Feb. 23, 1932. B. H. VARNAU ET AL 1,846,288

COOLING APPARATUS

Filed June 1, 1928 2 Sheets-Sheet 1

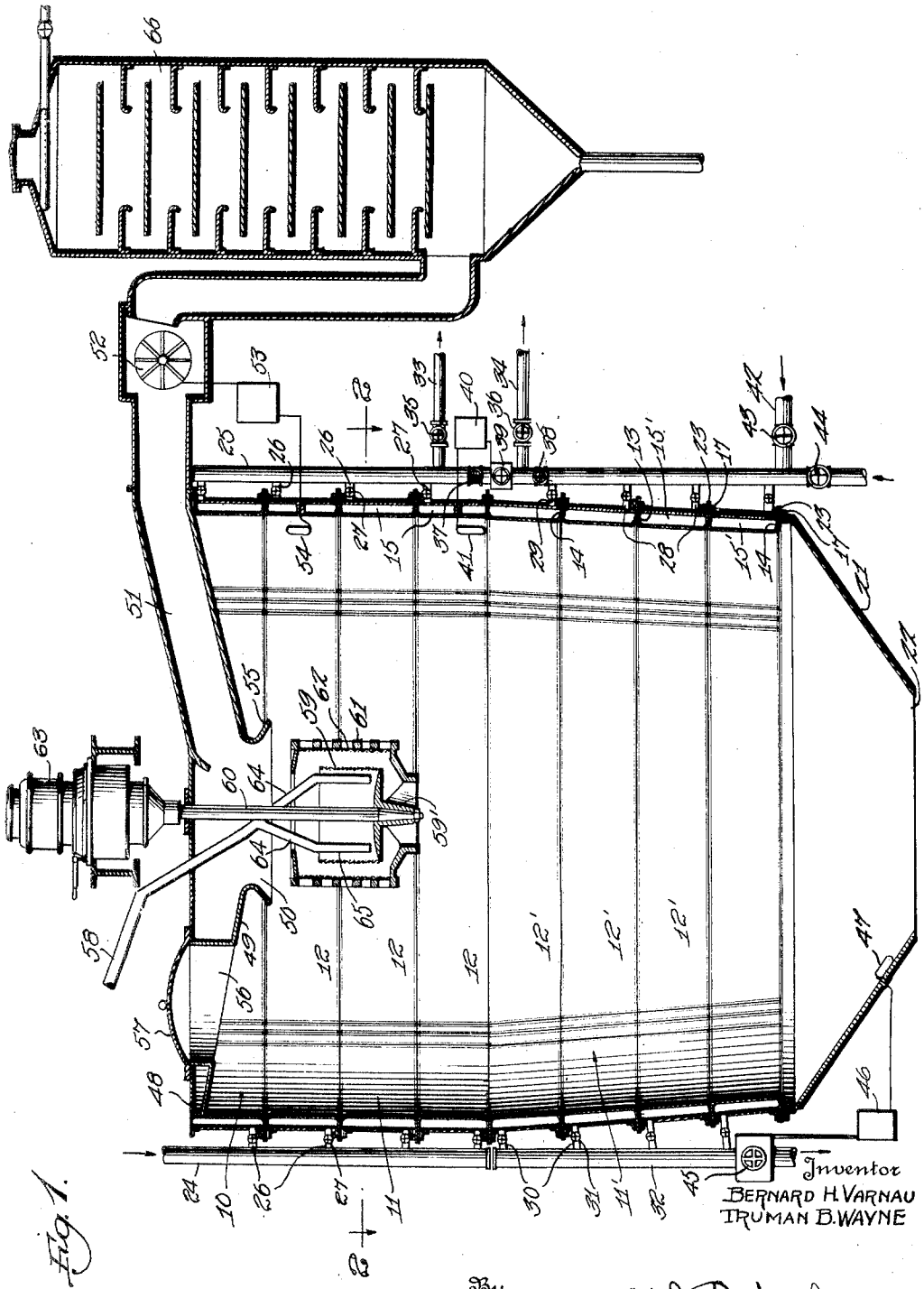


Fig. 1.

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Fig. 3.

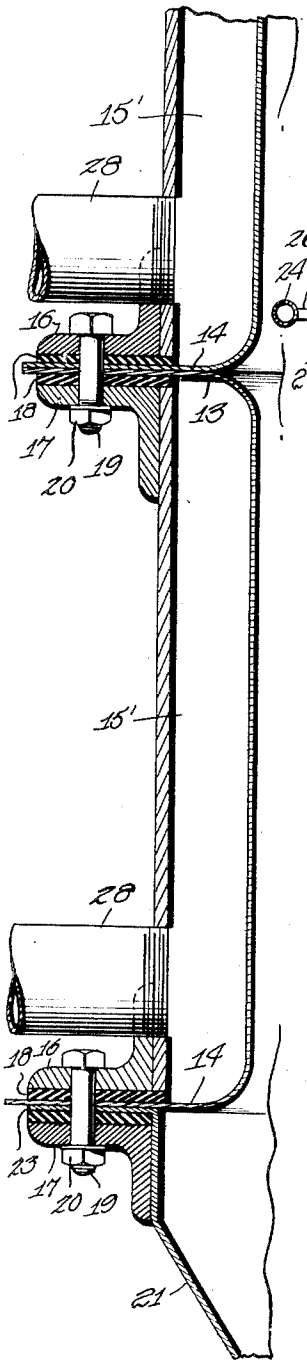


Fig. 2.

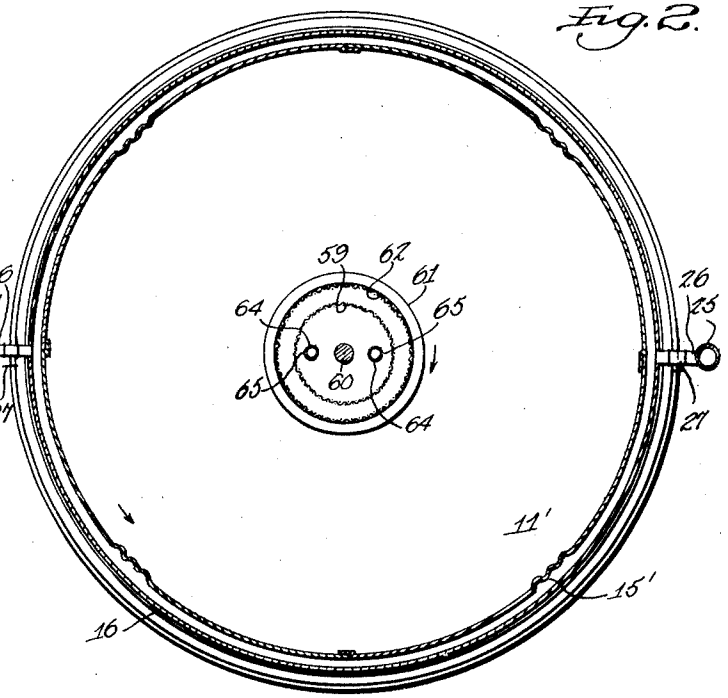
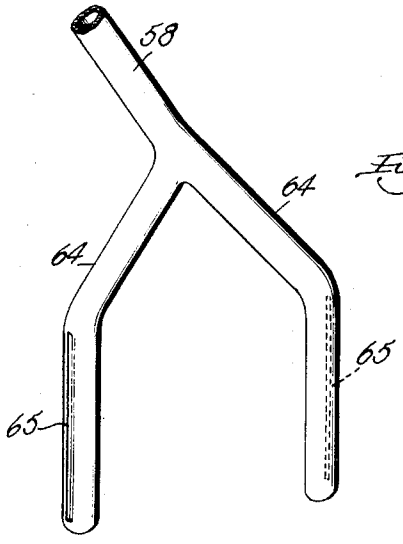


Fig. 4.



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COOLING APPARATUS

Application filed June 1, 1928. Serial No. 282,179.

This invention relates to improvements in an apparatus for use in the production of exceedingly fine, soft sugar crystals of substantially uniform character and more particularly to improvements in an apparatus for use in the rapid cooling of hot, supersaturated sugar solutions of high purity, especially sucrose solutions such as are commonly employed in sugar factories and refineries in the manufacture of high grade granulated cane sugars.

An object of this invention is to provide an apparatus which will rapidly cool under predetermined conditions of control, concentrated sugar solutions in such a manner that crystallization occurs with the production of numerous, very fine uniform crystals. In our copending application Serial Number 176,982, filed March 21st, 1927, we have disclosed an apparatus for accomplishing the purpose above mentioned which comprises a spraying device adapted to spray a concentrated sugar solution on the sides of a cooling chamber surrounded by a water jacket under predetermined conditions of control, in which chamber crystallization of the concentrated sugar solution occurs, resulting in the production of numerous very fine crystals which are sufficiently uniform in character to allow subsequent improvement thereof in the usual type of crystallizer to the point where purgable massecuites are obtained. In this copending application we have also stated that it is desirable to use a fan to force currents of air through the chamber to assist in the cooling action within the chamber.

Another object of the present invention is to provide an apparatus of the type referred to wherein a relatively large fan is employed to draw air currents through the chamber, means being provided to regulate the air temperature whereby the rapid cooling of a hot, super-saturated sugar solution is automatically controlled, making it possible to get an entire "grain" setting by means of the regulated fan without the aid of the water cooling system.

A further object is to provide an apparatus of the type referred to wherein when certain kinds of "grain" are desired it is possible to supplement the fan control system with the water jacket chamber cooling means, the latter means being under predetermined conditions of control.

A further object is to provide an apparatus of the type referred to formed of upper and lower communicating sections, each section being formed of a plurality of sub-sections joined together in unity, the walls of the upper section being arranged vertical and the walls of the lower section slanting inwardly toward their lower extremity to prevent fluid rolling downwardly without coming in contact with the cooling surface.

A further object is to provide an apparatus of the type referred to wherein an upper and lower water jacket surrounds each main section of the cooling chamber and each jacket is formed of a plurality of separate compartments, each compartment being provided with inlet and outlet openings communicating with a source of water supply and a discharge pipe, respectively, whereby the water supply may be quickly changed in each jacket.

A further object is to provide an apparatus of the type referred to wherein the upper section is provided with a head having an axial opening in the inner wall thereof through which a rotatable spindle carrying a centrifugal spray device, is adapted to project, said opening being in communication with an air outlet duct, the inner wall of the head being provided with a curved lip surrounding the opening to catch fine particles of mist or the like, attempting to pass into the outlet duct with the air currents.

A further object is to provide an apparatus of the type referred to wherein a centrifugal spray device is arranged in the upper section, said device comprising an inner perforated basket and an outer perforated basket both carried by a rotatable spindle, means being provided for distributing a concentrated sugar solution interiorly of the inner basket.

A further object is to provide an apparatus of the type referred to having a powerful fan arranged to draw air currents through the apparatus, said fan being adapted to be controlled by a variable speed motor which is connected to an automatic controller, the latter

also being connected to a thermostatic bulb arranged within the cooling chamber, whereby the air temperature within the chamber may be automatically controlled.

A further object is to provide a baffled spray collector adjacent the outlet end of the air duct to collect any particles of mist or the like, drawn through the outlet duct with the air current.

Other objects and advantages of our invention will become apparent during the course of the following description.

In the drawings we have shown one embodiment of our invention. In this showing:

Figure 1 is a vertical sectional view of the apparatus, parts being shown in elevation,

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

Figure 3 is an enlarged fragmentary sectional view showing the means for sealing the joints between the sub-sections of the chamber, and,

Figure 4 is an enlarged perspective view of the distributing pipe.

Referring to the drawings the numeral 10 designates a preferably cylindrical cooling chamber as a whole, the walls thereof being preferably formed of copper or other metal having a high degree of heat conductivity. The chamber 10 is formed of upper and lower communicating main sections 11 and 11′, each main section being formed of a plurality of sub-sections 12 and 12′, and each sub-section is provided with upper and lower annular flanges 13 and 14, respectively. As shown in Figure 1, the walls of the upper main section are arranged substantially vertical, and the walls of the lower main section slant inwardly toward their lower extremity. A water jacket, the outer walls thereof being preferably formed of steel or other suitable material, surrounds each main section of the chamber, and each water jacket is formed of a plurality of compartments 15 and 15′, respectively, of substantially the same height as the sub-sections 12 and 12′ of the cooling chamber. The outer walls of each water jacket are preferably arranged parallel to the walls of the cooling chamber. As shown in Figure 3, the adjacent flanges 13 and 14 of the chamber walls contact and extend through the outer walls of the water jacket to form the compartments 15, before mentioned. Annular flanges 16 and 17 are suitably secured to the outer walls of the water jacket, above and below the flanges 13 and 14, and preferably rubber gaskets 18 are arranged between each flange on the outer walls and each adjacent inner wall flange. A bolt 19, or the like, having a nut 20 threaded thereon is adapted to secure the flanges together whereby a tightly sealed joint will result. This construction provides great strength and rigidity even in very large diameter apparatus and allows the use of relatively thin copper to get the maximum rate of heat transfer. A funnel-shaped member 21 provided with an opening 22 is arranged below the lower section of the chamber and is secured thereto by means of an annular flange 23 (see Figure 3) contacting with the adjacent flange 14, the joint being sealed substantially in the manner as the joint previously described.

Means are provided for maintaining a circulation of water in each water jacket. The upper jacket is cooled by means of water introduced through the inlet pipe 24 and discharged through the pipe 25. Separate inlet and outlet pipes 26 provided with valves 27 are arranged between the pipe 24 and the compartments 15 and between the latter compartments and the pipe 25. As indicated in Figure 1 the point of entrance of the water into each compartment 15 is near the bottom thereof and the point of discharge through the pipe 25 is adjacent the top of each compartment 15. The pipe 25 extends downwardly for substantially the full length of the apparatus and if desired, water from the upper jacket may be allowed to circulate through the compartments 15′ of the lower jacket. Inlet pipes 28 provided with valves 29 are arranged between the pipe 25 and the lower portion of each compartment 15′ and outlet pipes 30 provided with valves 31 connect the upper portion of each compartment 15′ with a discharge pipe 32. Sometimes it is desirable to discharge water from the pipe 25 without circulating the same through the lower jacket and discharge pipes 33 and 34 provided with valves 35 and 36 respectively, are connected to the pipe 25. The pipe 33 is arranged just below the lowest outlet pipe 26 leading from the lowest compartment 15, and the pipe 34 is arranged slightly above the inlet pipe 28 leading to the uppermost compartment 15′. A valve 37 is arranged in the pipe 25 slightly below the discharge pipe 33 and a valve 38 is similarly arranged below the discharge pipe 34. Between the valves 37 and 38, the pipe 25 is provided with a motor driven valve 39, connected to a controller 40, the latter being connected to a thermometer 41 arranged in the lower portion of the upper section of the cooling chamber and being spaced from the inner wall thereof. Adjacent its lower extremity the pipe 25 is connected to an inlet pipe 42, having a valve 43 arranged therein, the latter pipe preferably being connected to a cold water supply (not shown), and below the pipe 42, the pipe 25 is provided with a valve 44 adapted to control communication between the pipe 25 and a thermostatically controlled warm water supply (not shown). The discharge pipe 32 is provided adjacent its lower extremity with a motor driven valve 45 connected to a controller 46, the latter being connected to a thermometer 47 arranged adjacent the opening 22 in the

funnel-shaped portion 21 of the cooling chamber.

A head 48 is suitably arranged to close the top of the cooling chamber and the inner wall 49 thereof is provided with an axial opening 50, the latter being in communication with an air outlet duct 51 having a powerful fan 52 suitably arranged therein. The fan 52 is preferably of the variable speed type and is adapted to draw air currents through the cooling chamber. A controller 53 is connected to the variable speed fan 52 and is also connected to a highly sensitive thermometer 54, arranged in the cooling chamber and spaced from the inner wall thereof. Surrounding the opening 50, the inner wall of the head is provided with a curved lip 55, the purpose of which will become apparent, and a man-hole or the like 56 adapted to be closed by the lid 57 is arranged in the head.

A pipe 58 for delivering the sugar solution to be treated, preferably under thermostatic control (not shown), is adapted to deliver the sugar solution for distribution on the inner wall of a rotatable perforated basket 59, the latter having a sleeve portion 59′ suitably carried on a rotatable spindle 60. An outer rotatable basket 61 provided with a mesh screen 62 is mounted on the sleeve portion 59′ and is adapted to rotate therewith. The spindle 60 is adapted to be rotated by the electric motor 63 preferably mounted on the head 48 of the apparatus. As shown in Figure 4, the pipe 58 is provided with diametrically opposed forked arms 64, each arm being provided with a longitudinal slot 65 adapted to distribute the sugar solution over a relatively large portion of the wall of the inner basket 59.

A baffled spray collector 66 is in communication with the air duct 51 and serves to collect any mist or the like, which has been entrained in the air currents, whereby further treatment thereof is possible.

The operation of the apparatus is as follows:

A hot super-saturated sugar solution of suitable purity and density is discharged through the pipe 58 onto the inner wall of the basket 59 which is preferably revolving at a high rate of speed. The sugar solution is thrown outwardly through the perforations in the basket 59 by centrifugal force against the perforated walls of the basket 61 which is also revolving at a high rate of speed. The solution is forced through the perforated walls 62 of the basket 61 against the inner wall of the cooling chamber, whereby the solution is atomized to a fine spray. It has been found that by providing a large air circulation the temperature of which is automatically controlled, it is possible to get an entire "grain" setting in the time it takes the liquor to travel from the basket to the wall of the chamber. Accordingly, we have provided the controller 53 adapted to control a variable speed motor (not shown), which operates the fan, the controller being connected to the highly sensitive thermometer 54, whereby, if the sprayed liquor at the point where the thermometer is located gets warmer or cooler, due to either the speeding up or slowing down of the liquor supply fed to the apparatus, or due to the liquor supply getting warmer or colder, the speed of the fan will automatically increase or decrease to bring the air temperature, and also the temperature of the liquor spray back to the point at which the controller 53 is set.

It is sometimes desirable to produce a finer grain than is possible with only the air control system in operation and accordingly it is possible to supplement the air control system with the upper water jacket cooling means, or with both the upper and lower water cooling systems. When only the upper water cooling system is used in conjunction with the air control system, water is supplied through the pipe 24, the valve 38 in the pipe 25 is closed, the valve 35 in the pipe 33 is closed, the valve 37 in the pipe 25 is opened and the valve 36 in the pipe 34 is opened. The thermostatically controlled valve arranged in the pipe 25 can then be made to control the rate at which the cooling water is supplied and circulated in the upper jacket compartments 15, the valve having been previously adjusted to allow the required temperature drop between the temperature of the liquor at the air control thermometer and that required in the upper section of the cooling chamber. Thus, if the liquor supplied to the apparatus is at a temperature of 170° F., and is to be cooled to 135° F., by the fan control system, the latter can be adjusted to draw enough air through the apparatus to cool the liquor to this predetermined point. The liquor spray will then strike the walls of the upper cooling jacket and the water control system therefor can be adjusted to lower the temperature further by the time the liquor reaches the location of the thermometer 41.

If the apparatus is to be operated at extreme liquor rates above the capacity of the air cooling and upper water cooling systems, the lower jacket water cooling system may also be used. To use the lower cooling system the valve 38 remains closed, valve 44 is also closed, and valve 43 is opened to admit more cold water. The control system for the lower jacket, comprising valve 45, controller 46 and thermometer 47 is regulated in the same manner as the control system for the upper jacket and can be adjusted to further lower the temperature of the solution by the time it reaches the opening 22 in the bottom of the chamber.

If desired the water from the upper jacket may be allowed to circulate through the lower jacket, to gradually cool the liquor run-

ning down, whence valves 35, 36, 43 and 44 are closed, and valves 37 and 38 are opened. The amount of water circulated and the temperature thereof can then be controlled by either water control systems, the one not employed being disconnected from its control system.

The temperature of the liquor may be held constant by admitting warm water through valve 44, controlled by the lower water control system, in which case water from the upper jacket is discharged by closing valve 38 and opening valve 36. The rate and amount of cooling to be effected depends on the nature of the sugar solution under treatment and is the subject matter of our copending applications Serial Numbers 133,594 and 133,595, filed September 4th, 1926.

The small valves on inlet and outlet connections are to be set to regulate the amount of water each section receives.

It will be apparent that any one or number of controls or combinations thereof can be used, thus making the apparatus fool-proof, as well as allowing a great diversity of operations and much flexibility.

Under normal conditions we prefer to do as much cooling as possible with the air, supplemented when necessary by the upper cooling system and thereby get the complete "grain" setting in the upper section. The lower section is then used to gradually improve the grain through a further reduction in temperature, thereby allowing the grain to grow considerably before it is discharged from the apparatus. This shortens the time required in a crystallizer and allows the use of relatively inexpensive types of crystallizers.

While we have described in detail the preferred embodiment of our invention it will be understood that the size, shape and details of construction of our apparatus may be varied without departing from the spirit of the invention or the scope of the subjoined claims.

We claim:

1. An apparatus of the character described comprising a chamber, means for introducing liquid into said chamber, means for discharging said liquid therefrom, a fan adapted to force a current of air through said chamber, and means connected to said fan for controlling the temperature within said chamber, the latter means including a temperature responsive member arranged in said chamber, and a controller connected to said member and said fan.

2. In an apparatus of the character described including a chamber, spraying means arranged within said chamber, and means for delivering liquid to said spraying means, the combination with means for modifying the temperature of the wall of said chamber, of means for controlling the temperature of the liquid within said chamber, said last named means including means for forcing a current of air through said chamber.

3. In an apparatus of the character described including a chamber, spraying means arranged within said chamber, and means for delivering liquid to said spraying means, the combination with means for modifying the temperature of the wall of said chamber, of means for controlling the temperature within said chamber, said last named means including a fan adapted to force a current of air through said chamber, a thermometer arranged in said chamber, and a controller connected to said thermometer and said fan.

4. An apparatus of the character described comprising a chamber, an inner rotatable perforated basket arranged within said chamber, an outer rotatable perforated basket spaced from and adapted to surround said inner basket, means for feeding liquid onto the wall of said inner basket, means for modifying the temperature of the wall of said chamber, and means for controlling the temperature within said chamber, said last named means including means for forcing a current of air through said chamber.

5. An apparatus of the character described comprising a chamber, an inner rotatable perforated member arranged within said chamber, an outer rotatable perforated member spaced from and adapted to surround said inner member, a pipe for feeding liquid into said inner member to distribute the liquid over a relatively large area of said inner member, means for modifying the temperature of the wall of said chamber, and a thermostatically controlled fan for controlling the temperature of said liquid.

6. In an apparatus for crystallizing liquids including a chamber, means for introducing liquid into said chamber, means for discharging said liquid therefrom, the combination with means for modifying the temperature of the wall of the chamber, of means for forcing a current of air through said chamber to modify the temperature of said liquid, and means for regulating the extent to which the temperature of the liquid is modified.

7. In an apparatus for crystallizing liquids including a chamber, means for introducing liquid into said chamber, means for discharging said liquid therefrom, the combination with means for modifying the temperature of the wall of said chamber, of a fan for forcing a current of air through said chamber to modify the temperature of said liquid, and a thermostatic controller connected to said fan to regulate the extent to which the temperature of the liquid is modified.

8. An apparatus for crystallizing liquids comprising a chamber, means for introducing liquid into said chamber, means for atomizing

said liquid therein, means for modifying the temperature of the liquid in said chamber, said last named means including a liquid cooling medium contacting the wall of said chamber and an induced air current forced therethrough, and means for regulating the extent to which the temperature of the liquid is modified.

9. An apparatus for crystallizing liquids comprising a chamber means for introducing liquid into said chamber, means for atomizing said liquid therein, means for modifying the temperature of the liquid in said chamber, said last named means including a liquid cooling medium contacting the wall of said chamber and an induced air current forced therethrough, and thermostatic controllers associated with said liquid cooling medium and said air current respectively to regulate the extent to which the temperature of the liquid is modified.

10. An apparatus for crystallizing liquids comprising a chamber, a rotatable spraying member arranged in said chamber, means for delivering liquid to said member to be sprayed onto the wall of said chamber, means for modifying the temperature of said liquid during the time it passes from said member to the wall of the chamber, and a separate means for further modifying the temperature of the liquid after it reaches the wall of said chamber, said first named temperature modifying means comprising a fan under thermostatic control, and said second named temperature modifying means comprising a liquid cooling medium contacting the wall of said chamber and also under thermostatic control.

In testimony whereof we affix our signatures.

BERNARD H. VARNAU.
TRUMAN B. WAYNE.