E. SPERRY.

Sorghum Evaporator.

No. 68,665. Patented Sept. 10, 1867.

Fig. 1.

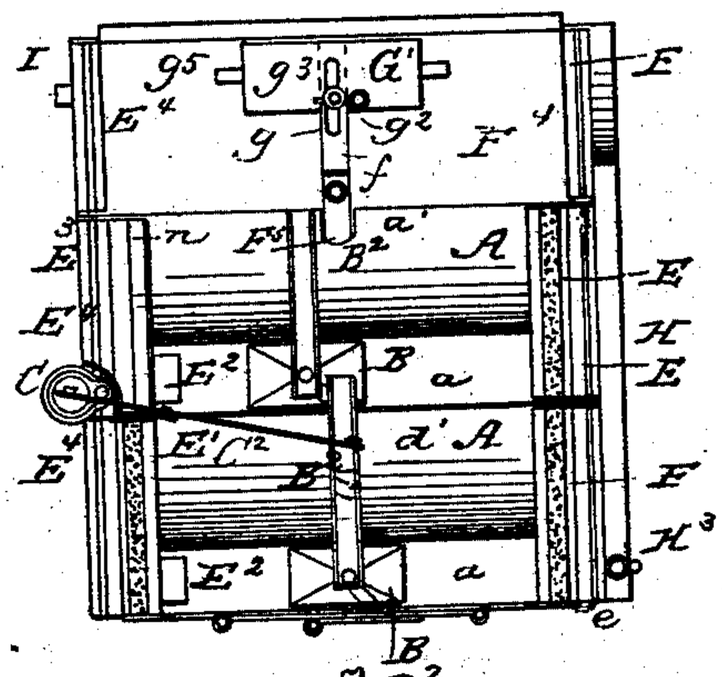


Fig. 2

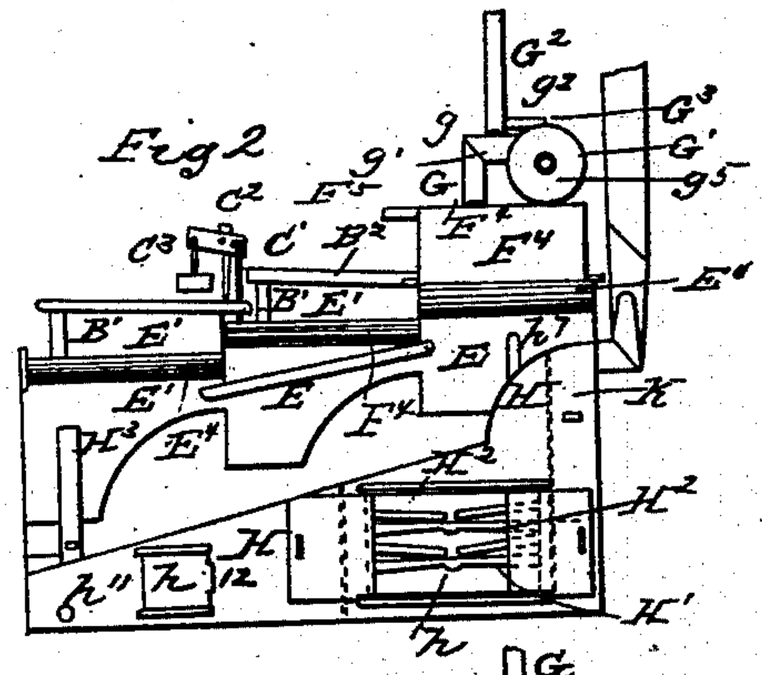


Fig. 3

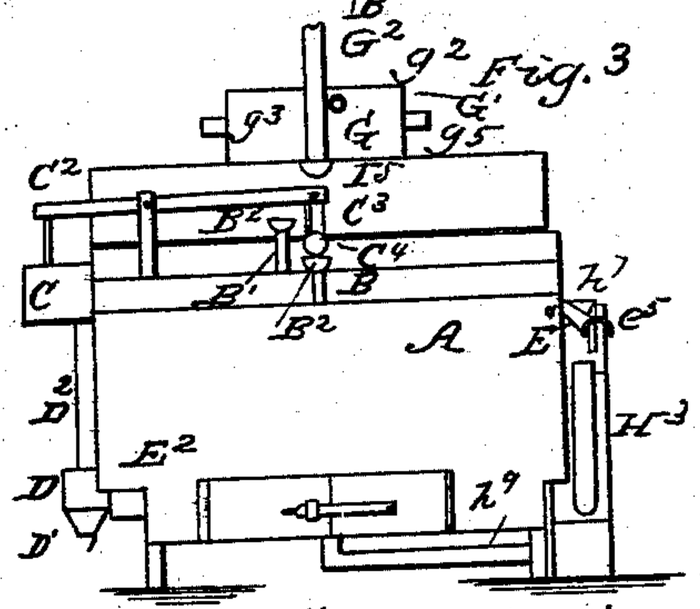


Fig. 4

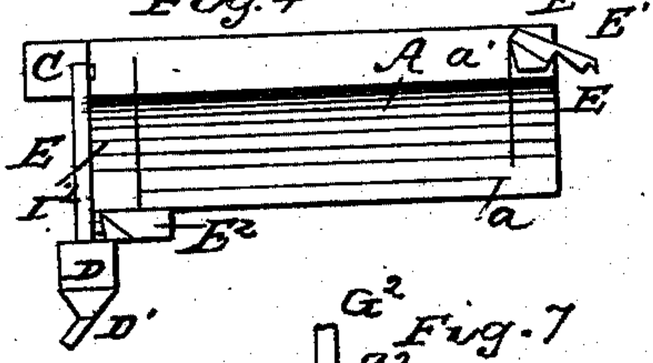


Fig. 5

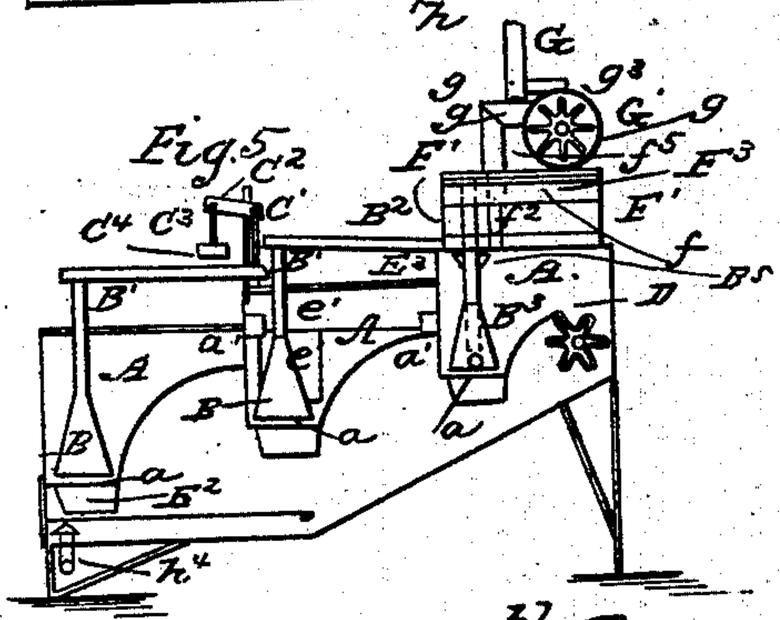


Fig. 6.

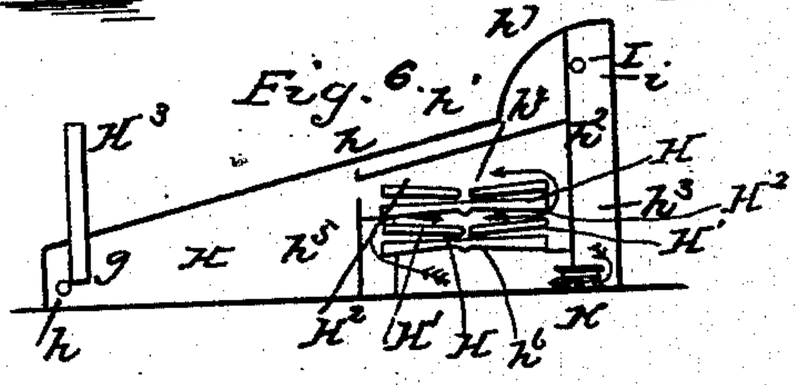
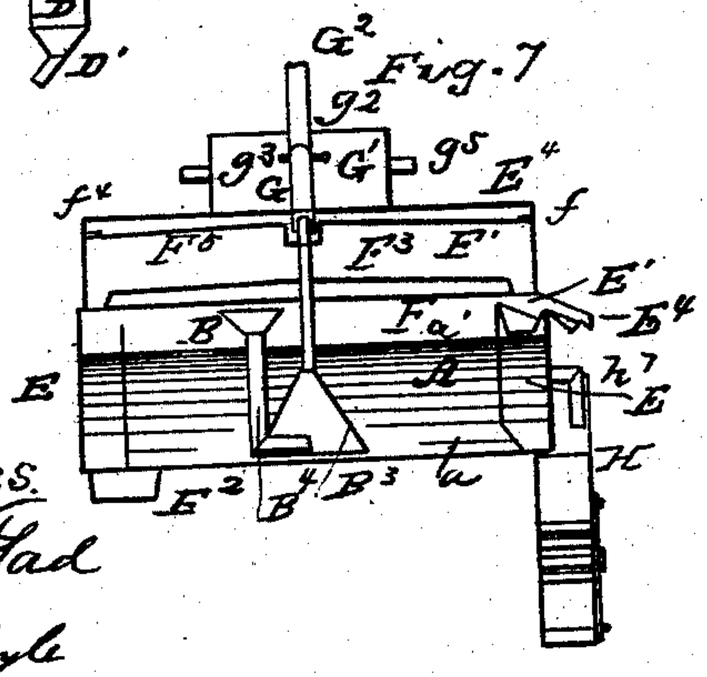
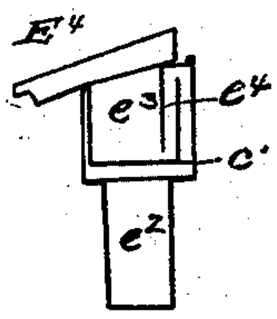


Fig. 7



Section of Sink E^3



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EBENEZER SPERRY, OF MIAMI VILLAGE, KANSAS.

Letters Patent No. 68,665, *dated September* 10, 1867.

IMPROVED SORGHUM-EVAPORATOR.

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, EBENEZER SPERRY, of Miami Village, in the county of Miami, and State of Kansas, have invented a new and useful Improvement in Evaporating Apparatus for the extraction of the saccharine matter from the juice of sorghum and sugar-cane, or other saccharine-producing materials; and I do hereby declare that the following is a full and clear description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

This invention relates, firstly, to the peculiar form of boiler used in this evaporator; secondly, to an elevator, by means of which the boiling fluid is elevated from one boiler to another; thirdly, to a cleanser, which is used for the purpose of drawing off from time to time sedimentary impurities, such as earthy matter or glutinous residue that will accumulate in the bottom of the boiler during the boiling process; fourthly, to an arrangement of skimmers and sinks, the former of which are self-operating, and the latter are designed to receive the new liquid supplied to the boiler and the drainage of the skimmers, or rather the fluid that will rise in the boiler by the process of boiling and flow over into the skimmers, and so on down into the sink again, thus forming a continuous upward and downward flow of the boiling liquid; the sinks are divided into an upper and lower portion to each separate one, the lower or sub-sink portion being designed to receive the heavy sedimentary deposit, that would superinduce burning or scorching of the sirup if it were allowed to settle on the bottom of the boiler in parts exposed to the direct action of the fire; fifthly, to a cooler, for lowering the temperature of the liquid in the boiler, where it is boiled to the highest state of concentration; sixthly, to a condenser and liquid-heater, where the steam from one or more of the boilers may be condensed and utilized; seventhly, to a hot-air drying-chamber, where the fumes from the boiling sirup may be utilized; and, eighthly, to the air-heater and heat-regulators, and also to the arrangement of hot-air flues.

To enable those skilled in the art to make and use my improved evaporating apparatus, I will proceed to describe its construction and operation.

Figure 1 of the drawings is a plan of the improved apparatus.

Figure 2 is a side elevation of one side of it.

Figure 3 is a front elevation.

Figure 4 is a longitudinal section of one boiler and its sinks, and the cleaner.

Figure 5 is a transverse section through the series of boilers, showing more clearly the construction of the boiler bottoms, also the cooler and the condenser.

Figure 6 is a sectional elevation of the hot-air drying-chamber.

Figure 7 is a sectional elevation of the finishing boiler.

A, in figs. 1, 3, 4, 5, and 7, represents the boilers receiving the green juice. The bottoms thereof are, as shown in fig. 5, composed of flat parts *a* and arched parts *a'*, for giving a large capacity and affording a large heating surface. The several boilers A are placed relative to each other in the positions as specially shown in fig. 5, and the liquid is raised successively from the lower to the higher boilers by an elevator device, specially shown in figs. 1, 2, and 5, and thus arranged: B is a funnel-shaped base, resting upon the bottom *a* of each boiler A. B connects at the top with a tube, B^1, which connects with the inclined trough B^2. When, now, the liquid in A boils, vapors collect in B and rise in B^1. If the pressure arising from the escaping vapors is sufficient, a current is induced through B and B^1 which will cause a flow of liquid up B and B^1, and into B^2. Should the steam current, however, be insufficient to raise the fluid, a small steam pipe may be introduced into B^1, and a jet of steam be used therefrom in connection with the forces aforesaid, said steam-jet acting on the principle of a steam-siphon. To insure a free and easy flow of the liquid in the trough B^2, that end of it which is supported by the tube B^1 should be a little higher than the other end, thereby giving a gentle descent to that end of the trough to which the liquid is expected to flow. The flow of the liquid in this trough may be regulated by means of a fountain-gauge, *i. e.*, a gauge which is actuated by a floating buoy, resting on the surface of the fluid, in a vessel communicating with the boiler. In the present instance it consists of a buoy-chamber, C, into which the fluid from the boiler flows through a connecting pipe, and stands at the same height in both boiler and buoy-chamber; and when this surface is as high as required for the boiler, a floating buoy within the chamber C will raise the rod C^1, to which it is attached, and this rod will in turn raise the outer end of the lever C^2, and conse-

quently the inner end of this lever will suffer a corresponding depression. The rod C^3, attached to the inner end of the lever, has a gate, C^4, which, when the buoy is raised, will be forced more or less into the trough B^2, and thus impede or wholly stop the flow of the liquid in the said trough. It is to be understood that the buoy-chamber is to be connected with the boiler that is to be filled, and there will be one of these fountain-gauges to each of the boilers, the first of which will regulate the flow of the raw juice or liquid from its reservoir into the primary boiler. The other gauges will regulate the flow of the fluid from the several elevators, one of which will be placed in each of the boilers, except the last, to feed the boiler next above and behind it. The elevator placed in the last boiler will be used for a different purpose, as will be hereafter more fully explained. When the gate C^4 is shut down tightly into the trough B^2, the fluid contained in the trough will overrun the sides of the said trough, and fall down again into the boiler from whence it was raised.

The third part of this invention, the cleanser, consists of the following devices: D is a reservoir or chamber, which has a hopper bottom, from the bottom of which there is a waste or discharging pipe, D^1, and this pipe should be provided with a stop-cock, (not shown.) The reservoir D should be connected with the bottom part of the boiler to which it belongs by a pipe leading into the sink connected therewith. Of this sink a more full and complete description will be given under that head, and this connection will thereby be more clearly understood. From the top end of the reservoir or chamber D there is a vertical pipe, D^2, the upper end of which is to be in open communication with the boiler A, and this communication may be made, as in the accompanying drawings, through the buoy-chamber C. The object of these connections is to keep up a continuous current into and through the reservoir or chamber D, where the heavy or earthy deposits will be left, as it is the lowest point in the whole series of vessels forming the boilers and their connections, and from this receptacle the heavy deposit may be drawn off through the discharge pipe D^1. The stop-cock or faucet which governs the discharge from D^1 might be made to operate automatically by a modified arrangement of the fountain-gauge already described.

There is at each end of every boiler a sink, E, into which the boiling or surface liquid is precipitated, and from the bottom of which it is afforded free and open access into the boiler again through an aperture made in the bottom part of the partition wall that divides the boiler from the sink. A continual upward and downward flow or current of the boiling liquid will thus be maintained during the whole operation of boiling. There may be other forms of sink used, but this one is the most preferable. The others will be described hereafter. There should be at one end of each boiler a sub-sink, E^2, into which the heavy deposit or earthy matter that may adhere to the cane when laid upon the field during harvesting, or the mucilaginous residue of the sirup, will settle, and may be drawn off through the pipe *e* into the purifier or cleanser D. Another form of sink is represented in figs. 1, 4, and 5, by the letter E^3. There is also a detailed sectional drawing of the sink E^3. The construction of this sink is as follows: A trough, e^1, placed at one end of the boiler, has a leg, e^2, reaching down into the deep part of the boiler, to within a short distance of the bottom *a*. There is a trough, e^3, placed within the trough e^2, and resting on it by means of short legs, so as to leave a space of half an inch (more or less) between the bottoms of the two trays. The tray or trough e^3 is also a little narrower than the other one, and the space left between the sides of the two should be adjacent to the boiler, and a skimmer, e^4, which is an L-shaped piece of metal, is arranged with one of its legs attached to the end of the boiler proper, or the inner side wall of the trough e^2, while its other leg is extended down into the trough e^3 to near its bottom. As the fluid from the boiler flows over the skimmer e^4 into the trough e^3, it will rise up in the space formed between the vertical leg of the skimmer and the contiguous side wall of the trough e^3, over the top of which wall it will find an exit down through the leg e^2 into the bottom of the sink, and thence again into the boiler as before. The vertical leg of the skimmer e^4 depending into the fluid in the trough e^3 will arrest all of the scum that may come over with the boiling fluid. This scum will be disposed of in a manner hereinafter explained. By constructing the sinks as in the foregoing description, the heavy deposit is allowed to settle outside of that part of the boiler which is exposed to the direct action of the fire, and consequently there is but little liability to burn the boiling fluid.

The skimmers E^1 are to be formed of sheet metal, and very finely perforated. They are to be attached to the ends of the boilers, directly over the sinks, and so arranged that the scum which rises up on the top of the boiling fluid will fall over into them, where what is really scum can be drawn off. The ascending volume of the boiling fluid within the boiler A will flow over into the sinks through the skimmers E^1, or those already described as belonging to the sink E^3, and thence down into the sub-sink E^2, and so on back into the boiler, thus keeping up a continuous upward and downward current of the boiling fluid. In case the scum should not be sufficiently drained before passing from the skimmers, there is a trough, E^4, along the sides of them, into which the surplus fluid may escape, and from whence it may be drawn through a siphonic tube or pipe, e^5, and be conducted thence back into a boiler through a tube, (not shown.) In order to make the scum and fluid boil over into the strainers and not into an adjoining boiler, or on to the ground, (if only one boiler is used,) the side walls of each boiler should be made some three or four inches (more or less) higher than the end walls thereof. For details of these parts see fig. 4.

We now come to the description of the last or finishing boiler, and of the cooler connected therewith. In order to prevent burning the highly-concentrated liquid under the funnel B^3 in this boiler, I cause the liquid to be fed directly into it through the stand pipe B^4, (see fig. 7,) which operates as a receiving-sink for this boiler. The trough B^2, which supplies this last-named boiler with its fluid, discharges its contents into a small funnel, B^5, on the upper end of the pipe B^4. In order to retain the fluid in the last boiler as long as possible, and at the same time to keep it at a uniform temperature, and to prevent scorching it, I employ a cooler of the following construction, which will be readily understood by reference to fig. 7. This cooler has a plate, F, which fits closely to the sides of the boiler, but so as to leave an opening at each end which will allow the air to enter.

On each side of the plate F there is a vertical plate, F^1, extending the whole length of the boiler, and, say, six to eight inches (more or less) above it. Just above the plate F, and between the plates F^1, is another horizontal plate, F^2, the ends of which are bent down to the plate F, and these two together form a double bottom, with a dead space of, say, half an inch between them. About one or two inches (more or less) below the top edges of the plates F^1 is another horizontal plate, F^3, which is perforated with a large number of very small holes. The plate F^3 has a channel, *f*, of the depth of one or two inches, more or less, extending across its centre, and from this groove the said plate has a gentle descent of about one degree (more or less) toward each end. There will be a flange turned up at each end of this perforated plate, and these flanges, together with the upper edges of the plates F^1, will form a shallow basin on the top of the plate F^3. The plate F^4 forms a close-fitting joint along the top edges of the plates F^1, and a cover for the shallow basin above F^3. This covering plate should be somewhat longer than the sides F^1, and have its outer ends turned downward, so as to properly direct the current of the incoming air in its flow into the chamber between F^2 and F^3. The covering plate F^4, like the plate F^3, has a transverse groove or channel, *f*, which, when the two plates are in place, will extend downward into the groove in the lower plate. The groove of the upper plate should be finely perforated, so as to permit the fluid to pass through without any of the scum. The channel *f* (in figs. 1, 5, and 7) connects with a spout, F^5. To retain the fluid in *f* to a proper height, it is compelled to flow over a partition, f^1, fig. 1, in its passage toward F^5. From *f* the fluid is forced to diffuse itself over the sloping perforated plate F^3. Through the perforations hereof the fluid filters, being cooled by the currents of air passing between the plates F^2 and F^3, and reaches the plates F^2 and F. The fluid then passes the skimmers E^1, fig. 7, in a manner similar to the one formerly described. I employ the pipes f^2 and f^3, of fig. 5, to carry off the vapors from the space between F^2 and F^3.

We next come to the description of the condenser and liquid-heater, by means of which the vapor that rises from the boiling sirup may be utilized. In the accompanying illustrations, the steam is only conveyed to the heater from the finishing boiler through the pipes f^2 f^3, (see fig. 5,) but it is obvious that by a similar arrangement of pipes, or of a single pipe and cover over any of the boilers, the steam from the boiler or boilers so connected might also be utilized in the same manner as that next hereinafter described. The pipe G receives the upper ends of the pipes f^2 and f^3, and conducts the vapor received therefrom into the heater G^1. The pipe G has an elbow at *g*, and a nearly horizontal pipe, g^1, leading from the said elbow into the heater G^1. This portion of the pipe g^1 should be slightly inclined downward from the elbow to the heater, so that any condensed steam therein will run into the heater. There is an escape chimney, G^2, leading upward from the horizontal pipe g^1, and this should be provided with a damper, g^2, near its lower end, so that the direct escape of the steam and air may thereby be cut off and turned aside into the heater. An escape pipe, G^3, leading from the top part of the heater, discharges the escaping steam and air into the chimney G^2, above the damper g^2. When the said damper is closed, the flow of the steam and air will be into and through the heater. The heater device G^1 is intended to receive waste steam from the pipes f^2 and f^3 and g^1, as shown in figs. 2 and 5. The said steam passes into the exterior cylinder g^3. Within this is a corrugated cylinder, closed at each end, g^4, to receive the fresh or green juice, which passes into and out of said cylinder g^4 by pipes, g^5, at each end of g^4. The steam surrounding g^4 then heats the liquid in g^4 preparatory to its being boiled in A. A faucet (not shown) draws off the water of condensation from g^3.

The next feature of this invention is the drying-chamber. This consists of a chamber, H, the general outline of which is clearly shown in figs. 1, 2, and 6. In the preliminary synopsis of this part of the invention, I would state that the primary object of the drying-chamber is to still further reduce the sirup to a more concentrated state after it leaves the finishing boiler, by running it in small streams through a heated current of air, and the said heated air would, by the operation, become so impregnated with the fumes of the boiling sirup that it might be utilized for the purpose of drying fruits, and afterwards fed into the furnace under the boilers in its heated state to support combustion. The internal arrangement of this drying-chamber will readily be understood by reference to fig. 6. The top plate *h* forms an angle of about ten degrees (more or less) with the horizon. A short distance below the plate *h* (say one or two inches) is another plate, h^1, set at the same angle of inclination as plate *h*. The vertical plate h^2, running from the top plate of the drying-chamber nearly to the bottom, forms the chamber h^3, fig. 6, into which the heated air passes (from a heater, I, yet to be described.) The temperature of the air in h^3 is regulated by a valve, K, which may be made to act automatically.

The air-heater I is formed (see fig. 5) similarly to the fluid-heater G^1, before described. It may be sustained on the air-supply pipe *i*, fig. 6, which receives fresh air from without and passes it into the corrugated cylinder of the air-heater I, at the same time the hot gases from beneath A strike the exterior of said corrugated cylinder, thus heating the air within it. The hot air having passed out of the heater I and into the chamber h^3, passes beneath the partition h^2, (see fig. 6,) and into the drying-chamber H, as before stated. Besides the division h^3, the interior of the chamber H is subdivided into two other apartments, h^4 and h^5. The apartment h^4 has a series of perforated shelves, H^1, as shown clearly in fig. 6. These shelves are similar in construction to the perforated plate F^3, already described as belonging to the cooler of the finishing boiler. Above each of the shelves H^1 are two covering plates, H^2, which are arranged so as to slope down gently toward the central trough h^6. The two ends of the shelves H^1 descend somewhat from the trough to the ends. The boiling fluid in the last boiler is discharged continuously through a pipe, h^7, into the top of the drying-chamber, where it will run down through the perforations of the plate h^1 in small streams on to the top of the inclined plates H^2, which inclined plates will cause it to run down into the trough h^6, from whence it will be again diffused over the top of the perforated plate or shelf H^1, through the perforations of which it will again pass down in small streams to the next lower shelf, where the operation of concentration into the central trough and of diffusion over the perforated shelf will again take place, and so on to the bottom shelf, from whence the finished sirup may be drawn off through the spout h^8 into a suitable receptacle outside of the chamber. While the sirup is thus passing down from one

shelf to another in minute streams, it will be still further reduced and concentrated by action of the air upon it, as the said air through which it drops down is a strong current taken from the heated air in the chamber h^3, and drawn through in the direction of the red arrows in fig. 6, alternately under and over the several trays or shelves H^1, until it finds its exit at the top of chamber h^4 into the contiguous one h^5, from whence it is discharged through the pipe h^9 into the fire-box, and there supports the combustion of the fuel that heats the boilers A. The end of the pipe h^9 that conveys the air into the fire-box should be turned up in a vertical direction, and a cap, h^{10}, placed over its upper end, so as to prevent ashes from the grate from passing down into the said pipe and stopping it up. There should be an escape chimney, H^3, erected upon the lower end of the chamber H, as seen in the side elevation, which will serve for the escape of the heated air or any portion of it, when not needed for the use of the fire. The lower end of this chimney should extend down into the chamber H to near its bottom, and should be provided with a suitable self-operating damper. As the fire in the furnace is to be supplied with air entirely from this source after the fire has been started, there will thus be kept up a continual current the whole time. Any steam that may be contained in the air after having passed through the chamber h^4, and that may become condensed in h^5, may be drawn off by means of a suitable stop-cock at h^{11}. The chamber h^5 should be provided with side doors, h^{12}, through which fruit may be introduced into it for the purpose of being dried by the passing current of hot air, charged with the fumes of the sirup in h^4.

The boilers A may be made of sheet or cast metal, and may be used singly or in groups. If they are to be set up in groups, (as will be most advantageous,) they should be made singly, and when set up the interstices between the different boilers may be stopped up with clay or mortar. Until the fluid of the finishing boiler has arrived at a sufficiently concentrated state to be drawn off into the drying-chamber H, it may be returned to the primary boiler through a pipe, L, and this is the principal advantage of raising one of the boilers higher than the one which precedes it.

Having described my invention, what I claim is—

1. The boiler A, when its bottom, $a\ a^1$, is constructed as herein described and set forth.

2. I claim the combination and arrangement of the boiler A, the elevators B B^1, and troughs B^2, substantially as and for the purpose described.

3. The arrangement of the cleanser D D^1 D^2, substantially as and for the purpose set forth.

4. The sinks E, with or without the sub-sinks E^2, substantially as and for the purpose set forth.

5. The arrangement and combination of the stand pipe B^4 and elevator B^3, substantially as set forth.

6. The combination of the pipes f^2 and f^3 with the cooler F F^2 F^3, substantially as set forth.

7. The arrangement and combination of the corrugated cylinder g^4 with the exterior casing g^3 and the pipes G g, as set forth.

8. The combination of the hot-air chamber h^3 with the finishing-chamber h^4 and drying-chamber H, arranged substantially as set forth.

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