United States Patent

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[15] **3,642,534**

[45] **Feb. 15, 1972**

[54] SUGAR-CRYSTALLIZING METHOD AND APPARATUS

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[22] Filed: **Dec. 5, 1969**

[21] Appl. No.: **882,604**

[30] **Foreign Application Priority Data**

Dec. 6, 1968 France 176907

[52] **U.S. Cl.** **127/15**, 23/273, 127/16, 127/58, 127/60, 241/72

[51] **Int. Cl.** **C13f 1/02**, C13g 1/04

[58] **Field of Search** 127/15, 16, 29–31, 127/58, 60–64; 23/273, 303; 241/72

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[57] **ABSTRACT**

A magma of sugar seed crystals is prepared by grinding the massecuite continuously withdrawn from a crystallizer in a ball mill until the crystalline, particulate sugar in the mother liquor of the massecuite is reduced to the necessary grain size of seed crystals and a suitable magma is thereby formed which is fed continuously to the crystallizer simultaneously with a body of concentrated syrup.

8 Claims, 3 Drawing Figures

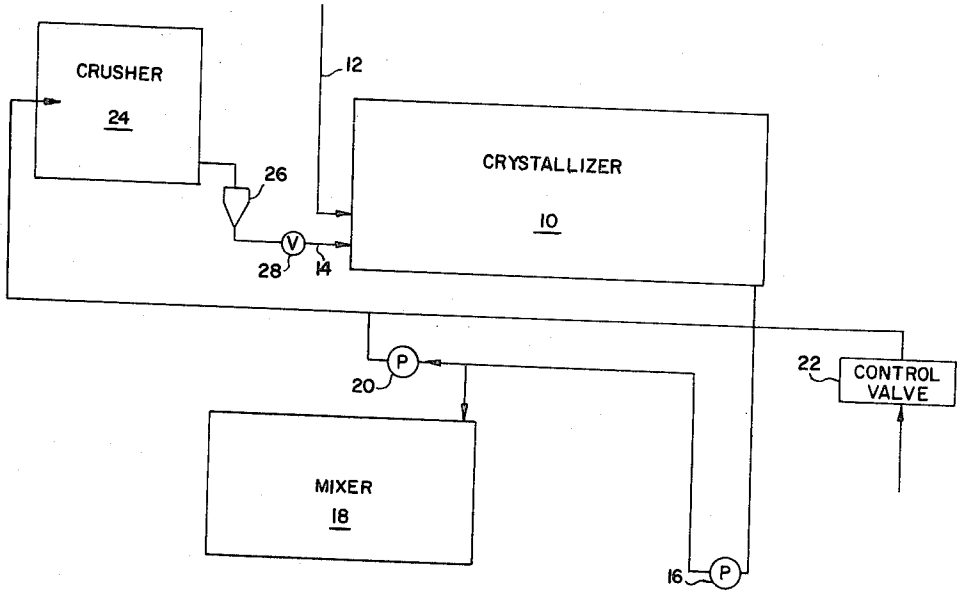

FIG. 1

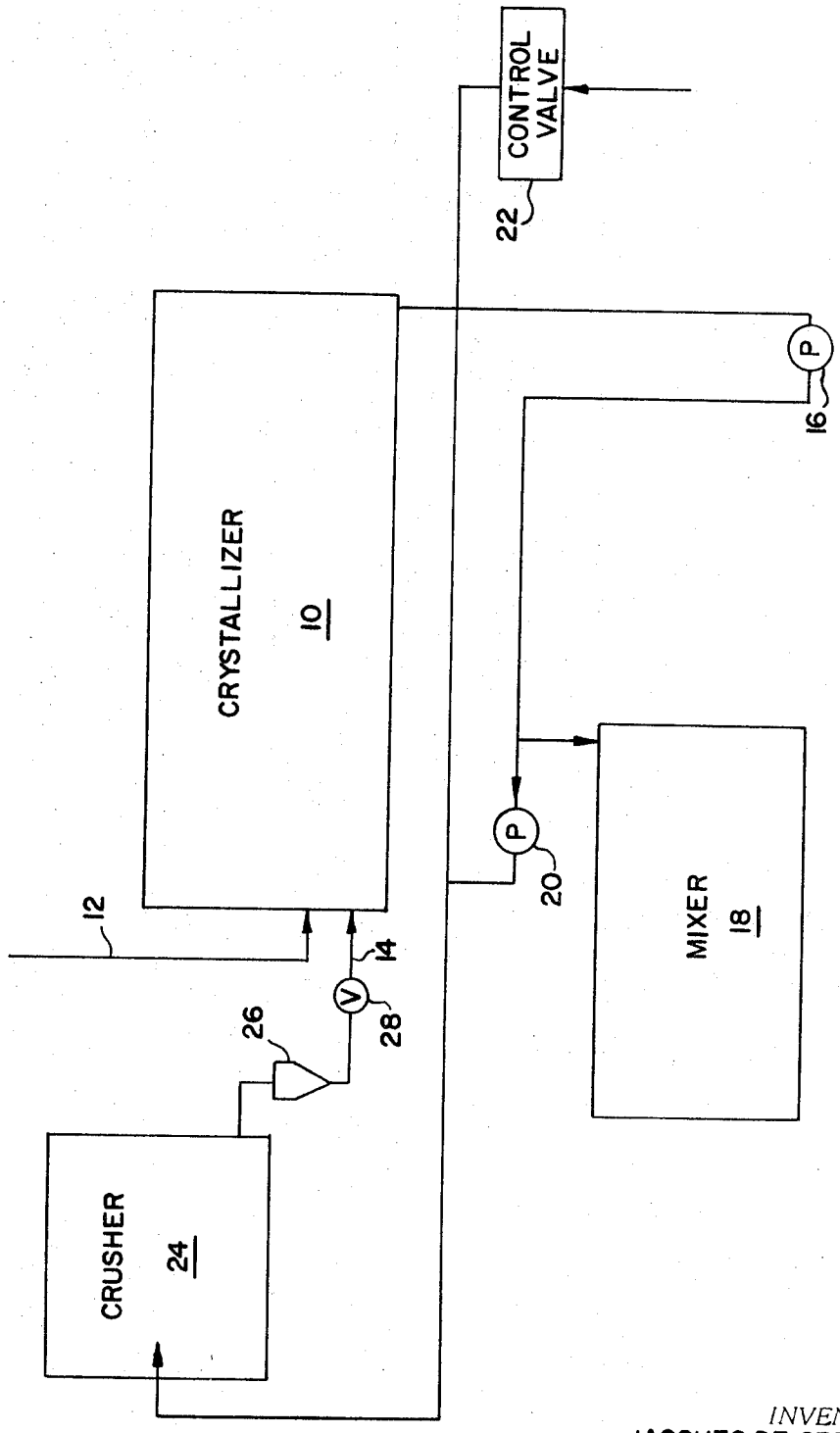

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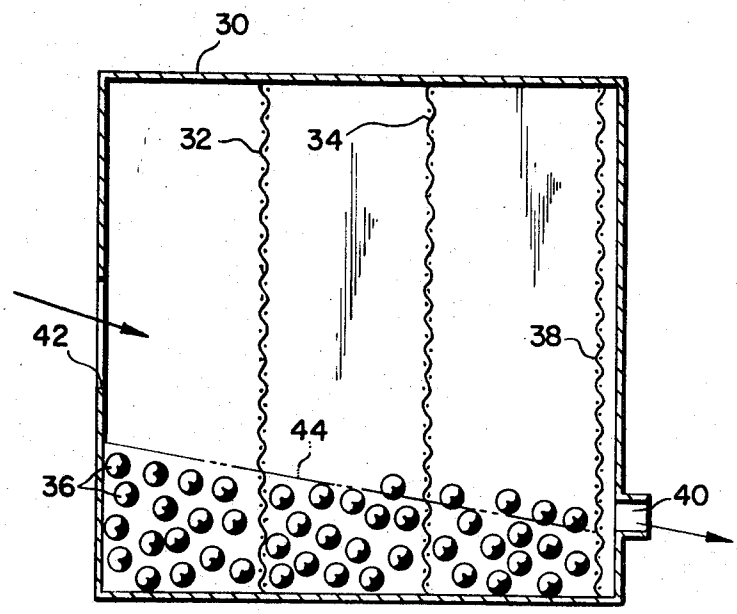
FIG. 2



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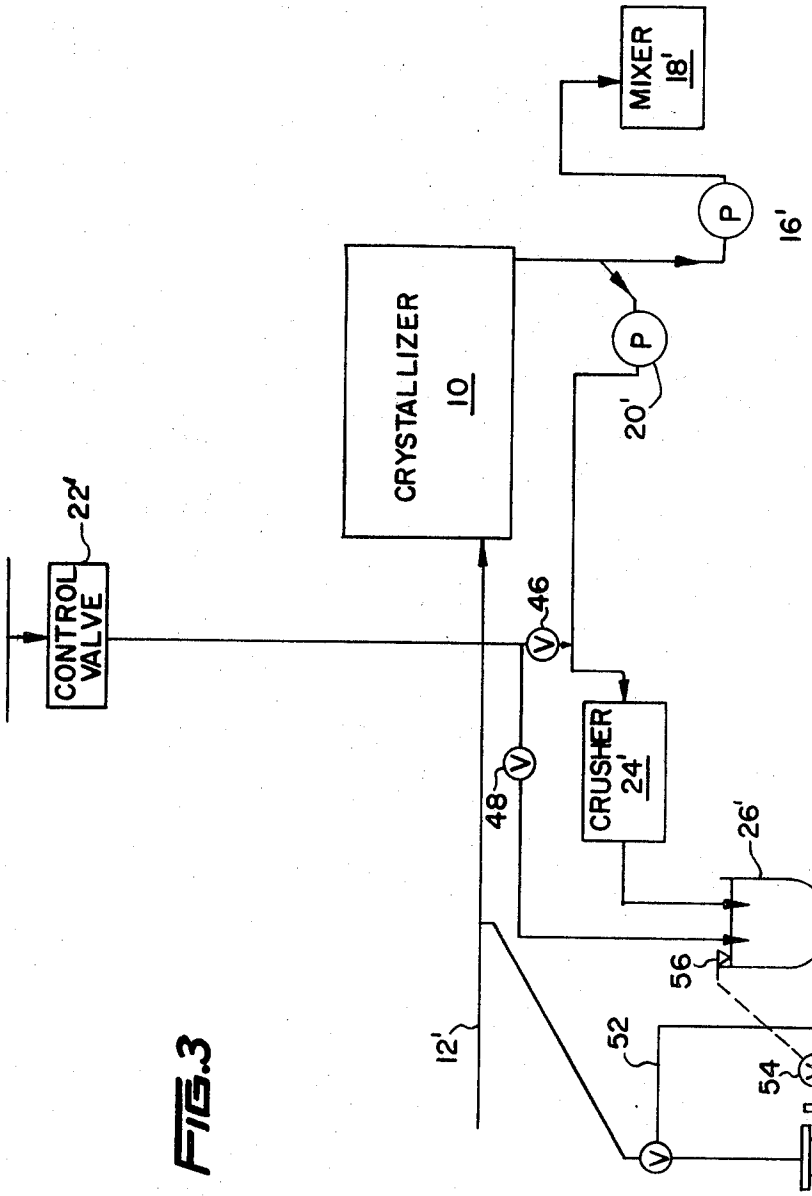

FIG. 3

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SUGAR-CRYSTALLIZING METHOD AND APPARATUS

This invention relates to the continuous crystallization of raw sugar from concentrated syrup, and particularly to a method of seeding the syrup and to apparatus for performing the method.

It is common practice to introduce a continuous stream of concentrated syrup into a crystallizer vessel, and to initiate crystallization of sugar from the syrup by a previously prepared magma of seed sugar crystals suspended in syrup. A massecuite of coarser crystals suspended in a mother liquor is continuously withdrawn from the crystallizer vessel. The number of crystals in the massecuite is practically identical with the number of added seed crystals, and the grain size distribution and quantity of the added seed crystals must be controlled precisely for obtaining a massecuite of desired properties.

For preparing a magma of seed crystals, it has been proposed to separate the raw sugar crystals from the mother liquor of massecuite by centrifugal extraction, to crush the recovered crystals, to screen the broken material for removal of fines and of an oversized fraction, and thereafter to mix the desired grain fraction with syrup. The known method requires a crusher or mill, classifying screens, and a mixer, and operation of these machines consumes an appreciable amount of labor and energy.

A principal object of the invention is a simpler and more economical method of preparing a magma of seed crystals. Another object is the provision of apparatus for performing the method.

It has now been found that a useful magma may be prepared by comminuting the particulate crystalline sugar of massecuite to the desired size while the crystalline sugar is immersed in the mother liquor of the massecuite. The wet grinding of the crystalline sugar does not produce the fines which are undesirable in the seed crystals and unavoidable in dry crushing or grinding. The equipment required for the method consists solely of a comminuting device, such as a ball mill, and the invention thus reduces the initial cost and the operating expense of a sugar crystallization plant.

If the massecuite withdrawn from the crystallizer is too viscous for partial use as magma, it may be diluted with water or syrup prior to grinding or after grinding and prior to being added to the body of concentrated syrup in the crystallizer.

A magma may be prepared according to the method of the invention either in batches or continuously, but continuous magma preparation normally is better adapted to use with continuously operating crystallizing equipment.

Other features, additional objects and many of the attendant advantages of this invention will readily become apparent from the following detailed description of preferred embodiments when considered in connection with the appended drawing in which:

FIG. 1 is a flow diagram of apparatus for performing the method of the invention;

FIG. 2 illustrates a ball mill for use in the method of FIG. 1 in elevational section on the axis of rotation of the mill; and

FIG. 3 shows a modification of the apparatus of FIG. 1.

Referring now to the drawing in detail, and initially to FIG. 1, there is shown a vacuum crystallizer **10** of a conventional type, not shown in detail, to which concentrated syrup is fed by a feed line **12**. A separate feedline **14** supplies magma to the crystallizer vessel, and massecuite is withdrawn continuously by a rotary slurry pump **16**, most of the withdrawn material being pumped into a mixer **18** for further processing, not relevant to this invention.

Metered amounts of the withdrawn massecuite are continuously transferred by a positive displacement pump **20** to a crusher **24**, together with dilute syrup admitted through a control valve **22**, and the magma of comminuted crystals suspended in the mother liquor of the massecuite is fed to the crystallizer **10** through the feedline **14** which connects the crusher to the crystallizer vessel and is equipped with a storage and settling tank **26** and a control valve **28**, the setting of the valve being coordinated with the operation of the pump **20** to maintain steady operating conditions in the crusher **24** and to maintain an adequate magma level in the storage tank **26**, which prevents air from being entrained with the magma fed to the crystallizer **10** in which a vacuum is maintained for rapid evaporation of water from the syrup, as is conventional.

A ball mill modified for the purpose of the invention has been found advantageous in apparatus of the type shown in FIG. 1, and a suitable ball mill is illustrated in FIG. 2. It has a cylindrical shell **30** which is rotated about a horizontal axis in the usual manner, not shown. The interior of the shell **30** is axially divided into three compartments by two upright screens **32, 34** of an aperture size sufficient to retain the grinding balls **36** which partly fill the shell. An additional screen **38** prevents discharge of the balls **36** through an annular aperture **40** in one radial end wall of the shell. Massecuite somewhat reduced in viscosity by the admixture of syrup is fed to the shell **30** continuously through a central aperture **42** in the other radial end wall. The material is still viscous enough to maintain in the shell **30** a surface **44** which slopes obliquely downwardly in the direction of the mill axis.

The particle size distribution of the comminuted sugar crystals discharged from the aperture **40** together with mother liquor depends mainly on the dwell time of the material in the shell, on the rotary speed of the shell, and on the size, weight and shape of the grinding bodies **36** in a manner well known to those skilled in the art. Suitable comminuting conditions must be established experimentally for each piece of comminuting equipment.

In an actual embodiment of the invention, a continuous crystallizer having an hourly capacity of 30 metric tons of massecuite was equipped with a metering pump capable of transferring 150 to 300 kg. of the withdrawn massecuite per hour to a ball mill of the type shown in FIG. 2. A control valve could be set for delivering 75 to 150 kg./hour syrup or hot water to the mill, approximately one half of the liquid being added to the massecuite prior to grinding, and the other half being added to the treated massecuite to form a magma which was returned to the crystallizer.

The grown crystals in the massecuite had an average particle size of 0.7 mm. The magma contained 20 to 25 percent seed crystals by weight, depending on the specific diluting conditions chosen, and the particle size on the seed crystals was practically entirely within the range from 20 to 100 microns.

The ball mill employed had an axial length of one meter, a diameter of 0.4 meter, and it was rotated at a speed of 44 r.p.m.

Another crystallizing arrangement is shown in FIG. 3. It includes a vacuum crystallizer **10'** from which massecuite is withdrawn by a slurry pump **16'** and largely flows into a mixer **18'**. A portion of the massecuite is transferred from the intake of the pump **16'** to a crusher **24'** by a metering pump **20'**. A calibrated control valve **22'** delivers syrup to two branch lines respectively equipped with valves **46, 48** for feeding respective portions of the syrup to the intake of the crusher **24'** and to an open storage tank **26'** equipped with a nonillustrated agitator to which the treated massecuite from the crusher **24'** is also transferred.

The mixture of treated massecuite and diluting syrup is held long enough in the tank **26'** to permit escape of entrapped air before the mixture flows to a pump **50** which discharges the magma into the feedline **12'** delivering concentrated syrup to the crystallizer **10'**.

A bypass **52** connects the intake and discharge conduits of the pump **50** and is controlled by a motor-operated valve **54**. The reversible valve motor is connected with a level gage **56** in the storage tank **26'** to open the valve **54**, and thereby to reduce the effective output of the pump **54** when the magma level in the tank **26'** drops below a desired height, and to reduce the flow section of the valve **54**, and thereby to increase the effective output of the pump **50** when the magma level rises above the desired height.

Many modifications and variations are obviously possible in the illustrated apparatus without departing from the scope and spirit of this invention as set forth in the appended claims.

What is claimed is:

1. In a method of crystallizing sugar from concentrated syrup by preparing a magma of sugar crystals of predetermined size, and adding said magma to a body of syrup under conditions in which said sugar crystals act as seeds initiating the crystallization of the sugar from said syrup, the improvement in the preparation of the magma which comprises comminuting the sugar crystals in a massecuite to said predetermined size.

2. In a method of crystallizing sugar from concentrated syrup by preparing a magma of sugar crystals of predetermined size, and adding said magma to a body of syrup under conditions in which said sugar crystals act as seeds initiating the crystallization of the sugar from said syrup, the improvement in the preparation of the magma which comprises comminuting the sugar crystals in a massecuite to said predetermined size, and diluting the magma with water prior to adding the magma to the body of syrup.

3. In a method of crystallizing sugar from concentrated syrup by preparing a magma of sugar crystals of predetermined size, and adding said magma to a body of syrup under conditions in which said sugar crystals act as seeds initiating the crystallization of the sugar from said syrup, the improvement in the preparation of the magma which comprises comminuting the sugar crystals in a massecuite to said predetermined size, and diluting the massecuite with water prior to comminuting the sugar crystals therein.

4. In a crystallizing arrangement for sugar including a crystallizer vessel, feeding means for continuously feeding a body of syrup and a magma of sugar crystals suspended in syrup to said vessel, and withdrawing means for withdrawing massecuite from said vessel, the improvement which comprises:

a. comminuting means;

b. transferring means for transferring a portion of said massecuite from said withdrawing means to said comminuting means for comminuting treatment of the massecuite; and

c. connecting means connecting said comminuting means with said feeding means for flow of the treated massecuite from said comminuting means to said vessel.

5. In an arrangement as set forth in claim 4, temporary storing means in said connecting means for temporarily storing said treated massecuite.

6. In an arrangement as set forth in claim 5, means for maintaining the level of said treated massecuite in said storing means at a level sufficiently high to prevent entrainment of air into said vessel with said treated massecuite.

7. In an arrangement as set forth in claim 4, said comminuting means including a rotary mill and grinding bodies in said mill.

8. In an arrangement as set forth in claim 7, said mill including a container mounted for rotation about a horizontally extending axis, an inlet and an outlet on said container axially spaced on said container, and a plurality of screens axially dividing the interior of said container into a plurality of compartments, the apertures of said screens being of a size to retain said grinding bodies but to pass said treated massecuite.

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