March 31, 1953 E. W. KOPKE 2,633,435

SUGAR CRYSTALLIZER

Filed Nov. 28, 1949 3 Sheets-Sheet 1

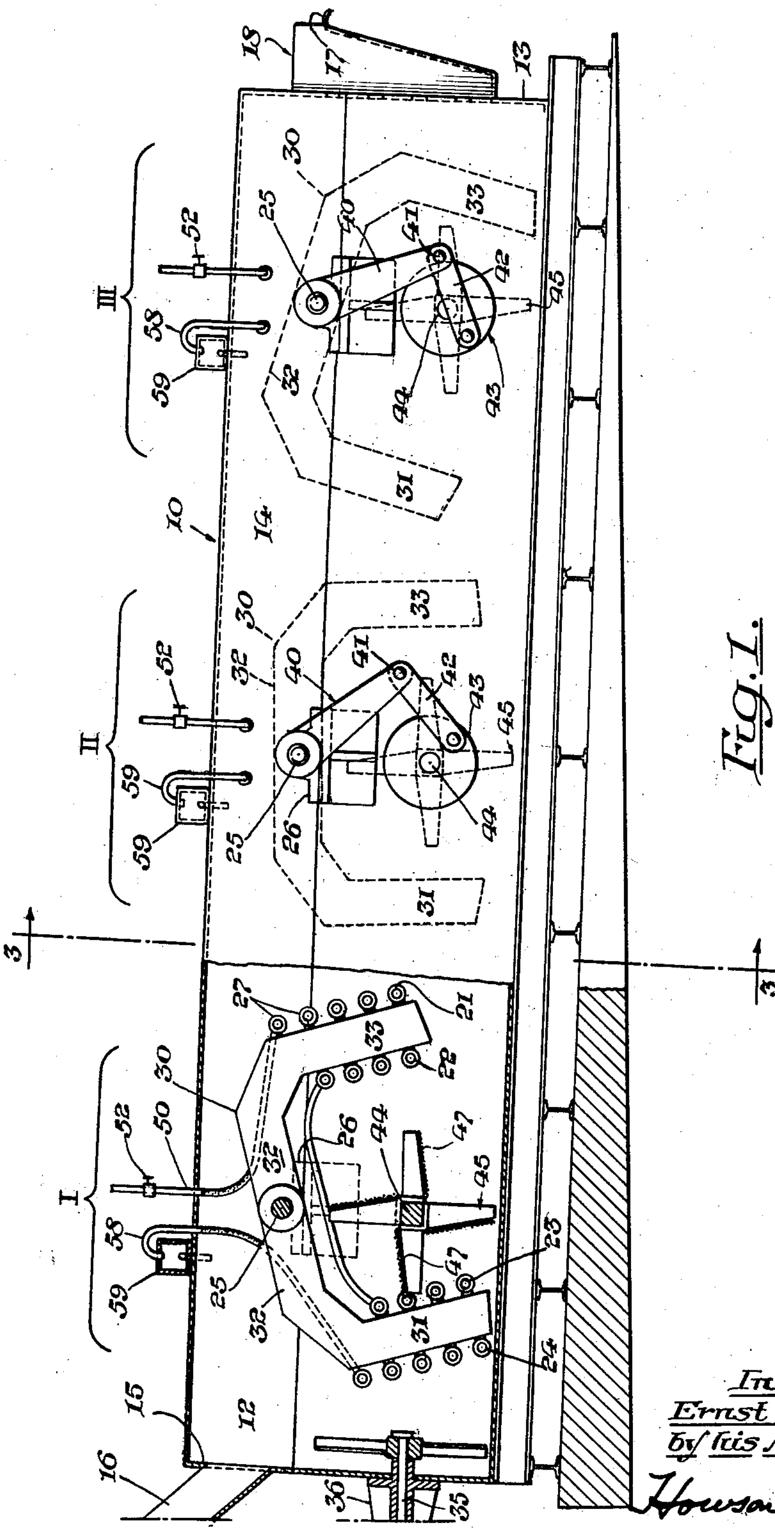


Fig. 1.

Inventor:
Ernst W. Kopke
by his Attorneys,
Howson and Howson.

March 31, 1953 | E. W. KOPKE | 2,633,435

SUGAR CRYSTALLIZER

Filed Nov. 28, 1949 | 3 Sheets-Sheet 2

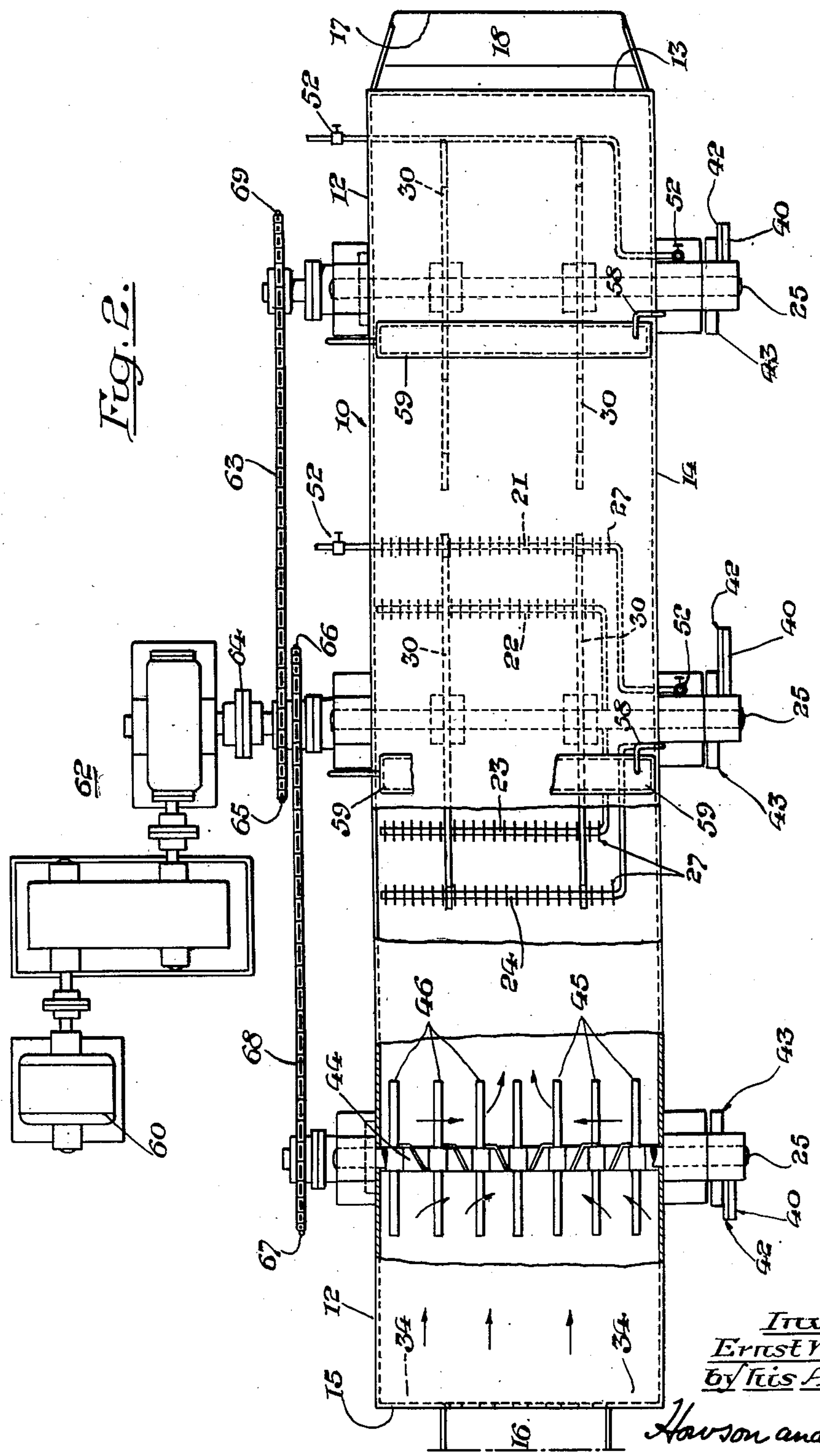


Fig. 2.

Inventor:
Ernst W. Kopke
by his Attorneys
Howson and Howson

March 31, 1953 E. W. KOPKE 2,633,435

SUGAR CRYSTALLIZER

Filed Nov. 28, 1949 3 Sheets-Sheet 3

Fig. 4.

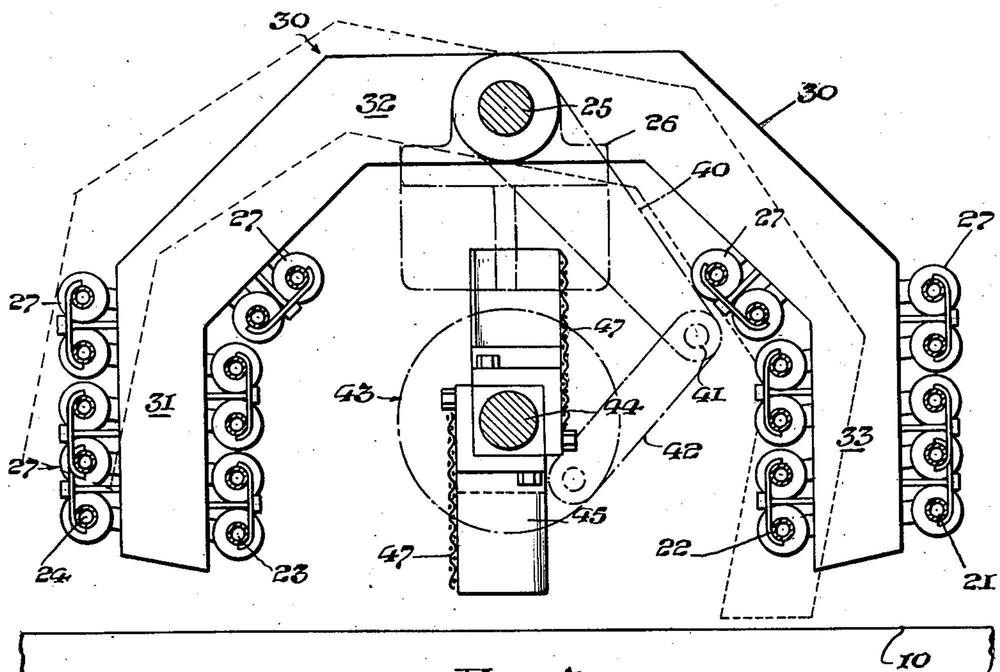
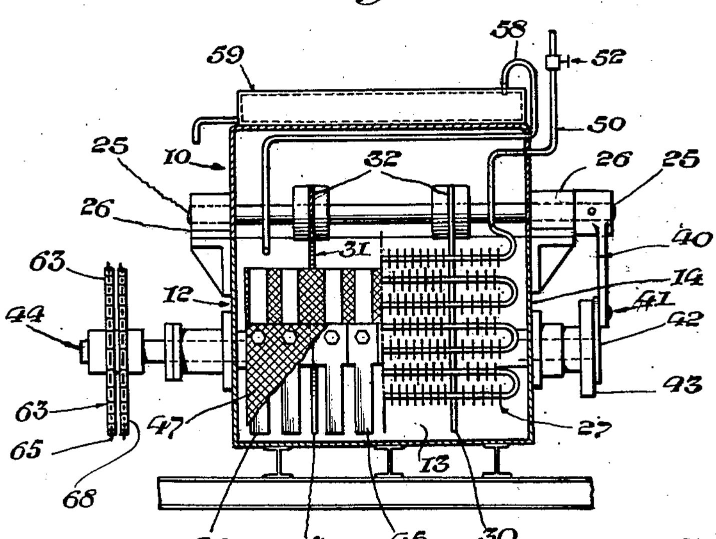


Fig. 3.



Inventor:
Ernst W. Kopke
by his Attorneys,

Howson and Howson.

Patented Mar. 31, 1953

2,633,435

UNITED STATES PATENT OFFICE

2,633,435

SUGAR CRYSTALLIZER

Ernst W. Kopke, New York, N. Y.

Application November 28, 1949, Serial No. 129,727

18 Claims. (Cl. 127—15)

1

This invention relates to crystallizers and more particularly to crystallizers used in the development of crystals in massecuite. The massecuite resulting from certain operations in the making of sugar is dropped hot into the sugar crystallizing apparatus and there is stirred while it is being cooled and the sugar crystals are developed. Many proposals, some of which have gone into commercial use, have been made for crystallizing sugar more rapidly from the massecuite. Crystallizer capacity and performance that was regarded as satisfactory in the past twenty years is now admittedly unsatisfactory. The objective has always been to cut down the time in crystallization to the smallest possible amount compatible with proper development of the sugar grain. To attain this objective, rapid uniform cooling is necessary. To secure uniform cooling, the massecuite is continuously circulated to bring all portions repeatedly into contact with the cooling coils while avoiding the development of stagnant pockets or zones in the material. For minimum time for crystallization, the largest amount of cooling surface possible must be provided without interfering with the stirring of the massecuite.

Therefore it is an object of my invention to provide larger amounts of cooling surfaces for the massecuite together with adequate means to circulate and stir the massecuite.

Heretofore it has been common to treat massecuites in crystallizers by the batch method. The whole mass of massecuite would be dumped into the crystallizer and cooled therein until it was judged that the practical maximum of crystallization and cooling had been attained. The mass would then be dumped into a storage or mixing tank to be treated and processed further. This batch treatment resulted in large amounts of the material being tied up in the process. Furthermore while one batch was being treated in a crystallizer, others had to be stored and treated as accummulated, and additional crystallizers had to be provided thus entailing increased investment in equipment.

It is another object of my invention to provide apparatus for crystallizing sugar on a continuous basis wherein the massecuite enters at one end of the crystallizing apparatus and is continuously treated and discharged at the other end.

As the end of the crystallization period is reached, the mass of sugar syrup and crystals becomes increasingly viscous, so much so that it cannot be effectively treated in later stages of processing without its viscosity being lowered by adding additional liquid or by heating or both.

2

Therefore it is another object of my invention to provide a continuous crystallizer with means for reheating the massecuite at the end of the crystallization process in order that it may be in better condition for further treatment.

Other objects and advantages of the invention will become apparent as it is described in connection with the accompanying drawings.

Figure 1 is a side elevation view partly in section of my new continuous crystallizer;

Figure 2 is a plan view of the crystallizer of Fig. 1;

Figure 3 is an end section view of the crystallizer of Fig. 2;

Figure 4 is an enlarged elevational section view of one of the units of the crystallizer of Figs. 1–3.

Referring to the drawings, a tank designated generally by the numeral **10** comprises flat parallel side walls **12** and **14** and parallel end walls **13** and **15** and a bottom wall. The whole tank is relatively long so that massecuite may enter through an entrance chute **16** at one end and discharge over a discharge lip **17** at the opposite end after treatment as will be more fully described.

Stirring apparatus is provided along the tank. The apparatus may be in the form of similar units spaced from one another along the length of the tank, the number of units being governed by the conditions of use. For many if not most purposes, two units for cooling will be sufficient with a third unit at the exit end for reheating since in the ordinary process of crystallization the massecuite becomes cool and viscous toward the end of crystallization and has to be reheated in order to be treated further in the sugar making process. Indeed it may be necessary in some cases to reheat in order to move the massecuite out of the crystallizer.

Since the units are identical only one need be described. Each of the units **I**, **II** and **III** may comprise a plurality of horizontal parallel pipes wound sinusoidally in a vertical direction and arranged preferably in four sets of coils **21**, **22**, **23** and **24**. These coils of pipes are mounted in such a way that they may be rocked up and down in an arc of a circle. The coils are mounted on two spaced inverted U-shaped plate members designated generally by the numeral **30**. These plate members are fixedly mounted on a horizontal rock shaft **25** passing through the middle of the transverse arms **32** of the U-members.

The rock shafts are preferably mounted in bearings 26 supported from the side walls 12 and 14 of the tank or otherwise suitably supported. The coils of pipes are mounted on opposite sides of the substantially parallel arms 31, 33 of the U-members so that the coils 21 and 22 are spaced by the width of the arm 33 and the coils 23 and 24 are spaced by the width of the arm 31. Thus the coils 21, 22 are spaced by the length of the transverse arm 32 from the sets 23, 24.

In order to cause rocking movement of the shaft 25 and the U-members carried thereby and consequently arcuate motion of the coils, one end of the rock shaft 25 is extended outside the tank and has fixedly mounted thereon a lever 40. To the free end of the lever 40, a connecting rod 42 is pinned by a pin 41. The other end of the connecting rod is connected with a rotating disc or plate member 43. The disc 43 is mounted on an extending end of a stirring shaft 44 passing horizontally through the side walls 12, 14 of the tank parallel to and below the rock shaft 25. It will be observed therefore that as the disc 43 rotates, it carries with it the connecting rod 42 which in turn causes the lever 40 and the rock shaft 25 to rock.

This rocking motion of the U-members and the coils carried thereby causes the coils to continuously move through the massecuite and hence to cool it as it passes along the crystallizer toward the exit end thereof. The rocking motion also tends to agitate and stir up the massecuite.

In order to improve the heat transfer or cooling function of the tubes of the coils 21, 22, 23 and 24, the various tubes of these coils are each provided with a series of radial fins 27. The fins may each be in the form of round thin metal plates welded to the tubes. Preferably the fins on one tube will be offset or staggered relatively to the fins on an adjacent tube. In this way, intimate contact between the massecuite and the fins of the cooling coils is accomplished so that as the massecuite passes through the plane of a coil, it is effectively cooled by said intimate contact. The fins do more than merely cool the massecuite. They more effectively stir and mix it.

In units I and II, the cooling water enters the coil 21 at the top through an inlet pipe 50 having a control valve 52 therein. A rubber hose or other suitable flexible connection rather than a flexible joint with packing and glands is preferred between the stationary inlet pipe 50 and the coil 21. At the bottom of the coil 21, it is joined to the coil 22, the top of the coil 22 being joined to the top coil 23 while the bottom of the coil 23 is joined to the bottom of coil 24. The cooling water exit is through a pipe from the top of the cooling coil 24 through a flexible connection to the outlet pipe 58 and then into a trough or outlet tank 59. By this arrangement of cooling coils and passage of cooling water the warmest portion of the massecuite will come in engagement with the warmest portion of the cooling coils. This tends to even the temperature differential between the massecuite as it is cooled and passes along the crystallizer. If the cool water entered the first coil 24 there would be less cooling at coil 21 and hence the massecuite would have been made needlessly viscous when the coils are connected in series.

Alternatively, in order to expedite the first stage of cooling the coils 23, 24 may be connected for separate inlet and outlet pipes and so also may the coils 21 and 22.

As another alternative, the coils 23, 24 may be connected in series and fed separately from the coils 21 and 22; and the latter also may be connected in series and separately fed. In this alternative, the last coil of each series will have the cool water fed to it first, for reasons similar to those already given.

In order to stir and move the massecuite within the compass of the inverted U-members and between the coils 22 and 23, a series of stirring blades 45, 46 are provided upon the stirring shaft 44. They may extend in diametrically opposite directions from shaft 44 and the blades 45 on one end of the shaft 44 are inclined or turned at an angle to the length of the tank so as to move the massecuite inwardly. The stirring blades 46 on the other end of the stirring shaft 44 are turned at an opposite angle so as to cause the massecuite to move inwardly from the other side of the tank. Thus the massecuite at the side walls of the tank which would tend to cool by reason of contact with the side walls is constantly moved inwardly by the stirring blades 45 and 46. At the same time, it is thoroughly stirred and mixed by those blades. Although two blades per set, as illustrated in Fig. 4 are effective, four or more per set as in Fig. 1 may be used, if desired.

In order to improve the stirring action of the stirring devices and thus to provide further crystal movement beyond what is provided for by the stirring blades 45 and 46, I provide a layer of coarse wire mesh 47, for example, heavy wire with three-quarter inch to one inch or thereabouts interstices. This layer of wire mesh is laid and secured against one edge of the blades 45, 46, preferably the leading edge so that the mesh extends in approximately a radial direction to the ends of the blades from the center of the stirring device. This mesh also serves to drag the massecuite from the bottom portion of the tank to the top and vice versa. This novel feature is valuable and important in maintaining uniformity of treatment of all parts of the massecuite.

In order to drive the stirring shaft 44 and hence the rock shaft 25 with the parts carried thereby, a motor 60 connected with suitable reduction gearing 62 may be provided. A flexible coupling 64 between the reduction gearing and the stirring shaft of the unit II causes the stirring shaft of that unit to be driven by the reduction gearing and motor 60. On the stirring shaft of this unit II are two sprocket wheels 65 and 66 which rotate with it. Similar sprocket wheels 67 and 69 are mounted upon the stirring shafts of the units I and III, the sprocket wheel 67 being connected to the wheel 66 by a chain 68 and the sprocket 69 being connected with the sprocket 65 by a chain 63. Thus all of the stirring shafts of the three units are driven together and at the same speed by the motor and reduction gearing.

To distribute the entering massecuite as it comes down the chute 16 and to give it initial uniform movement into the first unit, distributing and mixing means are provided in the form of rotating blades 34 on a horizontal shaft 35 extending longitudinally through the end wall 15 being supported in bearing 36 abutting the outside of wall 15.

To cause movement of the massecuite from the entrance toward the discharge end of the crystallizer, the whole apparatus is tilted so that the entrance end of the crystallizer is slightly above the discharge end. As the mass moves along the tank it is effectively and thoroughly mixed, stirred and cooled uniformly and finally reheated before discharge over the end plate 17. Preferably the end plate 17 is perforated so as to distribute the flow of massecuite as it discharges.

Many modifications within the scope of my invention will occur to those skilled in the art. Therefore I do not limit it to the specific form illustrated.

What is claimed is:

1. A continuous crystallizer for sugar bearing mixtures comprising a tank into which the mixture is let at one end and discharged at the other, a plurality of individual heat transfer devices spaced along the tank each having heat transfer surfaces arranged transversely of the tank substantially in vertical planes, means to move said devices to and fro in a direction parallel to the length of the tank to cause stirring of the mixture and heat transfer between said devices and mixture, and means causing movement of the mixture continuously along the tank from the inlet to the discharge end.

2. A continuous crystallizer for sugar bearing mixtures comprising a tank into which the mixture is let at one end and discharged at the other, a plurality of individual heat transfer devices spaced along the tank each having heat transfer surfaces arranged transversely of the tank substantially in vertical planes, means to move said devices to and fro in a direction parallel to the length of the tank to cause stirring of the mixture and heat transfer between said devices and mixture, means causing movement of the mixture continuously along the tank from the inlet to the discharge end and means causing stirring of the mixture between the planes of said heat transfer surfaces.

3. A continuous crystallizer for sugar bearing mixtures comprising a tank into which the mixture is let at one end and discharged at the other, a plurality of individual heat transfer devices spaced along the tank each having heat transfer surfaces arranged tranversely of the tank substantially in vertical planes, means to move said devices to and fro in a direction parallel to the length of the tank to cause stirring of the mixture and heat transfer between said devices and mixture, means causing movement of the mixture continuously along the tank from the inlet to the discharge end, and stirring means causing movement of marginal portions of the mixture into said heat transfer devices.

4. A continuous crystallizer for sugar bearing mixtures comprising a tank into which the mixture is let at one end and discharged at the other, a plurality of individual heat transfer devices spaced along the tank each having heat transfer surfaces arranged transversely of the tank, means to move said devices to and fro in a direction parallel to the length of the tank to cause stirring of the mixture and heat transfer between said devices and mixture, means causing movement of the mixture continuously along the tank from the inlet to the discharge end, and means at the inlet end to distribute the mixture and move it toward the first heat transfer device.

5. A continuous crystallizer for sugar bearing mixtures comprising a tank into which the mixture is let at one end and discharged at the other,

a plurality of individual heat transfer devices spaced along the tank each having heat transfer surfaces arranged transversely of the tank, means to move said devices to and fro in a direction parallel to the length of the tank to cause stirring of the mixture and heat transfer between said devices and mixture, means causing movement of the mixture continuously along the tank from the inlet to the discharge end, and means associated with each heat transfer device to stir and mix the mixture within the zone of that device.

6. A crystallizer as claimed in claim 5 having means at the inlet end to distribute the mixture and move it toward the first heat transfer device.

7. A crystallizer as claimed in claim 5 wherein the means to stir and mix is provided with blades which move the mixture inwardly from the side walls at both sides of the tank.

8. A crystallizer as claimed in claim 1 wherein the heat transfer devices comprise tubes within which water may circulate.

9. A crystallizer as claimed in claim 8 wherein the tubes each have a plurality of radial fins thereon.

10. A crystallizer as claimed in claim 9 wherein the fins on adjacent tubes are staggered.

11. A crystallizer as claimed in claim 1 wherein the heat transfer devices comprise a plurality of substantially parallel sets of sinusoidally arranged tubes within which water circulates.

12. A heat transfer device adapted for use as a unit of a continuous crystallizer for sugar bearing mixtures comprising a rockable shaft located transversely to the mixture flow, supporting means mounted on said shaft and rockable therewith, a plurality of tubes for circulating water mounted on said supporting means and positioned transversely relative to the mixture flow and extending entirely across the path of mixture flow, and means to rock said shaft and tubes continuously to and fro parallel to the direction of the mixture flow.

13. A heat transfer device as claimed in claim 12 wherein the tubes comprise a plurality of substantially parallel sets of sinusoidally arranged tubes.

14. A heat transfer device as claimed in claim 13 wherein the sets of tubes are spaced apart, and between them is located stirring means.

15. A heat transfer device as claimed in claim 15 wherein the stirring means rotates and has blades turned to cause movement of the mixture axially inwardly from each end of the stirring means.

16. A heat transfer device as claimed in claim 12 wherein the supporting means comprise axially spaced parallel inverted U-plates having tubes mounted along the edges thereof.

17. A continuous crystallizer for sugar bearing mixtures comprising a tank into which the mixture is let at one end and discharged at the other, a plurality of individual heat transfer devices spaced along the tank each having heat transfer surfaces arranged transversely of the tank, means to move said devices to cause stirring of the mixture and heat transfer between said devices and mixture, means causing movement of the mixture continuously along the tank from the inlet to the discharge end, said tank being tilted downwardly toward the discharge end causing continuous flow of the mixture along the tank through said heat transfer devices.

18. A continuous crystallizer for sugar bearing

mixtures comprising a tank into which the mixture is let at one end and discharged at the other, a plurality of individual heat transfer devices spaced along the tank each having a set of heat transfer surfaces arranged transversely of the tank substantially in vertical planes, means to pass cooling fluid through said heat transfer devices to cause progressive cooling of said mixture as it passes each set of heat transfer surfaces in moving from the inlet toward the discharge end of the tank, means to move said devices to and fro in a direction parallel to the length of the tank to cause stirring of the mixture, and means causing movement of the mixture continuously along the tank from the inlet to the discharge end.

ERNST W. KOPKE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
736,875	Ragot	Aug. 18, 1903
817,010	Schultze	Apr. 3, 1906
1,273,058	Hansen	July 16, 1918
1,749,588	Kopke	Mar. 4, 1930
1,868,406	Bonath	July 19, 1932
1,934,006	Ralston	Nov. 7, 1933
1,971,873	Peck	Aug. 28, 1934
2,032,160	Widmer	Feb. 25, 1936
2,160,533	Bonath	May 30, 1939
2,263,704	Platte	Nov. 25, 1941

FOREIGN PATENTS

Number	Country	Date
17,010	Great Britain	of 1914
313,290	Great Britain	June 13, 1929