Cross Reference
159/6

Feb. 27, 1940. S. LONG 2,192,089

EVAPORATOR

Filed Nov. 1, 1938 2 Sheets-Sheet 1

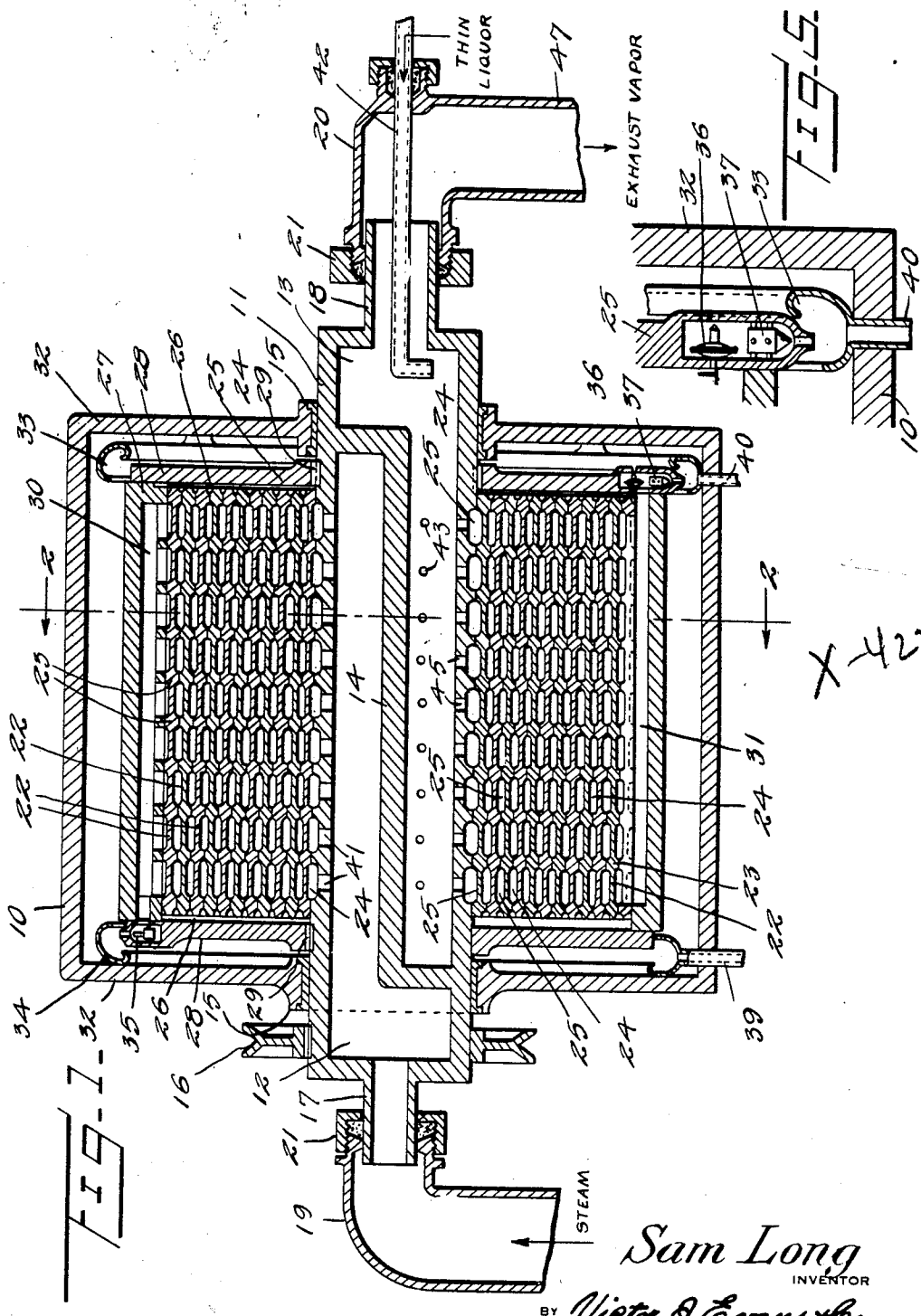



FIG. 1

FIG. 5

X-4220

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Fig. 2.

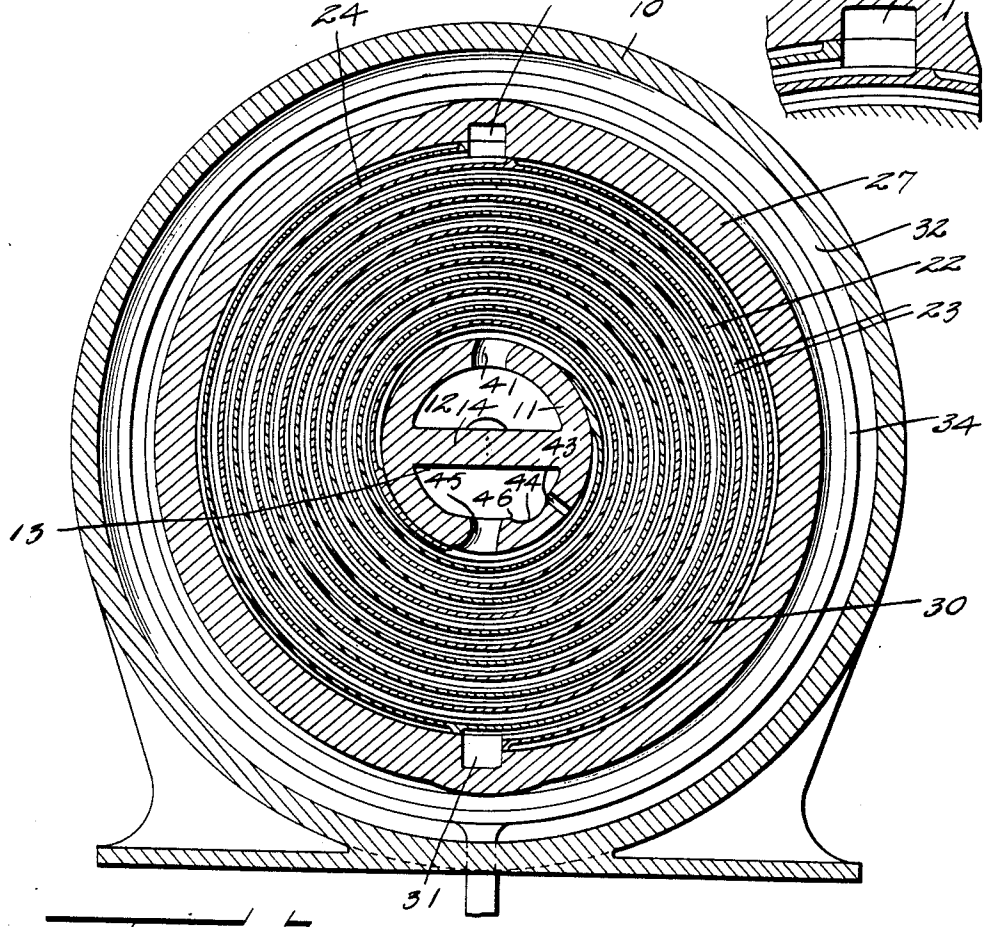



Fig. 6.




Fig. 3.

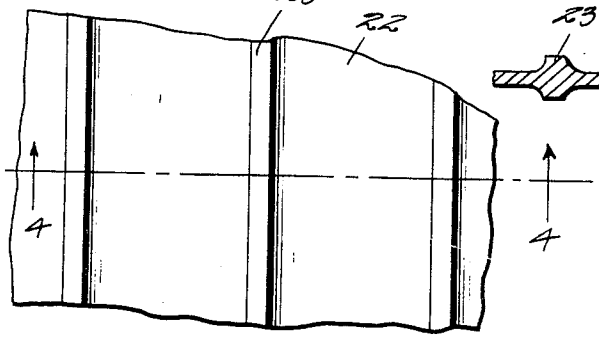
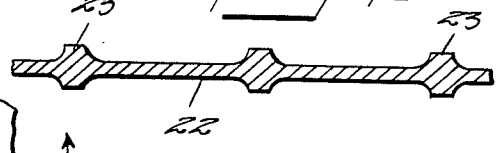



Fig. 4.




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Patented Feb. 27, 1940

2,192,089

# UNITED STATES PATENT OFFICE

2,192,089

## EVAPORATOR

Sam Long, Manhattan, Kans.

Application November 1, 1938, Serial No. 238,285

9 Claims. (Cl. 159—6)

The present invention relates to a new and improved evaporator especially designed for any non-salting evaporation, such as the concentration of clarified sugar beet or sugar cane juices.

In the process of evaporation, there are several factors which limit the capacity of a given piece of apparatus. One of these factors is the film of water which collects on the heat transfer surface of the steam chamber and hinders the passage of heat from the steam to the evaporating chamber. Another factor is the film of vapor which forms on the heat transfer surface of the liquor chamber and also materially affects the transfer of heat. The depth of liquor in a large evaporator may often cause an appreciable increase in the boiling point of the liquor at the heat transfer surface due to hydrostatic pressure. Foaming and entrainment are also serious problems in some cases.

In order to reduce the difficulties as outlined above, the primary object of the present invention is to provide an evaporator in which the boiling liquor compartment and condensing steam compartment constitute spiral passages arranged about a common axis and adapted to be rotated at high speed so that centrifugal force will cause the liquids to flow toward the outer end of the spiral passages.

A further object of the invention is to provide an evaporator having a large heat transfer surface which is assembled within a comparatively small area combining the use of centrifugal force to aid in the removal of water film from the heat transfer surface.

A still further object of the invention is to provide a compartment for the liquor to be evaporated which is formed of spiral passages with a means of feeding the liquor thereto in a thin, rapidly moving film thereby materially reducing the thickness of the vapor film on the heat transfer surface, thus promoting surface evaporation rather than a boiling action.

The invention will be fully and comprehensively understood from a consideration of the following detailed description when read in connection with the accompanying drawings which form a part of the application.

In the drawings:

Figure 1 is a longitudinal sectional view through the evaporator and illustrating the principal details thereof;

Figure 2 is a vertical sectional view taken substantially on line 2—2 of Figure 1;

Figure 3 is a fragmentary elevational view of a sheet of material employed for the forming of the spiral passages;

Figure 4 is a longitudinal sectional view taken substantially on line 4—4 of Figure 3;

Figure 5 is an enlarged fragmentary sectional view of a portion of the evaporator and illustrating an arrangement of valves for permitting the discharge of condensation and vapors, and

Figure 6 is an enlarged fragmentary sectional view of the steam discharge end of the evaporator.

Referring to the drawings for a more detailed description thereof, the numeral 10 indicates a stationary casing adapted to house the apparatus which may be sealed and evacuated or kept under atmospheric pressure. A specially designed hollow shaft 11 extends transversely through the casing and is formed to provide non-communicating chambers 12 and 13 respectively, by means of the partition indicated generally at 14. The shaft 11 is free to rotate within the journals 15 mounted in the casing 10 and is driven by appropriate means such as a V belt and pulley 16. Each ond of the shaft 11 has a reduced portion 17 and 18 for the reception of a steam inlet pipe 19 and exhaust vapor pipe 20. Each pipe 19 and 20 is attached to its respective end by means of suitable packing glands 21, and the utility of each pipe will be more fully explained as the description proceeds.

As afore-indicated, the evaporator includes a liquor compartment and condensing steam compartment which constitute spiral passages arranged about a common axis and adapted to be rotated at high speed so that centrifugal force will cause the liquids to flow toward the outer end of the spiral passages. The two compartments are formed by spirally winding two specially designed sheets of metal of the type illustrated in Figures 3 and 4 of the drawings. The sheets of material indicated generally by the numeral 22 are formed with spaced ribs 23 and when spirally wound about the shaft 11 form alternate rows of passages. Referring to Figure 1 of the drawings, the steam condensing passages are indicated at 24 and the liquor receiving passages are indicated at 25, and it will be readily understood that the depth of said passages is approximately equal to the sum of the thicknesses of the ribs 23. After the plates have been spirally wound about the shaft 11 the ends thereof will terminate at diametrically opposed positions within the stationary casing 10 whereby the contents of the liquor receiving passages are discharged at one end of the casing and the steam condensate and

noncondensing gases are discharged at the other end of the casing.

The side walls 26 of the spiral formation are sealed by any appropriate means such as solder or the like and the multiplicity of spirals are preferably held in position by welding. The entire formation is then positioned within a suitable casing which may be secured thereto by any desired means and which is adapted to rotate with the formation. The casing includes a cylindrical hoop 27 and end plates 28, the end plates being keyed as indicated at 29 to the shaft 11, and may be bolted or otherwise secured to the hoop 27. This construction is provided to reduce strains due to variance of the speed of rotation.

The hoop 27 is constructed with passages 30 and 31 for receiving the condensed steam and thick liquor. By this construction the condensed steam, after traveling through the spirally formed steam passages, will be discharged within the collector passage 31 and likewise the liquor, after being driven by centrifugal force through the spirally formed liquor passages, will be discharged in the collector passage 30.

The side walls 32 of the stationary casing have attached thereto hollow substantially ring shaped members 33 and 34 which are directly connected to the collector passages 30 and 31. The means for connecting the collector passage 30 with the ring 34 comprises a freely movable float valve 35 mounted in the upper end of the head plate 28 and the ring 33 is connected to the collector passage 31 by means of the thermostatic valve 36 and freely movable float valve 37 mounted in the other head plate 28, as clearly shown in Figure 1 of the drawings. Liquor is discharged from the end 39 of the ring 34 after passing from the collector passage 30, through the float valve 35 and into the ring 34. Likewise, steam condensate escapes through the float valve 37 from the collector passage 31 and into the ring 33 and is discharged through the end 40 of said ring 33. The non-condensible gases which represent the condition of the admitted steam after passing through the spirally formed passages is discharged through the thermostatic valve 36 into the ring 33.

Steam is admitted into the chamber 12 through the inlet pipe 19 and extending from said chamber is a multiplicity of inlets 41 which cause the steam to be admitted to the spiral passages 24 and to circulate therethrough. The liquor to be evaporated is fed in a thin stream into the chamber 13 through the tube 42 which projects through the reduced end 18 of the shaft 11. The inlet liquor chamber 13 is formed with a row of minute orifices 43, which allow an even flow of liquor into the spiral liquor chamber 25. A small groove 44, see Figure 2 of the drawings, extends parallel to the row of orifices 43 to provide an even supply of liquor to all of the orifices. The supply of liquor when fed into the chamber 13, while being rotated, will be caused to deposit in the groove 44 and continual feeding, with the centrifugal action accomplished, will further cause the liquor to be supplied to the orifices 43. Closely adjacent the groove 44 is provided a series of vapor outlets 45. These outlets will be formed with raised edges 46 to prevent the flow of liquor therethrough from the chamber 13 to the spiral liquor passages 25. The vapor formed within said liquor passages will be expelled through the outlets 45 and will be exhausted at the end 47 of the pipe 20.

In operation, the evaporator rotor comprising the hollow shaft 11, spiral compartments 24 and 25, hoop 27 and head plates 28, will be rotated at a speed of 250 to 1500 R. P. M. Steam is admitted to the steam passage 24 through the compartment 12 of the shaft 11. All condensate formed on the exterior walls of the steam passages will be discharged through the collector pasage 31 and float valve 37 and the non-condensible gases will escape through the thermostatic valve 36. The thin liquor, at the same time, is introduced into the compartment 13 of the hollow shaft and is driven by centrifugal force through the orifices 43 which distribute it evenly among the sections of the liquor compartment or passages 25. The ports 45 allow the vapor from the evaporating liquor to pass back into the compartment 13 and be discharged through the exhaust end 46 of the pipe 20. The thick liquor is then driven by centrifugal force to the collector passage 30 and thence through the float valve 35 into the collector ring 34 for discharge from the end 39 of said ring.

From the above description and operation it will be readily apparent that there is provided an evaporator so designed that the collection of a film of water on the heat transfer surface of the steam chamber is eliminated. Means has also been provided for freeing and discharging the film of vapor which normally forms on the heat transfer surface of the liquor chamber which materially hinders the flow of heat. The evaporating liquor is driven by centrifugal force to cause the liquor to flow toward the outer end of the evaporator and to be discharged therefrom.

Also it will be understood, of course, by those skilled in the art that variations in the hereinabove described device involving the substitution of substantial equivalents for the devices described are intended to be comprehended within the spirit of the present invention and that the invention is capable of extended application and is not confined to the exact showing of the drawings nor to the precise construction described and, therefore, such changes and modifications may be made therein as do not affect the spirit of the invention nor exceed the scope thereof as expressed in the appended claims.

What is claimed is:

1. A device of the character described comprising a stationary casing, a shaft rotatably disposed within said casing and forming a pair of non-communicating chambers, means for forming a multiplicity of spiral passages circumferentially of said shaft, said means including a ribbed sheet of metal wrapped on said shaft and the ribs thereof being arranged perpendicular to the axis of the spiral, a cylindrical hoop-like member attached to said spiral and adapted to support the ribs on the outside thereof, head plates attached to each end of said spiral and forming with said hoop-like member an enclosing casing for said spiral passages, means for admitting a heating medium to certain of said passages and means for feeding an evaporating liquid to other of said passages.

2. A device of the character described comprising a stationary casing, a shaft rotatably disposed within said casing, said shaft being hollow throughout its length, a multiplicity of spaced spirally formed walls defining spiral passages therebetween having communication with said shaft, one passage arranged in heat transfer relation with the other, means for admitting a heating medium from said shaft to certain of said passages and means for feeding an evap-

orating liquid from said shaft to the other of said passages.

3. A device of the character described comprising a stationary casing, a shaft rotatably disposed within said casing, said shaft being hollow throughout its length and forming a pair of non-communicating chambers, a multiplicity of spaced spirally formed walls defining spiral passages therebetween having communication with said shaft, one passage arranged in heat transfer relation with the other, means for admitting a heating medium from one of said chambers to one of said passages, and means for feeding an evaporating liquid from the other of said chambers to other of said passages.

4. A device of the character described comprising, a rotative member, a pair of sheet-like elements wound upon said member, rib-like means on said elements having contacting relation one with the other to support the sheet-like elements in predetermined spaced relation and cooperating therewith to provide two sets of conduits extending circumferentially about the axis of said member, with the two sets of conduits arranged in heat transfer relation with respect to each other, said sheet-like elements being fixedly related one to the other and with respect to said member for rotation therewith, one set of said conduits being adapted to circulate a heating fluid therethrough and the other set of said conduits being adapted to circulate a fluid to be evaporated, and means for controlling the inlet and exit of the respective fluids with respect to said two sets of conduits.

5. A device of the character described comprising a rotative member being hollow throughout its length and forming a pair of non-communicating chambers, a pair of sheet-like elements wound upon said member, rib-like means on said sheet-like elements having contacting relation one with the other to support the sheet-like elements in predetermined spaced relation and cooperating therewith to provide two sets of conduits extending circumferentially about the axis of said member, with the two sets of conduits arranged in heat transfer relation with respect to each other, said sheet-like elements being fixedly related one to the other and with respect to said member for rotation therewith, one set of said conduits being adapted to circulate a heating fluid therethrough received from one of said chambers and the other set of said conduits being adapted to circulate a fluid to be evaporated and received from the other of said chambers, and means for controlling the inlet and exit of the respective fluids with respect to said two sets of conduits.

6. A device of the character described comprising a stationary casing, a shaft rotatably disposed within said casing and having formed therein a pair of non-communicating chambers, a multiplicity of spaced spirally formed walls defining spiral passages therebetween having communication with said shaft, one passage arranged in heat transfer relation with the other, a casing journalled on said shaft for enclosing said spiral passages, discharge means within said second casing and communicating with said passages, means for admitting a heating medium in certain of said passages, and means for feeding an evaporating liquid to other of said passages.

7. A device of the character described comprising a stationary casing, a shaft rotatably disposed within said casing, said shaft being hollow throughout its length and forming a pair of non-communicating chambers, a multiplicity of spaced spirally formed walls defining spiral passages therebetween having communication with said shaft, one passage arranged in heat transfer relation with the other, a casing journalled on said shaft and rotatable therewith for enclosing said spiral passages, said casing having a collector passage therein, collector rings secured to each end of said stationary casing, means for admitting a heating medium to certain of said spiral passages, means for feeding an evaporating liquid to other of said spiral passages, and means within said second casing for permitting discharge of the evaporated liquid and heating medium.

8. A device of the character described comprising a stationary casing, a shaft rotatably disposed within said casing, said shaft being hollow throughout its length and forming a pair of non-communicating chambers, a multiplicity of spaced spirally formed walls defining spiral passages therebetween having communication with said shaft, one passage arranged in heat transfer relation with the other, a casing journalled on said shaft and rotatable therewith for enclosing said spiral passages, said second casing having a collector passage therein, collector rings secured to each end of said stationary casing, means for admitting heating medium to certain of said spiral passages, means for feeding an evaporating liquid to other of said spiral passages, and means within said second casing for permitting discharge of the evaporated liquid and heating medium, said means including a thermostatically controlled valve mounted in one end of said second casing and float waves mounted in each end of said second casing.

9. A device of the character described comprising a stationary casing, a shaft rotatably disposed within said casing, said shaft being hollow throughout its length and forming a pair of non-communicating chambers, a multiplicity of spaced spirally formed walls defining spiral passages therebetween having communication with said shaft, one passage arranged in heat transfer relation with the other, means for admitting steam to one of said chambers, means for admitting and discharging an evaporating liquid to the other chambers, said shaft having a plurality of orifices formed therein for admitting liquid to certain of said passages and having a second row of larger orifices for permitting the escape of vapor from said passages into one of the chambers within the shaft, said larger orifices having raised edges to prevent the flow of liquid therethrough.

SAM LONG.