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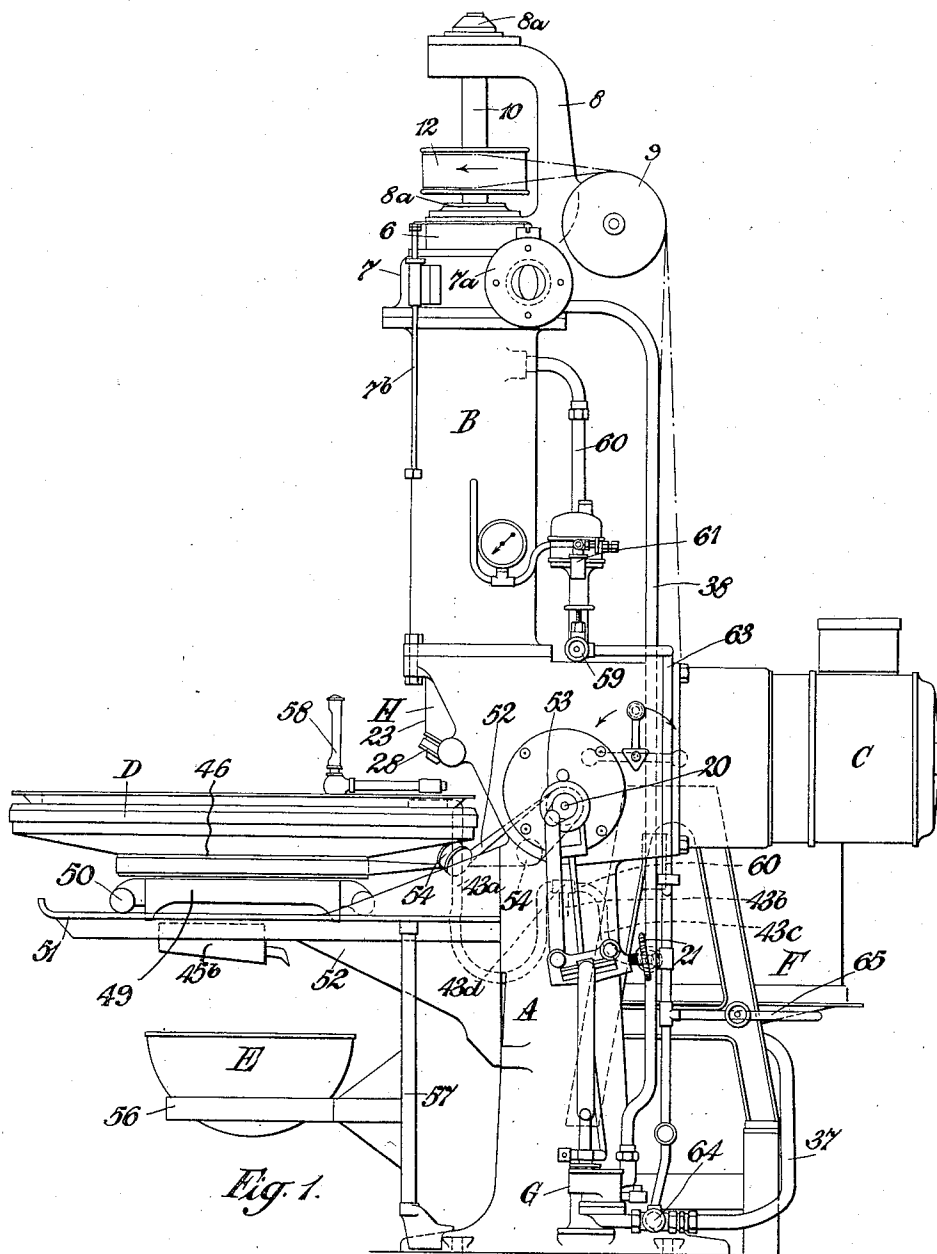
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2,024,299

HEAT TRANSFERENCE APPARATUS

Filed July 24, 1933

4 Sheets-Sheet 1



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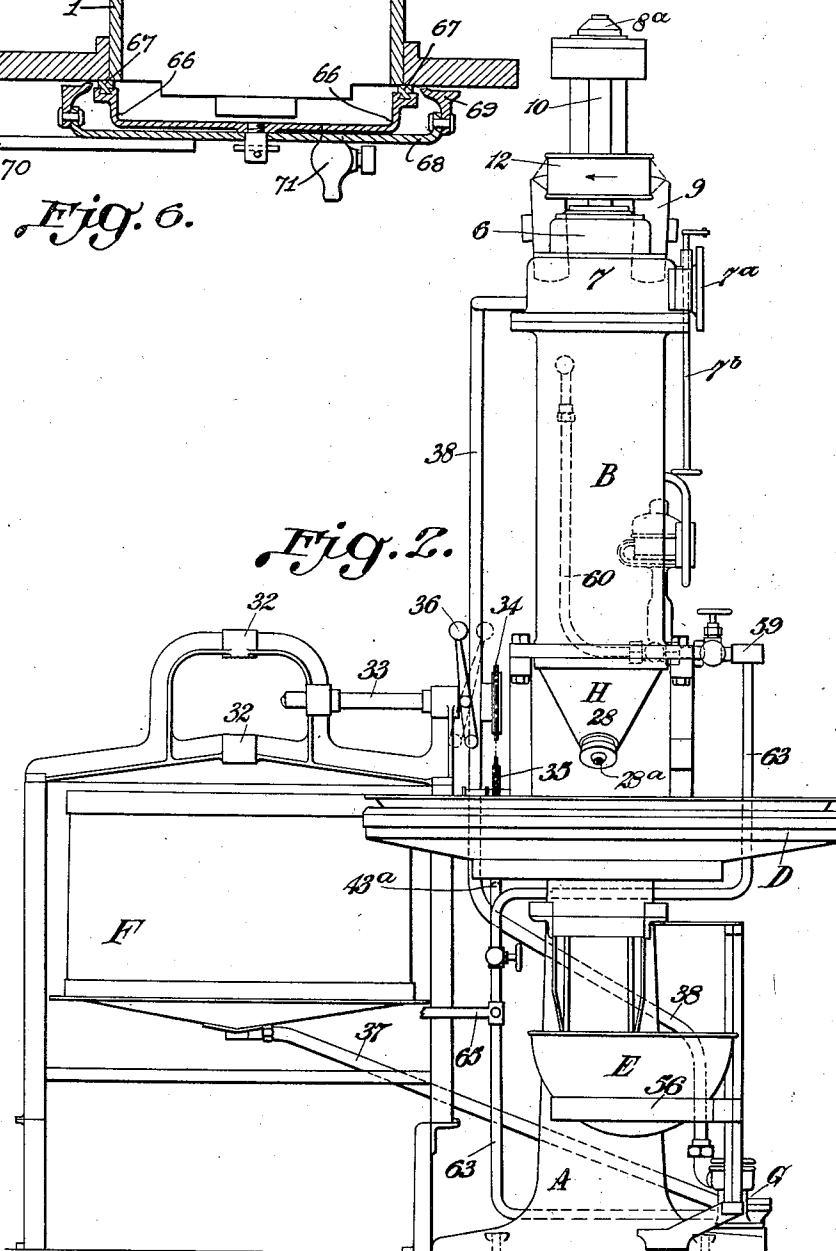
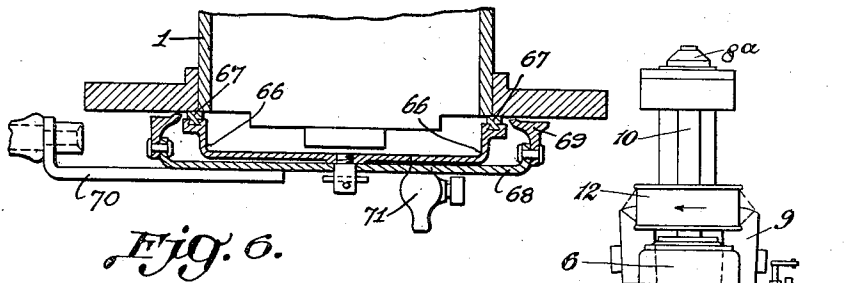
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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

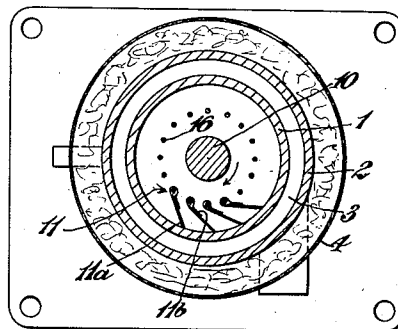
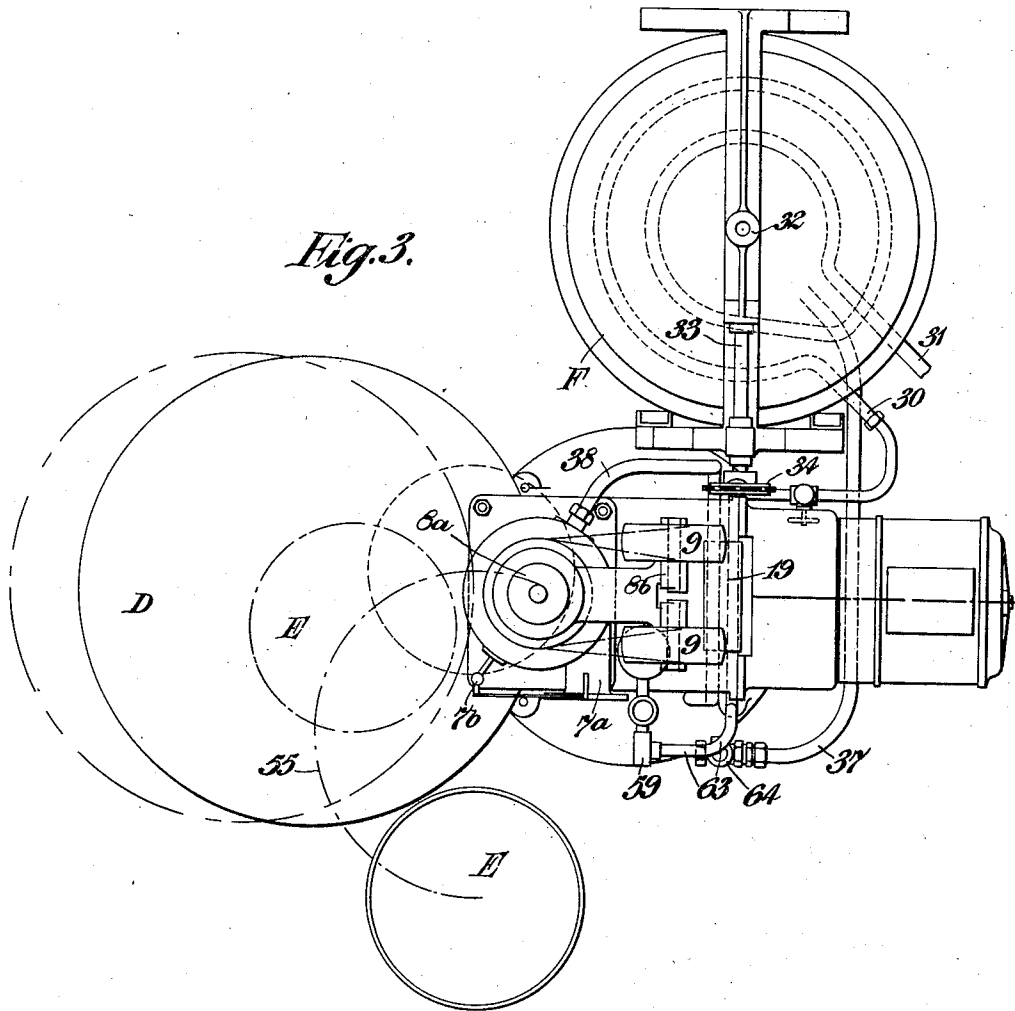


Fig. 5.

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4 Sheets-Sheet 4

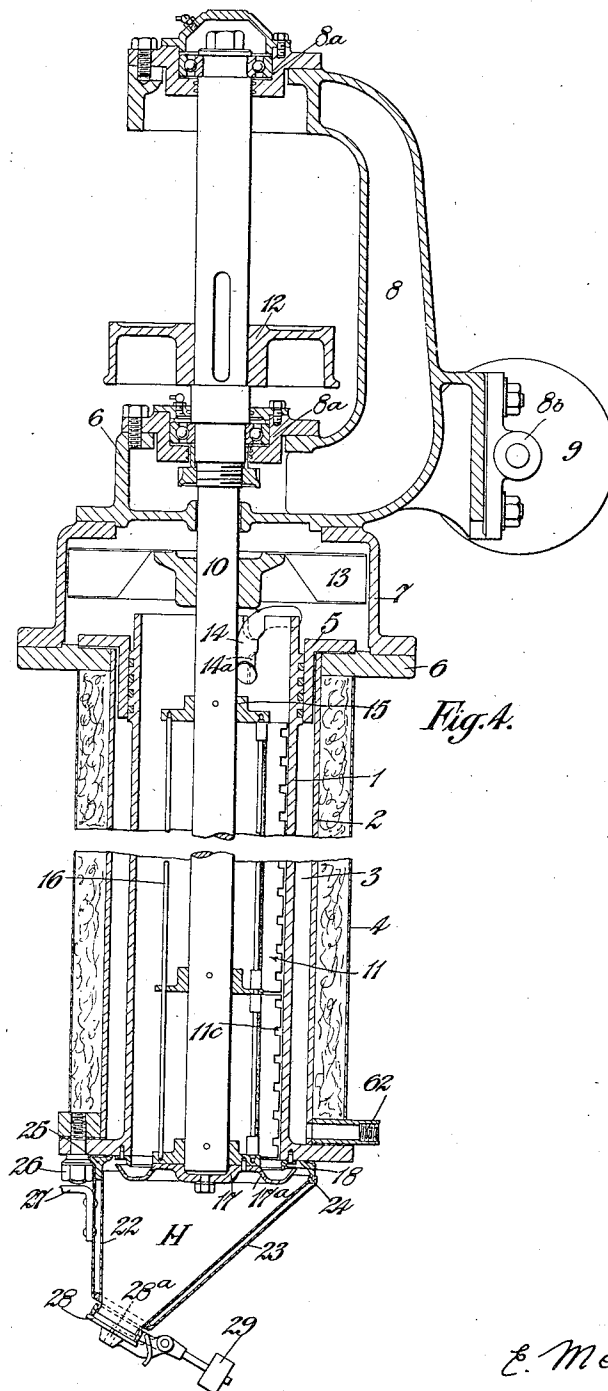


Fig. 4.

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UNITED STATES PATENT OFFICE

2,024,299

HEAT TRANSFERENCE APPARATUS

Edward Metcalfe-Shaw, Chiswick,
London, EnglandApplication July 24, 1933, Serial No. 682,033
In Great Britain July 27, 1932

12 Claims. (Cl. 257—108)

This invention relates to machines or apparatus for the transference of heat from solid surfaces to liquids or semi-liquids, including plastic or viscous compositions or mixtures (which for convenience may be referred to hereinafter as "liquids"), of the type comprising a vertical heat-jacketed cylinder or tube and a plurality of elongated blades rotating round a vertical axis, each blade being rearwardly inclined and adapted to travel and press against the liquid fed onto the heating surface at the top and existing only as a layer on the heating surface of the tube.

An object of the present invention is to provide an improved apparatus for heating liquids whereby the transference of heat to the liquid is facilitated and the time factor of the heating treatment is reduced and relatively high temperatures may be employed without damage to the liquid under treatment.

A further object of the invention is to prevent the formation of solid deposits, crystalline or otherwise, from the solutions or mixtures under any of the treatments for which the invention is intended.

The invention consists in apparatus of the type described characterized in this that the layer of liquid is constantly disturbed at a very rapid rate by a substantial number of blades rotating at a high speed, for example of the order of sixteen blades travelling at the rate of twenty-five feet per second; that a free escape is provided at the bottom of the cooker tube for the treated liquids so that it leaves the heating surface and blades as soon as it reaches the lower termination thereof and the treatment is complete; and that means may be provided to prevent access of air to the cooker tube as the treated liquid is discharged from the apparatus.

In the accompanying drawings:—

Figure 1 is a side elevation of a machine suitable for sugar boiling or cooking in conjunction with a cooling table for discharged syrup.

Figure 2 is a front elevation of the machine according to Figure 1.

Figure 3 is a plan view according to Figures 1 and 2.

Figure 4 is a sectional side elevation of the cooker part of the machine shown in Figures 1 and 2.

Figure 5 is a cross section of the cooker tubular structure shown in Figure 4.

In Figures 1, 2, 3 and 5 certain parts have been omitted or illustrated diagrammatically for the sake of clearness.

Figure 6 is a sectional side elevation of a clo-

sure device for the inner cooking tube of the cooker suitable for application when it is desired to clean the latter.

The invention is particularly serviceable for the heat treatment of sugar such as is usually known in the confectionery art as sugar boiling or cooking, and for convenience hereinafter the invention will be described with respect thereto, the raw sugar or sugar solution being referred to as "syrup" whilst the sugar after treatment is referred to as "boiled sugar".

In carrying the invention into effect according to one convenient mode as described by way of example, a machine is provided comprising a stand or frame A of any suitable design on which is mounted a jacketed cooker element B, an electric driving motor C, a cooling table D with a collecting bowl E. Associated with the stand A and suitably supported upon an adjacent frame is a reservoir F for syrup (melted sugar or a mixture of melted sugar and other ingredients according to the nature of the sweetmeat to be produced). The syrup is drawn from the reservoir F by a variable throw pump G and delivered to the interior heating surface of the cooker B where it is treated by revolving blades driven by the motor C and discharged preferably through a valve-controlled hopper chamber H. The circulating system for the steam for heating the cooker and for other purposes and the pipe lines for conveying the sugar will be referred to hereinafter.

The cooker part B comprises an inner cylindrical or tubular member 1, the inner periphery or surface of which is machined and is adapted to act as the heating surface for the sugar, an outer tubular member 2 arranged coaxially with the inner member 1 so as to leave a steam-jacketing space 3 for the inner member. The tube 2 may additionally be surrounded with a sheet metal casing or sleeve 4, if desired, to afford the tube 2 a heat insulating layer of air or non-conductor packing. The inner member has a flanged foot to which is detachably secured the hopper member H. The upper end of the inner tube 1 is provided with a piston or like jointing or packing adapted to engage a flange ring 5 seated on a flange 6 carried by the upper end of the outer tubular member 2. Above the flange 6 a casing 7 is provided which embodies a fan chamber and has a mounting for a head or bracket 8 which carries a pair of spaced ball or other vertical shaft suspensory bearings 8a and bearings 8b for pulleys 9. From the bearings 8a a rotary vertical shaft 10 is suspended within the cooker tube or cylinder 1 for carrying sugar film or layer treat-

ing blades having the general reference 11. Upon this shaft a driving pulley 12 and a fan 13 are keyed, the fan being for the purpose of carrying off steam or vapour arising from the heat treatment taking place within the cylinder or tube 1. The fan may discharge to atmosphere or to a condenser through an exhaust outlet 7a which is controlled by a butterfly valve connected to an operating hand-wheel rod 7b.

The upper end of the tube 1 receives the syrup through a bent pipe end 14 which is closed and has a lateral slot 14a through which the syrup is directed or laid upon the internal surface of the tube 1.

The shaft 10 carries a series of annular members 15 spaced apart longitudinally for supporting vertical spindles 16. Upon these spindles 16 the blades 11 are hinged or pivotally mounted. The lowermost annulus 15 also serves as a convenient support for an annular gutter member or lipped tray 17 into which the boiled sugar from the heating surface 1 flows and from which it is discharged peripherally under the aid of centrifugal force. The tray may be provided with additional outlets 17a on the inner side of the gutter. A downwardly projecting flange member 18 may be provided which extends into the gutter of the tray so as to make a seal in conjunction with the outflowing treated liquid.

This arrangement is more suitable for liquids other than sugar as if used with sugar, it is liable to cause a clouding of the sugar due to the churning or mixing action.

Each of the blade elements 11 preferably comprises an elongated rectangular steel plate 11a secured to a pair of bearing members 11b freely pivoted on a spindle 16, the arrangement being such that the blade mountings may freely swing about the axis of the spindle under the action of centrifugal force. A substantial number of blades are provided to give a contact with the layer at many points simultaneously around the cylinder. According to the preferred arrangement the blades are arranged in a series of sets, for example there may be an annular series of sixteen blade spindles as shown in Figure 5 for a heating surface of, say, 6" in diameter. On each vertical spindle of the series a set of four or more blades, according to the axial length of the heat treatment surface, may be provided. Each blade is of a width and so mounted as to be trailed against the surface of the tube 1, a suitable arrangement being that the blades each take up an angle of about 50° to the radial plane passing through the axis of a spindle 16 and the shaft 10.

The film contact edges of the blades are preferably cut with square notches such as 11c to afford intermediate rectangular teeth or projections of about twice the longitudinal extent of the notches. It has been found in practice suitable to make the notches $\frac{3}{8}$ " in depth. The notches of the blades are staggered and preferably disposed so that those in one vertical set are arranged to lie midway of the teeth of the blades of adjacent vertical sets in order that those areas that are passed over by the notches of one set of blades are dealt with by the teeth of the following set of blades. Practice has shown that the contact area of a blade should be in the neighbourhood of 62 per cent. of its length which may be about 7" while the width may be about 1½" from the pivotal axis to the edge for a tube diameter of about 6".

The vertical shaft is revolved at a relatively high speed such, for example, as 1,000 revolu-

tions per minute or at a peripheral speed of about 25 ft. per second in connection with a heating surface of 6" in diameter. It will be appreciated that with the blades revolving at this rate a considerable centrifugal force will be developed and that the mass of the blades must be calculated to afford an appropriate pressure contact with the film (according to the nature thereof) being treated. Where sugar is to be heated it has been found suitable to make the blades of 22 S. W. G. plate and each blade (including its pivotal bearings) should weigh approximately 1¾ ounces in connection with a heating surface of 6" diameter and with the blades revolving at about 1,000 revolutions per minute.

The electric motor C has a shaft (not shown) on which a belt pulley 19 is keyed for driving the pulley 12 on the shaft 10 in the direction of the arrow shown in Figures 1 and 5. The belt from the pulley 19 is passed over the guide pulleys 9. Means, such as a clutch or loose pulley may be provided for discontinuing the drive to the shaft 10. The motor also serves to drive the pump G and to rotate the cooling table D. The pump is driven by a transverse shaft 20 which is geared to the motor shaft and having a crank connected to the adjustable link mechanism for reciprocating the pump. The adjustable link mechanism may be varied by operating the hand-wheel 21 and the motor may be controlled from an operating handle indicated in Figure 1 at the side of the upper part of the stand A.

The shaft 20 also has a pulley for a belt drive for the cooling table and an extension carrying a chain wheel for driving stirring means for the reservoir F, as will be described hereinafter.

The hopper chamber H for collecting the boiled sugar coming from the tray 17 and discharging it from the machine comprises an inner funnel member 22 which is surrounded by a corresponding jacketing member 23 for containing an insulating layer of air to prevent the boiled sugar whilst passing through the hopper H from becoming unduly cooled. The members 22 and 23 are secured to a bezel 24 which has lugs or spaced arcuate projections 25 for connecting the hopper to the cooker by a bayonet-like fitting. This fitting may be conveniently formed by the provision of bevelled heads 26 on screws secured in the flange of the outer jacket member 2 which is bolted to the flange of the inner tubular member 1. The outer funnel member 23 has secured to it a bracket 27 (see Figure 4) terminating in a handle (not shown). By giving the hopper a partial rotation either in one direction or the other the projections 25 on the bezel 24 may be secured to or released from the heads 26.

The funnel member 22 terminates in a self-sealing outlet. The outlet comprises the funnel opening covered by a pivoted cap valve 28 which has a counterweight 29. The cap has a small permanent orifice 28a for the escape of a small quantity of sugar which is directed upon a thermometer associated with the cooling table or receiving vessel. Normally boiled sugar is discharged from the cooker at a rate above that at which the sugar passes through the orifice 28a and no air can enter through this orifice. As discharge from the cooker continues sugar will accumulate in the bottom of the hopper and will overcome the action of the counterweight 29 and push the cap valve from its seat allowing the sugar to escape without permitting air to enter past the issuing sugar.

The reservoir F is provided with a steam heat-

ing coil shown in dotted lines in Figure 3, the entrance end of which is seen at 30 while the outlet end 31 may be connected to a steam trap. The reservoir may be provided with any known stirring blades for use where a mixture is used which requires stirring. The bearings for a vertical shaft for supporting stirrer blades are shown at 32 but the blade stirrer and vertical shaft are omitted. The vertical shaft may be driven through bevel gearing by a cross-shaft 33 having a chain wheel 34 driven by a chain and a chain wheel 35 mounted on the extension of the pump shaft 20 as above mentioned. In order to put the stirrers into and out of operation a clutch is provided on the shaft 33 to disconnect it from the chain wheel 34. This clutch is thrown into and out of engagement by a clutch operating lever 36. The reservoir has an outlet at the bottom connected by a pipe 37 to the suction of the pump G. The pump G discharges through a pipe line 38 which terminates in the bent end portion 14 for distributing the syrup upon the internal surface of the tube 1.

The direct delivery of boiled sugar into a pan is not to be recommended for many purposes as the collection of a mass of boiled sugar of relatively high temperature for a period is liable to impair its qualities. Accordingly, the hopper H should discharge to the cooling table D where hard boiled goods are to be manufactured while the hopper H may be discharged direct into the bowl E. The cooling table D and the bowl E are displaceable and the cooling table is described in my concurrent application Serial No. 729,517 filed 7th June, 1934 as a divisional from the present application which has now matured into Patent No. 2,005,271, issued June 18, 1935.

According to a modification as applied in connection with an internal heating surface, the blades extend upon each side of their spindles or have rearward extension, the masses being devised so that the blades are balanced and rendered neutral to the action of centrifugal force. In this case springs are employed and positioned to act on the blades or their extensions to cause the blade edges to be pressed resiliently against the film or layer of sugar.

The cooling table is mounted on a carriage 49 having wheels 50 adapted to travel on rails 51 supported upon a bracket 52 extending from the stand A. The bracket 52 also supports the elongated trough 45b. Locking means (not shown) are provided for securing the cooling table in its inward position while it is being driven for receiving the sugar from the hopper H.

The outer surface of the flange 46 is adapted to act as a pulley by which slow rotation is communicated to the table by the belt 52 driven from a pulley 53 on the pump shaft 20 and guided by jockey pulleys 54. The belt is disconnected when the table is in the outward position and sugar is discharged directly to the bowl E. The bowl E is carried in a ring bracket 56 pivotally mounted upon the vertical shaft 57. The table is carried by the rollers 50 in order that it may be moved with facility into the inward position (shown diagrammatically in full lines in Figure 3) in which it may receive boiled sugar from the hopper H and into an outward position (shown in dotted lines in Figure 3) in which the sugar may be discharged directly into the bowl or receptacle E which may be swung on the path 55 into either the position indicated by dot and dash lines, for the reception of sugar from the cooling table or

the position indicated in dotted lines, Figure 3, in which the sugar is received directly from the hopper.

The cooling table D may be provided with a thermometer 58 positioned so that the boiled sugar in discharging may contact with a sensitive portion thereof.

Steam for the machine, from any suitable source, is supplied to the valve-controlled connection 59. A pipe 60 on which is mounted a pressure regulating device 61 of any known kind carries steam to the upper portion of the jacket. The steam is exhausted from the jacket by a connection 62. A second pipe line 63 carries steam to a three-way valve 64 which may be adjusted either for supplying steam to the pump or to the pipe 37 leading to reservoir F for cleaning purposes. A branch 65 supplies steam to the entrance end 30 of the steam heating coil of the reservoir F. The pipe 43c for supplying steam to for warming up the cooling water for the cooling table is also connected to the pipe 63 as a branch. Each of the steam pipes and branches may be controlled by suitable valves.

For the purpose of periodically cleaning out the interior of the cooker the hopper H may be removed and replaced by a closure member 56 having a packing ring 67. The closure member has pivotally connected to it a spider 68 on which is secured a bezel 69 like that provided on the hopper H so that it may be secured by the same bayonet nut devices 26 as are used in connection with the hopper. The spider 68 has a handle 70 for locking and unlocking the closure member to seal the bottom of the tube 1. When the tube 1 has been closed the interior may be filled with any suitable cleaning or treating liquid (which may if desired be heated by aid of the steam jacket) in order to remove all traces of sugar or other material which has been under treatment. For the purpose of draining off the treating liquid a cock 71 may be provided in the closure 66. Steam is probably the most convenient means for heating the jacketed cooker and other parts but, if desired, electrical heating or gas heating elements may be used both for the tube 1 and for preheating the syrup in the reservoir and tempering the cooling water for the cooling table.

In operation of the machine syrup is drawn from the reservoir F through the pipe line 37 by the pump G, pumped up the pipe line 38 and continuously discharged upon the interior heating surface of the tube 1 through the slot 14a of the pipe end 14. The delivered sugar is caught by the blades 11 revolving at high speed and spread out in a film (on the interior periphery of the tube 1) which is maintained and constantly kept moving by the action of the blades, a certain proportion of it being turned over and over as the sugar rolled up by the blades travels downward under the action of gravity. The boiled sugar flows freely away from the lower terminations of the tube 1 into the tray 17 so that the sugar does not remain in contact with the heating surface and blades after the predetermined treatment has been completed whence it is discharged radially over the lip of the trough of the tray into the funnel 22 of the hopper H. To prevent undue radial discharge an annular baffle flange may be associated with the lip of the trough. Boiled sugar will collect in the bottom of the funnel 22 and when sufficient head is established to overcome the action of the counterweight 29 the cap 23 will be depressed from its seat, allowing the es-

cape of the surplus boiled sugar while the head is maintained.

In applying the invention for certain purposes as for the evaporative concentration of certain liquids such, for instance, as milk, it will be appreciated that such a treatment as above indicated in a heating device may not only be used to concentrate milk under treatment without reducing it to the solid state but is also adapted for pasteurization or sterilization purposes according to the temperatures employed and the time of treatment.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of rearwardly inclined blades, means for rotating them at high speed round the vertical axis of the tube, each blade being adapted to travel and press against the liquid fed onto the heating surface of the tube and existing only as a layer on the heating surface of the tube, so as constantly to disturb and displace the liquid over the said surface, and a free escape at the bottom of the tube for the treated liquid so that it leaves the heating surface and blades as soon as it reaches the lower termination thereof and the treatment is complete.

2. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of rearwardly inclined blades, means for rotating them at high speed round the vertical axis of the tube, each blade being freely pivoted with its trailing edge pressed by centrifugal force against the liquid existing only as a layer on the heated surface, so as constantly to disturb and displace the liquid over said surface, and a free escape at the bottom of the cooker tube for the treated liquid so that it leaves the heating surface and blades as soon as it reaches its lower termination thereof and the treatment is complete.

3. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of rearwardly inclined blades, means for rotating them at high speed round the vertical axis of the tube, each blade being adapted to travel and press against the liquid fed onto the heating surface at the top and existing only as a layer on the heating surface of the tube, a free escape at the bottom of the tube for the treated liquid so that it leaves the heating surface and blades as soon as it reaches the lower termination thereof and the treatment is complete, and means to prevent access of air to the tube as the treated liquid is discharged from the apparatus.

4. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of pivoted rearwardly inclined blades, means for rotating them at high speed round the vertical axis of the tube, the blades being balanced to be neutral to centrifugal force and having resilient means for pressing them against the liquid which exists only as a layer on the tube surface, so as constantly to disturb and displace the liquid over said surface, and a free escape at the bottom of the tube for the treated liquid so that it leaves the heating surface and blades as soon as it reaches the lower termination thereof and the treatment is complete.

5. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of vertical sets of pivoted rearwardly inclined blades, means for rotating the blades at

high speed around the vertical axis of the tube, each blade being adapted to travel and press against the liquid existing only on the heating surface of the tube, so as constantly to disturb and displace the liquid over said surface, a liquid feeding device flowing the liquid exclusively onto the heated surface in a layer above the blades and a free escape at the bottom of the tube for the treated liquid so that it leaves the heating surface and blades as soon as it reaches the lower termination thereof and the treatment is complete.

6. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of rearwardly inclined blades, means for rotating the blades at high speed round the vertical axis of the tube, each blade being adapted to travel and press against the liquid which exists only as a layer on the heating surface, and a device for feeding liquid to the tube consisting of a downwardly extending conduit closed at its end and having a slot outlet against the interior surface of the tube so that liquid is discharged in a layer onto said heating surface above the blades.

7. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a central vertical shaft therein, a substantial number of vertical spindles carried by and coaxial with the shaft, a vertical set of rearwardly inclined blades freely pivoted on each of said spindles and having notched edges, means for rotating the spindles and blades at high speed around the axis of the tube whereby the blades are pressed by centrifugal force against liquid existing only as a layer on the heating surface of the tube, a free escape at the bottom of the tube for the treated liquid so that it leaves the heated surface and blades as soon as it reaches the lower termination thereof and the treatment is complete.

8. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of pivoted rearwardly inclined blades, means for rotating the blades at high speed round the vertical axis of the tube, each blade being adapted to travel and press against the liquid fed onto the heating surface at the top and existing only as a layer on the heating surface of the tube, and a lipped tray and flange at the bottom of the tube to prevent access of air to the tube as the treated liquid is discharged.

9. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of rearwardly inclined blades, means for rotating the blades at high speed round the vertical axis of the tube, each blade being adapted to travel and press against the liquid fed onto the heating surface at the top, and existing only as a layer on the heating surface of the tube, a free escape at the bottom of the tube for the treated liquid so that it leaves the heating surface and blades as soon as it reaches the lower termination thereof and the treatment is complete and a hopper having a liquid sealed outlet located below the tube whereby air is prevented from entering the tube as liquid is discharged from the hopper.

10. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of rearwardly inclined blades, means for rotating the blades at high speed round the vertical axis of the tube, each blade being adapted to travel and press against the liquid fed onto the heating surface at the top, and existing only

as a layer on the heating surface of the tube, a free escape at the bottom of the tube for the treated liquid so that it leaves the heating surface and blades as soon as it reaches the lower termination thereof and the treatment is complete and a hopper located below the tube having a valve counterweighted against the free discharge of the liquid, and having a small permanent orifice, the arrangement being such that air is prevented from entering during the egress of the liquid.

11. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of rearwardly inclined blades rotating at high speed round a vertical axis, each blade being adapted to travel and press against the liquid fed onto the heating surface at the top, and existing only as a layer on the heating surface of the tube, a free escape at the bottom of

the tube for the treated liquid so that it leaves the heating surface and blades as soon as it reaches the lower termination thereof and the treatment is complete, a bezel carrying a discharge hopper for the liquid and means at the end of the tube for detachably engaging the bezel of the hopper to secure the hopper in position.

12. Apparatus for heat treating liquids comprising a vertical heat-jacketed tube, a substantial number of rearwardly inclined blades rotatable at high speed round a vertical axis, each blade being adapted to travel and press outwardly towards the wall of said tube, a closure member for the bottom of the tube having a bezel adapted detachably to engage supporting means at the bottom of the tube for closing off the tube for cleaning purposes.

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