement to adjust itself to the contraction or the expansion of the chains or belts, allowing no other movement of the basin, for the purpose of adjusting tension in the chains or belts, as set forth.

In some of the forms of construction of the liquid-conveyers already described the weight of the basin A and the weight of the liquid which is contained in the basin is sufficient to properly tighten the chains or belts if the basin is allowed to hang upon the lower wheels, C′ C′, so that its weight and the weight of the liquid it contains is suspended by the chains or belts, as is shown in Fig. 14. In this case it is necessary to prevent lateral motion of the basin, and also to prevent a tendency of the basin to revolve around the lower wheels, which is caused by the resistance of dense liquids to the motion of the compound slats through the liquid. The basin must be confined so that it can move only in a vertical direction up and down sufficiently to allow the chains or belts to expand when hot or when dry, and to contract in length when cold or when wet. This may be done by making the ends of the basin A square and placing them between guide-strips *h*, as shown in Fig. 14, or by substantially equivalent methods. By this method of construction belt-tighteners or "take-up boxes" may be dispensed with. The basin and the liquid give self-adjusting tension, avoiding the danger of overtightening the belts or chains and of contraction in the chains or belts after tightening them by the ordinary take-up boxes, which are unyielding, and avoiding the great weight necessary to overbalance the weight of the liquid-conveyers on the upper wheels.

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

1. An oblong elongated liquid-conveyer composed of chains or belts passing over two axes or centers of motion, these chains attached to compound slats, the compound slats so attached to the chains or belts that they may hang in any suitable position, and so attached that there may be a vacant central space between the ascending and the descending sides of the liquid-conveyer, or may closely fill all the available space in the air-chamber, as desired, and as set forth.

2. In an oblong liquid-conveyer having two centers of motion, a compound slat consisting of single strips of metal or of wood, and placed a proper distance apart to allow air to circulate between them, and attached to the chains or belts by double pivot attachments, as set forth.

3. In a compound slat, single strips of metal or of wood rigidly attached to a cross-bar, or to a double cross-bar, and placed a proper distance apart to allow air to circulate freely between them, with collars or blocks or equivalent between them, and the whole firmly fastened together, this compound slat having a crosswise position with reference to the chains or belts, while the single strips of which this compound slat is composed have a direction parallel with the chains or belts, and this compound slat so attached to the chains or belts as to hang in any suitable position, so that it always presents its edges to the currents of air and also to the liquid, as set forth.

4. In the liquid-conveyer of an evaporating apparatus, the combination of slats having slots or bearings in each end, as described, with the carrying chains or belts, and pivot attachments, whereby said attachments will engage in two slots of each slat, or in one bearing and in one slot, or in two bearings.

5. The basin A, having a metallic bottom, combined with the hot air chamber *d*, in the manner and for the purposes described.

6. In an evaporating liquid-conveyer as described, the combination of the conveyers or slats with the basin containing the liquid and the heating-chamber beneath and about its ends, as and for the purposes set forth, whereby the heated air passes under the basin about

its ends and into the open or vacant space between the ascending and descending liquid-conveyers.

7. In an evaporating apparatus as described, having ascending and descending conveyers, the provision of heat-deflectors in the spaces between the conveyers.

8. In an evaporating apparatus, a liquid-conveyer combined with its conveying chains or belts, as described, whereby the slats may hang outside the chains or belts, or centrally therein, or partly outside and partly inside, all as set forth and described.

9. In an evaporating apparatus, the compound slats of the liquid-conveyer combined with chains or belts and wheels at top and bottom, said wheels being of different diameters, whereby a vacant central space is provided between the inner edges or sides of the ascending and descending slats or conveyers, substantially as described.

10. The combination of the liquid-basin with the lower driving-wheels, whereby the weight of the basin and its contents will give suitable tension to the conveying belt or chain, substantially as described.

11. The basin A, confined by guides or side walls, as described, whereby it will have suitable vertical and adjusting movement, but no other, substantially as set forth.

12. In an evaporating apparatus, an oblong liquid-conveyer having two centers of motion, the single strips or slats composing each alternate compound slat being staggered or alternated, substantially as and for purposes described.

In testimony whereof I affix my signature in presence of two witnesses.

ALBERT A. DENTON.

Witnesses:

C. A. HUBBARD,

ORLO HUBBARD.