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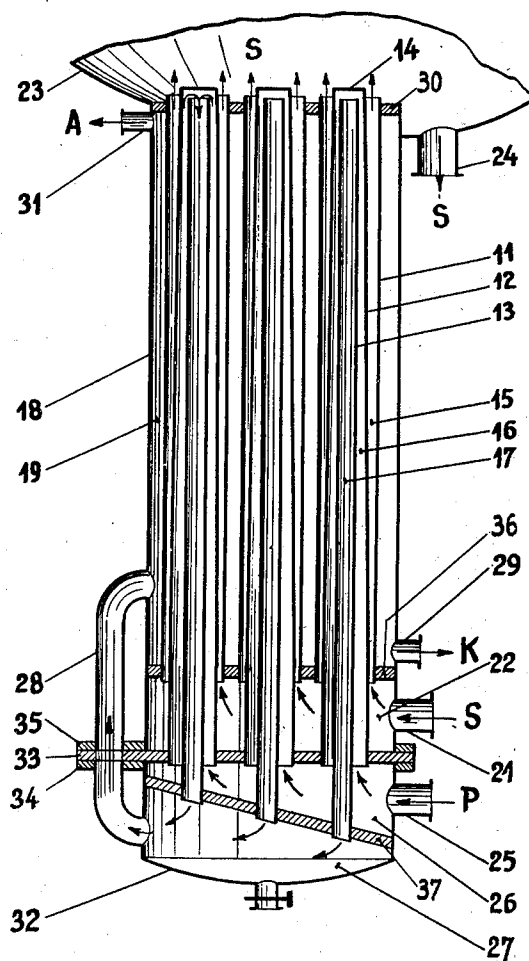
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EVAPORATOR

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2 Sheets-Sheet 1

Fig.1



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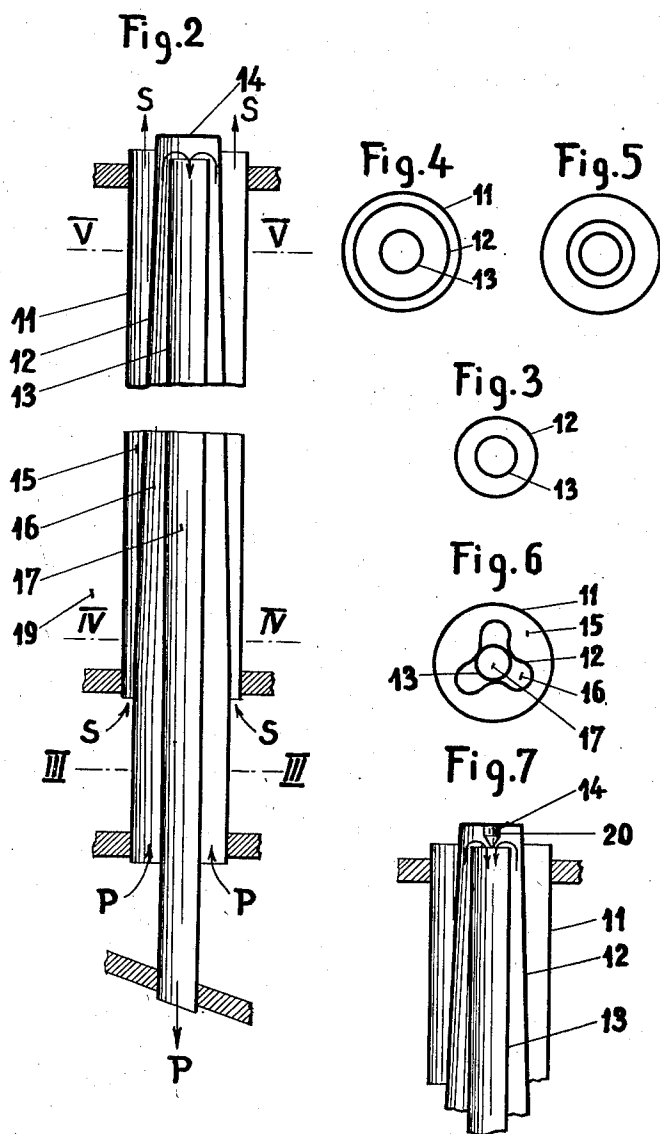
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EVAPORATOR

Karel Löbl and Karel Kšír, Prague,
CzechoslovakiaApplication May 20, 1936, Serial No. 80,794
In Czechoslovakia November 3, 1934

5 Claims. (Cl. 159—27)

This application has been filed in Czechoslovakia on November 3, 1934, and in Austria on November 31, 1935.

The present invention relates to evaporators, more particularly evaporators for concentrating sugar liquor, juice or saccharine solutions. The hitherto known constructions of evaporators having vertical evaporator tubes have the disadvantage that the boiling or evaporating of the liquor to be concentrated does not proceed rapidly owing to the fact that transmission of heat is considerably retarded by the formation of condensate upon the sides of the tubes, this condensate forming a liquid jacket covering the tube. In connection with sugar evaporators it is very important that the boiling and concentration of the sugar should take place very rapidly, in order to avoid the possibility of various detrimental chemical processes being set up in the liquor during slow boiling. It has already been proposed to construct evaporators with vertical evaporator tubes in which the liquor passes through an intermediate tubular conduit which is heated both externally and internally by means of steam. In these constructions, the steam either does not move at all in the inner tube or only with a very small velocity and in the direction of the flowing down condensate, and consequently it was impossible to obtain an intensive heat exchange. The boiling or evaporation was therefore a very slow process.

The invention relates to evaporators of the kind in which the liquor to be concentrated passes through an intermediate tubular conduit or passage which is heated both externally and internally by means of steam, and consists substantially in so constructing the evaporator that live, and if desired, slightly superheated, steam is passed with considerable velocity through an inner heating tube in an upward direction, and is discharged through the centre of the inner heating tube into the boiler, in which latter it moves with slow velocity along the outer heating tubes. By this arrangement it is attained that the steam does not condense upon the walls of the inner heating tubes, but merely becomes slightly moist, although giving off a considerable amount of heat, and that the steam is condensed only in a space into which it moves with small velocity in contact with the outer heating tubes. In this manner a very intensive heat exchange is attained and consequently also rapid boiling and concentration of the liquor.

In a preferred construction the inner heating tubes are closed at their upper ends, and the

discharge of the steam from the inner heating tubes takes place through the centre by means of separate central tubes which extend almost up to the upper end of the inner heating tubes. These central discharge tubes open at the lower ends into a chamber, and are adapted to be removed together with this chamber from the heating tubes. The heat passes from this chamber into a space or chamber surrounding the outer heating tubes. A chamber which is supplied with live steam is arranged under a chamber through which the liquor is admitted. Under the chamber through which live steam is admitted is arranged the chamber into which steam delivered from the inner heating tubes is discharged.

In order to obtain a uniform concentrating or heating surface in the inner heating tubes, and in order to obtain at the same time a progressive increase of the cross sectional area for the liquor which increases in volume, and also in order to obtain a progressive reduction of the cross sectional area of the passage through which the steam moves, the inner heating tubes have a circular cross section which gradually changes into a star-shaped section or a section with undulating periphery so that the periphery of the cross section of the inner tube remains practically the same upon the whole length of the inner tube.

One embodiment of the invention is illustrated by way of example in the accompanying drawings, in connection with an evaporator particularly suitable for concentrating sugar liquor.

In the drawings:

Fig. 1 is a diagrammatic sectional elevation of a vertical evaporator,

Fig. 2 is a sectional elevation of a heater element,

Fig. 3 a section on line III—III of Fig. 2,

Fig. 4 a section on line IV—IV of Fig. 2,

Fig. 5 a section on line V—V of Fig. 2,

Fig. 6 a section on line V—V of Fig. 2 showing a modified construction, and

Fig. 7 the upper portion of a heater element in section.

Referring first to Figs. 1 and 2, a heater element of the improved evaporator comprises three telescoped tubes 11, 12, 13 which are all open at the lower ends. The outer tube 11 and the central tube 13 are open at the top, whilst the middle tube 12 is closed at the top end 14. Three passages 15, 16, 17 are formed by the tubes, namely an outer passage 15 for the liquor to be treated indicated by the letter S, which moves from below to the top, as indicated by arrows. The heating medium, say live steam, indicated by the letter P, passes

with great velocity through the median passage 16 upwards, and returns downwards through the central passage 17.

The outer heating tubes 11 are rolled into or otherwise fixed in the ends 30, 36 of the heating chamber 18. Under the heating chamber 18 is arranged a lower liquor chamber 22 for the admission of the sugar or other liquor S, the latter rising through the heater elements into an upper chamber 23. The liquor chamber 22 is closed by a removable bottom 33 in which are fixed the inner heating tubes 12 so that the latter tubes can be pulled together with the removable bottom 33, out of the evaporator. The inner discharge tubes 13 are fixed with the lower ends in an inclined bottom 37, which divides a chamber 32 into two parts, namely, a chamber 26 into which live steam P is admitted and a collecting chamber 27 into which moist steam coming from the tubes 13 is discharged. The bottom 33 and a flange 34 of the chamber 32 are both fixed to a flange 35 of the heating chamber 18. The steam passes from the chamber 27 upwards through a tube 28 into the interior 19 of the heating chamber 18 and moves in the heating chamber 18 with small velocity upwards sweeping the outer heating tubes 11. It transmits some heat to these outer tubes and is condensed upon the latter. The condensed water K is discharged through a port 29, whilst the waste steam A is discharged through a port 31.

In order to facilitate the flowing of the liquor to be condensed through the heater elements, the diameter of the inner heating tube 12 decreases in the upward direction, thereby providing for a gradual increase in the cross sectional area of the liquor in the direction of flow and in accordance with the increase of the volume of the liquor. At the same time, the cross sectional area of the steam passing through the tube 12 is progressively reduced.

As the reduction of the diameter of the middle tube 12 in the upward direction would reduce the surface through which heat exchange takes place, the reduction of diameter is compensated for by changing the cross section of the tube 12 from a circular cross section at the lower end gradually into a star-shaped section or a section having an undulating periphery at the upper end, as shown in Fig. 6. This change of the shape of the cross section of the tube 12 is so effected that the periphery of the cross section of the tube remains practically the same upon the whole length of the tube. The same effect could be attained by providing the tube 12 with suitable corrugations increasing upwardly in depth.

In order to guide the steam at the point of transmission from the tube 12 into the discharge tube 13, guide members 20 may be provided as shown in Fig. 7.

The described construction is given only by way of example and it will be understood that various modifications may be made without departing from the scope of the invention, as disclosed in the appended claims.

We claim:

1. In a vertical evaporator more particularly for concentrating sugar, the combination of: a chamber containing vertical outer heating tubes; inner vertical heating tubes arranged within said outer tubes, said inner heating tubes being closed at the top and open at the bottom; discharge tubes arranged within said inner heating tubes and open at the top and at the bottom and forming with said inner heating tubes an inner an-

nular passage; said outer heating tubes being open at the top and at the bottom and forming with the inner heating tubes annular vertical passages for the liquor to be treated; a liquor admission chamber arranged under and communicating with the lower ends of said outer heating tubes; means in said chamber for admitting liquor to said outer heating tubes; a heating medium admission chamber arranged under said liquor admission chamber and subdivided by a wall into two compartments, means in one of said compartments for admitting heating medium to said inner heating tubes and said other compartment being in communication with the lower ends of the discharge tubes located in said inner heating tubes, and being also in communication with the chamber containing the outer heating tubes, whereby heating medium passes from the admission chamber upwards through the inner heating tubes and around the outer surface of said discharge tubes and then downwards through said discharge tubes and finally from the second compartment of the admission chamber into the chamber containing the outer heating tubes, whilst liquor passes from the admission chamber upwards through the annular passages between the inner and the outer heating tubes.

2. In a vertical evaporator, more particularly for concentrating sugar, the combination of: outer vertical heating tubes open at both ends; inner heating tubes closed at the top and open at the bottom; discharge tubes open at the top and at the bottom located within said inner heating tubes; vertical annular passages between said outer and said inner heating tubes for the liquor to be treated; the cross sectional area of the inner heating tube decreasing in the upward direction, and the cross sectional area of the passages for the liquor increasing in the upward direction, the periphery of the inner tube changing from a circular shape at the bottom of the tube to an undulating shape in such a manner that the length of the periphery remains substantially constant along the whole length of the inner heating tube.

3. In a vertical evaporator the combination of: a vertical container having two substantially horizontal perforated partition walls and a plurality of outer heating tubes open at both ends and fixed in said partition walls and having a lower end flange; a plurality of inner heating tubes located within said outer heating tubes, said tubes being closed at the top and open at the lower ends and fixed to a perforated plate adapted to be fixed to the end flange of said container; a casing having an upper end flange for connection to said plate and said end flange, said casing being subdivided into two compartments by a perforated partition wall; a plurality of discharge tubes open at the top and at the bottom and fixed in said partition wall and located within said inner heating tubes; means for admitting liquor to be treated to annular conduits formed between said outer and inner heating tubes; means for admitting live heating medium to the upper compartment of said lower casing and to the interior of said inner heating tubes; a conduit connecting the lower compartment of said casing with said vertical container and means for discharging said heating medium from the lower ends of said discharge tubes into the lower compartment of said casing.

4. In a vertical evaporator, more particularly for concentrating sugar, the sub-combination of: an outer heating tube open at both ends; an inner heating tube closed at the top and open at the bottom; a tube located in said inner heating tube

and open at both ends for discharging the heating medium from said inner heating tube; said inner heating tube having longitudinal undulations increasing in depth in the upward direction, whereby passages are formed between the outer and inner heating tubes the cross section of which increases in the upward direction, the heat exchange cross section of the inner tube remaining substantially constant for the whole length of the tube.

5. In a vertical evaporator, more particularly for concentrating sugar, the combination of: outer heating tubes open at both ends; inner heating tubes within said outer tubes closed at the top and open at the bottom; internal discharge tubes in said inner heating tubes, open at both ends; means for introducing liquor into the

annular spaces formed between said outer and inner heating tubes from the bottom and discharging the liquor at the top; means for introducing live heating medium such as steam into the inner heating tube from the bottom to cause said heating medium to flow upwardly in said inner heating tubes around the outside of said discharge tubes and then downwardly through the interior of said discharge tubes; means for discharging said heating medium from the lower ends of said inner discharge tubes; and, means for passing said discharged heating medium into a chamber containing said outer tubes to heat said outer tubes.

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