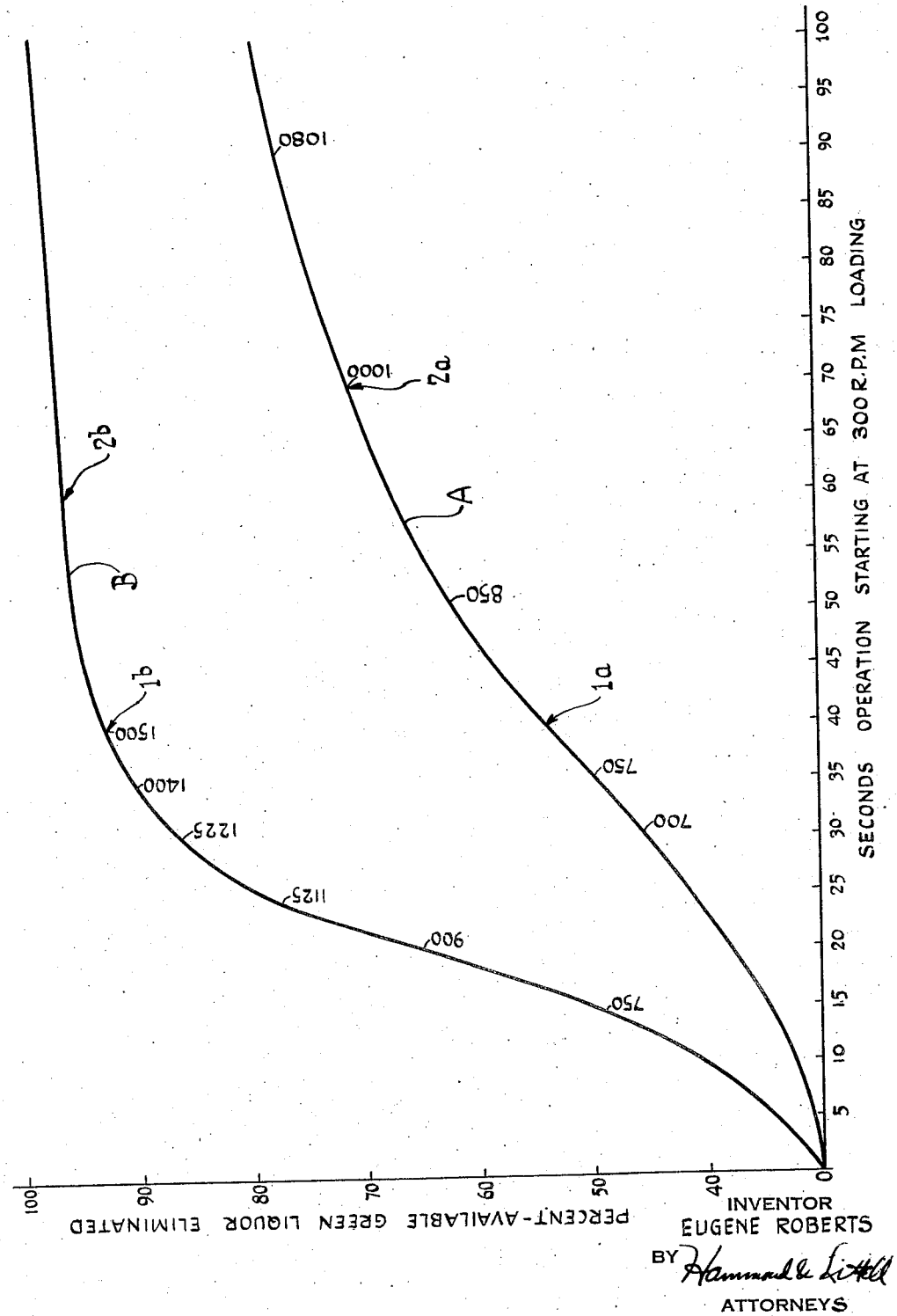
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METHOD OF CENTRIFUGING SUGAR

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INVENTOR
EUGENE ROBERTS
BY Hammond & Littell
ATTORNEYS

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METHOD OF CENTRIFUGING SUGAR

Eugene Roberts, Hastings, N. Y., assignor to The Western States Machine Company, New York, N. Y., a corporation of Utah

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13 Claims. (Cl. 127—56)

This invention relates to improved methods of separating sugar crystals from syrup by centrifuging mixtures of these materials, which may be massecuites of any grade encountered in the manufacture of sugar or magmas comprising mixtures formed by the addition of syrup to preformed crystals.

While it has been common practice for many years to effect separation of the sugar crystals from mixtures of sugar and syrup by centrifuging operations, within recent years there have been few improvements in the methods employed to carry out these operations. The centrifugals generally used heretofore have been driven by belts or by motors directly connected to the spindles upon which the centrifugal baskets are mounted, and speeds of around 900 to 1,200 revolutions a minute have been considered quite satisfactory for most purposes. In some instances, speeds as high as 1200 revolutions per minute or higher have been employed for the centrifuging of low grade, or crystallizer, massecuites, with slow uncontrolled acceleration and in cycles of operation which extended for a period of from 20 to 30 minutes or longer, but in the treatment of free-purging massecuites and magmas, which are of considerably higher purity than crystallizer massecuites, the use of lower speeds approximating 1,100 R. P. M. has been the prevalent practice. Aside from the slight consideration given to speeds of operation, little attention has been devoted to other aspects of the centrifuging operation. A considerable lapse of time has always been employed to bring the basket to its top speed. Moreover, prior to my invention the prevailing practices have been considered entirely adequate, and there have been few suggestions for improvement of centrifuging operations as a whole or of individual phases thereof.

Among the objects of my invention are to provide an improved method of centrifuging sugar which enables the recovery of substantially greater amounts of sugar crystals from a given quantity of material forming a single charge, to increase the production of sugar by permitting the amount of a single charge to be increased, to increase production by speeding up the cycle of operation, to improve the separation of sugar crystals from the syrup with which they are mixed, to obtain crystals that are more perfectly formed and freer from contamination than those available by known centrifuging methods, to decrease the loss of sugar that is incident to washing of the crystals with water, to obtain wash syrup of greater purity, with attendant economies in the reprocessing of this material, and to permit a greater spread between green syrup and wash syrup purities so that these materials may be collected separately, or combined into materials of controlled purities, and subsequently processed in the most efficient manner.

In addition to the foregoing objects of the invention, others will be made apparent as the description of my invention proceeds.

I have found that an essential feature of the centrifuging operation, for the accomplishment of the foregoing objects and others to be mentioned hereinafter, is rapid acceleration of the centrifugal, coupled with high speed operation. With proper control over acceleration and proper co-ordination of the successive steps in the centrifuging cycle, results may be obtained which are far superior to anything formerly considered possible. The method herein described produces efficient and rapid elimination of syrup from mixtures of sugar crystals and syrup, and is of particular value in the treatment of "free purging" massecuites and magmas. This efficient syrup elimination, when combined with control over the consistency of successive charges of the material introduced into the centrifugals, in accordance with preferred embodiments of the invention, permits maximum benefits of massecuite boiling and conditioning operations to be realized. When coupled with the cycle control and washing practices which are features of further embodiments of the invention, it enables the final cleansing of sugar crystals in centrifugals to be accomplished with maximum yield and quality of product, and enables other plant operations

that are affected by the qualities of the sugar crystals and run-offs produced from the centrifugals to be improved in important respects.

In the practice of my invention, a charge of the mixture of sugar crystals and syrup is introduced into a centrifugal, and the latter is brought to a speed of at least 1250 R. P. M. in less than forty seconds. In this manner, and as will be explained more fully hereinafter, I am able to obtain far superior results with reference to total yields of sugar and the qualities of the materials produced in the centrifuging operations, as compared with prior practices.

It is apparent that any centrifugal apparatus of the filtering type which is capable of rapid acceleration and high speed operation may be employed in carrying out the invention. An especially suitable form of apparatus is illustrated in my copending application, Serial No. 124,244, filed Feb. 5, 1937, for Centrifugal apparatus. In the ensuing description reference is had to filtering centrifugals in which the centrifugal basket is of the standard perforated type having a diameter of 40 inches. It is to be understood, however, that the invention is not limited to the use of a basket of this size, since the principles of the invention apply to baskets of various sizes, with corresponding variations in the speeds of revolution.

For purposes of illustration, the invention is described as it is applied specifically to the treatment of white massecuites and low grade massecuities. It produces unproved results, however, when applied to any grade of massecuite or to magmas produced by mixing raw cane sugar crystals with syrup, although the most outstanding advantages accure in connection with the so-called "free purging" massecuites, such as white or "A" and "B" massecuites and affination magmas.

In the treatment of white massecuites, the general practice is to flow the massecuite from a mixing chamber into the centrifugals in successive quantities, the sugar crystals being separated from the motor liquor in the centrifugals and the crystals being washed and finally discharged for subsequent treatment preliminary to packaging. While the present invention results in substantial improvements when applied to massecuites introduced into the centrifugals without reheating after leaving the vacuum pan, the better procedure is to reheat or maintain successive charges of the massecuite at a substantially uniform temperature between about 150 and 195° F., and preferably between 170 and 190° F., immediately before introduction into the centrifugals. The charging of the centrifugals may take place before the basket has reached a substantial speed, or up to speeds of about 600 R. P. M., and may be completed at substantially the same speed, before the acceleration stage of the centrifuging cycle is started. I prefer, however, to begin charging the basket after it has reached a speed of approximately 300 R. P. M. and to carry out the charging operation during the acceleration of the basket, between about 300 and 500 R. P. M. The speeds actually employed in either practice depend on the fluidity of the massecuite and the size of the sugar grain, which will vary with different grades of massecuites and different temperatures. For coarse grain sugars the speed of the basket during charging must be kept at a low point to avoid unevenness in the sugar wall so as to maintain a smoothly running, perfectly balanced basket, while for sugars of finer grain higher speeds within the range specified above are preferably employed, with acceleration during loading.

Regardless of the particular speed at which the charging takes place, or begins, the loaded basket, or the basket to which the charge is being added during acceleration is accelerated from such speed to a speed in excess of 1250 R. P. M. in less than 40 seconds, and the acceleration is preferably continued to a speed of not less than 1500 R. P. M. in less than one minute. In actual practice I find that acceleration to 1500 R. P. M. in forty seconds gives splendid results on white massecuites of medium fine grain size. More rapid acceleration and much higher top operating speeds than those specified may be employed with good results.

In accordance with the invention, washing of the sugar with water is correlated with the speed of the centrifugal in order to attain best results. The practice followed heretofore has required that the wash water be turned onto the sugar while the basket is spinning at a relatively low speed, since the centrifugals reached their top speed relatively slowly, and failure to apply the wash water until top speed was reached would uneconomically prolong the cycle and would permit cooling and stiffening of the material in the basket so that purging of the film of syrup retained on the sugar crystals could not be accomplished, if at all, without large losses through dissolving of the crystals themselves. I have found that this prior practice is highly inefficient because the wash water is applied while much of the syrup is still retained on the crystals, and the wash water, contaminated by this syrup, is incapable of leaving behind a sugar of highest purity. Moreover, the syrup interferes with complete purging of the wash water, while the speed of the basket during the washing stage is insufficient to eliminate these materials effectively. Large quantities of wash water and relatively lengthy spinning cycles are therefore necessary if a high quality sugar is to be obtained. I have found, however, that rapid acceleration of the basket and its load to at least 1250 R. P. M. in about 40 seconds flashes off the syrup before it has an opportunity to cool and to assist in the formation of a stiff wall of sugar crystals and syrup in the basket. This flashing off of the syrup leaves the crystals with only a very thin film of syrup surrounding them. Furthermore, quick removal of practically all of the syrup during acceleration leaves the mass in a condition more resistant to packing than when large quantities of syrup are present. I apply the wash water to the sugar after the basket has reached a speed of 1250 R. P. M. or higher, and the water must remove only the thin film of syrup that is retained by the crystals after the period of rapid acceleration.

A given amount of wash water, when following the method of my invention, dissolves considerably less sugar than in the prior practice. This result I attribute to the decreased contact time between the water and sugar at speeds above 1250 R. P. M. and to the pervious nature of the sugar wall formed by rapid acceleration to such speeds.

The greatly improved elimination of syrup obtained by my method is caused by the continued rapid pick-up of the centrifugal after it has passed speeds in the neighborhood of 750 R. P. M. The removal of the first quantities of green liquor or other syrup can be accomplished by common methods of operation. After this has

been eliminated, however, the crystals are left with thinner coatings of adherent syrup and only by following the practice described herein can this remaining syrup, up to more than 95% of the total available quantity, be eliminated during the acceleration stage of the cycle and prior to application of wash water.

As a further improved feature of the invention, I employ wash water at a temperature of from about 150 to 195° F. and preferably at a temperature of about 175 to 190° F. This water is sprayed onto the sugar from nozzles maintained under a pressure of about 25 to 35 pounds per square inch. There results a mist-like spray of hot water which is heated sufficiently to remove quickly the molasses film from the sugar and which strikes the sugar in a manner to penetrate the mass uniformly and to effect complete removal of the syrup. When unheated water is employed for washing it has a chilling effect which tends to congeal the mother liquor on the crystals, resulting in poor filtration and incomplete purging of the crystals unless larger quantities of wash water are used. When steam is employed, there is neither sufficient penetration of the sugar wall nor a sufficient body of liquid to carry off the retained syrup. According to my invention, however, a sugar of very high purity and substantially free from the frosting effect due to syrup dried thereon is obtained. Moreover, in the practice of the present invention the syrup and the wash water are flashed through the sugar so quickly and the amount of wash water necessary to secure perfect purging is so reduced that there is minimum dissolving of the crystals themselves, and the crystals retain their sharp corners with consequent improved luster as compared with sugar obtained by known methods.

Referring to the drawing, the figure graphically illustrates the advantages of my improved method over standard prior practice, in the treatment of white massecuite. The abscissa represent elapsed time in the centrifuging cycles. The ordinates represent the percent of available green liquor thrown off the sugar crystals. Curve A shows the operation of a standard centrifugal equipped with a directly connected motor and capable of reaching a speed of 1100 R. P. M. in two minutes. Curve B represents the operation of a centrifugal used in carrying out the present invention and capable of reaching a speed of more than 1500 R. P. M. with acceleration to 1500 R. P. M. in 40 seconds. According to the example of prior practice, the wash water was turned on after forty seconds of operation, at the point indicated at *1a* on the curve A, and the wash water was turned off at the point indicated at *2a* on this curve. Less than 55% of the green liquor had been eliminated when the wash water was turned on according to this practice, and less than 75% had been eliminated when the water was turned off. As indicated by curve B, however, the improved method involving acceleration to more than 1250 R. P. M. in less than 40 seconds results in a flashing off of the green liquor such that more than 85% has been eliminated in less than 40 seconds. When the wash water is turned on, after 40 seconds as indicated at *1b*, the sugar has already been purged of considerably over 90% of the available green liquor, and over 95% of available green liquor has been eliminated when the wash water is turned off, as at *2b*.

The advantages of the improved method are further illustrated by the following table showing data from typical cycles employing, first, the prior practice and, second, the method described herein, for the centrifuging of massecuite refinery of extra fine grain from 1st inboiled pans, reheated before charging into the centrifugals.

	Prior practice	Improved method (acceleration to 1,500 R. P. M. in less than 1 minute)
Weight of sugar from baskets	375	459
Weight of green syrup	186	371
Weight of wash syrup	304	180
Total weight	865	1,010
Cu. ft. massecuite per charge	9.3	10.46
Percent sugar yield (net crystallization)	40.2	47.1
Quarts wash water	18	12
Pounds sugar yield per quart wash water	20.8	38.4
Capacity increase (improved over prior)		45.7
Length of cycle (clutch into stop) minutes	3	2
Pounds sugar per 100 cu. ft. mass	4,032	4,388
Percent pan yield increase (same amount wash water)		8.8
Wet sugar, percent moisture	2.05	1.12
Wet sugar, specific conductance	4.4	3.2
Wet sugar, percent ash	.008	.0059

It will be noted that the improved practice permitted the introduction of at least one more cubic foot of massecuite per charge, that the sugar yield (net crystallization) was increased approximately 7%, and that the cycle of operation was one minute shorter. There was a consequent increase in capacity of 45.7 percent. as compared with prior practice. Moreover, the amount of wash water was reduced one third, and the new process enabled an increase in the yield of crystallized sugar from the massecuite leaving the vacuum pan of approximately 9%. The crystals contained little more than half as much moisture as those obtained by the prior practice, and they possessed a lower specific conductance and a lower ash content; hence substantial economies in subsequent treatments and a product of much better quality.

The above data relate to massecuites of extra fine grain. In the treatment of massecuites of coarser grain the invention easily produces products of less than 1% moisture content, and the amount of wash water required for perfect purging is reduced to as low as seven quarts.

In its application to low grade sugar massecuities, the present invention effects improvements in the capacity of the centrifugals and the purity of the raw sugar obtained after separation of the mother liquor. As in the treatment of white massecuites, the centrifugal is brought to a speed of at least 1250 R. P. M. in 40 seconds and to a speed of 1500 R. P. M. or higher in less than one minute. The low grade massecuite is preferably heated to a temperature between about 95° F. and 130° F. before introduction into the centrifugals. Whether heated to such a temperature or not, the rapid acceleration imparted to the massecuite according to this invention quickly throws the syrup from the crystals in a manner to obtain optimum purging, and a product of high purity is obtained in a relatively short operating cycle. The centrifuging of low grade massecuites generally does not involve washing of the sugar in the basket nor separation of wash syrup from green liquor. The following table includes comparative data

on the treatment of reheated low grade massecuites, taken from common sources of supply.

	Massecuite		Prior practice, 1180 R. P. M. in 3.5 minutes						Improved method, 1500 R. P. M. in 45 seconds					
					Raw sugar						Raw sugar			
	Brix	Purity	Length of cycle	Temp. of mass.	Percent dry sub.	Pol.	Pur.	Molasses, average purity	Length of cycle	Temp. of mass.	Percent dry sub.	Pol.	Pur.	Molasses, average purity
				°F.						°F.				
Test #1	92.2	57.6	10′	128	96.6	84.0	87.0	36.2	10′	124	98.5	91.6	93.0	36.3
			20′	131	98.3	91.2	92.5		20′	127	98.6	92.0	93.3	
			30′	135	98.1	91.0	92.8		30′	130	98.5	91.8	93.2	
Test #2	96.3	58.1	10′	127	97.3	85.0	87.4	36.1	10′	122	98.1	89.9	91.8	35.9
			20′	127	98.0	89.0	90.8		20′	122	98.4	90.5	92.0	
Test #3	96.3	58.1	5′	138	97.0	81.0	83.9	36.4	5′	134	97.4	87.6	89.9	37.1
			20′	138	97.6	88.8	91.0		10′	134	98.4	90.2	91.8	
Test #4	95.9	59.1	10′	129	96.9	85.3	88.0	37.12	10′	125	98.6	92.3	93.6	37.5
			20′	128	98.4	91.3	92.8		20′	124	98.7	92.5	93.7	
									#10′	113	97.7	88.6	90.7	

The table clearly indicates the improvements in purity and capacity obtainable by this invention. As shown in Tests Nos. 1, 2 and 4, spinning cycles of ten minutes, following the prior practice, produced raw sugars of 87.0, 87.4, and 88.0 purity, while the same length of cycle, applied to the same massecuites at approximately the same temperatures but according to the improved method, yielded products having purities of 93.0, 91.8, and 93.6 respectively. Continued spinning of the sugar according to the prior practice improved the purity of the product substantially, but in no instance, regardless of the length of cycle, was the product of as high purity as that obtained according to the invention by the treatment of a comparable massecuite in a ten minute cycle. Following the improved method, a ten minute cycle on the massecuite of Test #4, heated only to 113° F., produced a product of much higher purity than that obtained by treating the same massecuite, heated to 129° F. for a like period by the prior practice. Furthermore, the table shows that rapid acceleration produces maximum purity in a short cycle, since lengthening of the cycle fails to add materially to the results attained. Consequently the centrifugals are available for additional charges, and capacity is greatly increased.

The invention is applicable to the centrifuging of affinations or raw sugar magmas in much the same manner as it applies to white massecuites, with correspondingly improved results. Similarly, it provides important advantages in the treatment of any type of sugar-syrup mixture. Essentially, the method of the invention, involving rapid acceleration to high speed, produces a maximum filtration, or maximum elimination of syrup. The practical accomplishments include:

1. Higher capacity because of heavier charges, made possible by loading during acceleration and rapid syrup separation, and shorter operating cycles, which in turn means that fewer centrifugals are required to handle a given amount of material.

2. Increased sugar yields per unit volume of mixture, due to higher net crystal content, and to less loss of sugar by dissolution wherever washing is employed.

3. Greater flexibility such that the various components of the centrifugal cycle can be more readily adjusted to meet the conditions for centrifuging various grades of massecuites and still produce sugar of maximum quality.

4. When washing is employed, better separation between green and wash liquors, producing maximum purity wash syrup with minimum amount of water. Thus high quality wash syrup may be returned direct to storage tanks for the vacuum pans, or filtered and then returned for boiling into massecuite of the same quality as its source.

5. Lower wash water requirements.

6. Less sugar dissolved per unit quantity of wash water.

7. The sugar, when using the invention for the production of consumption sugar, is dried to the lowest possible moisture content at which it can be safely discharged from the centrifugals. This reduces the cost of drying, allows maximum granulator capacity and produces sugar of better luster. It also reduces the amount of "screenings" through easier and faster drying and formation of less "hard lumps", thereby further increasing direct yields through reduction in material requiring remelting.

As stated hereinbefore, the improved method relates to any mixture of sugar crystals and syrup, whether termed technically a "massecuite" or a "magma". Furthermore, it is not restricted to specific types of apparatus, nor specific temperatures for the material undergoing treatment, nor specific speeds of operation or cycles of operation, except as required by the claims appended hereto.

I wish it to be understood that any statement of actual speeds of revolution in the specification and claims refers specifically to a 40 inch centrifugal basket, but comprehends also speeds of revolution of larger or smaller baskets sufficient to impart the same degree of force to the materials undergoing treatment. In dealing with baskets of practicable size the speed necessary to produce forces corresponding to any given speed of a 40 inch basket may be easily determined from the following equation, derived from the laws of centrifgal force:

$$N_b = \sqrt{\frac{1.667N^2}{V_b}}$$

where N_b is the speed of a basket whose radius, in feet, is V_b, and N is the given speed for a 40 inch basket. The constant 1.667 is the radius, in feet, of the 40 inch basket.

I claim:

1. The method of centrifuging mixtures consisting of grain sugar suspended in syrup which comprises introducing a charge of the mixture into a centrifugal and accelerating the centrifu-

gal to a speed in excess of 1250 R. P. M. within forty seconds.

2. The method of centrifuging mixtures consisting of grain sugar suspended in syrup which comprises introducing successive charges of the mixture into a centrifugal while maintained at a substantially uniform temperature between 150 to 195° F. and bringing the centrifugal in each instance to a speed in excess of 1250 R. P. M. in less than forty seconds.

3. The method of centrifuging mixtures consisting of grain sugar suspended in syrup which comprises introducing a charge of the mixture into a centrifugal and accelerating the centrifugal to a speed of at least 1500 R. P. M. within forty seconds.

4. The method of centrifuging mixtures consisting of grain sugar suspended in syrup which comprises introducing a charge of the mixture into a centrifugal during acceleration of the centrifugal between 300 and 600 R. P. M. and completing acceleration of the centrifugal to a speed in excess of 1250 R. P. M. within 40 seconds from the beginning of the charging operation.

5. The method of centrifuging mixtures consisting of grain sugar suspended in syrup which comprises introducing a charge of the mixture into a centrifugal during acceleration of the centrifugal between 300 and 600 R. P. M., completing acceleration of the centrifugal to a speed in excess of 1250 R. P. M. in less than 40 seconds from the beginning of the charging operation and applying a spray of hot water to the material in the centrifugal after a speed of 1250 R. P. M. has been reached.

6. The method of centrifuging mixtures consisting of grain sugar suspended in syrup which comprises introducing a charge of the mixture into a centrifugal and accelerating the centrifugal to a speed in excess of 1500 R. P. M. in less than 1 minute.

7. The method of separating the constituents of mixtures consisting of grain sugar and adhering syrup which comprises introducing a charge of the mixture into a centrifugal, accelerating the centrifugal to a speed in excess of 1250 R. P. M. in less than 40 seconds, and applying a spray of washing liquid to the material in the centrifugal after a speed of 1250 R. P. M. has been reached.

8. In the centrifuging of mixtures consisting of grain sugar and adhering syrup the method of removing final quantities of syrup from the sugar which comprises applying to the material in the centrifugal a spray of water at a temperature in excess of 150° F. while the centrifugal is revolving at a speed in excess of 1250 R. P. M.

9. A method of separating the constituents of mixtures consisting of grain sugar and adhering syrup which comprises introducing successive charges of the mixture maintained at a uniform temperature between 170 and 195° F. into a centrifugal, accelerating the centrifugal in each instance to a speed in excess of 1250 R. P. M. within 40 seconds and applying to the material in the centrifugal after a speed of 1250 R. P. M. has been reached a spray of water at a nozzle temperature in excess of 170° F. and a nozzle pressure of from 25 to 35 pounds per square inch.

10. The method of centrifuging free-purging sugar massecuites which comprises introducing successive charges of the massecuite or magmas maintained at a substantially uniform temperature between 170 and 195° F. into a centrifugal and expelling more than 85% of the mother liquor from each charge before washing the sugar by accelerating the centrifugal to a speed in excess of 1250 R. P. M. within 40 seconds.

11. The method of centrifuging free-purging sugar massecuites which comprises introducing successive charges of the massecuite or magmas maintained at a substantially uniform temperature between 170 and 195° F. into a centrifugal, expelling more than 85% of the mother liquor from each charge before washing the sugar by accelerating the centrifugal to a speed in excess of 1250 R. P. M. within 40 seconds and applying to the material in the centrifugal after more than 85% of the mother liquor has been expelled a mist-like spray of water at a nozzle temperature in excess of 170° F.

12. The method of centrifuging mixtures of grain sugar and syrup and of producing sugar crystals of high quality and wash syrup of high purity in comparison with the syrup purged from the sugar, which comprises charging a batch of the mixture into a centrifugal revolving at loading speed, purging more than 85% of the syrup from the batch before washing the sugar by accelerating the centrifugal from loading speed to a speed in excess of 1250 R. P. M. within 40 seconds, and applying a spray of water to the material in the centrifugal after more than 85% of the syrup has been purged therefrom.

13. The method of centrifuging mixtures of grain sugar and syrup and of producing sugar crystals of high quality and wash syrup of high purity in comparison with the syrup purged from the sugar, which comprises charging successive batches of the mixture maintained at a substantially uniform temperature and fluidity into a centrifugal revolving at loading speed, purging more than 90% of the syrup from the batch in each instance before washing the sugar by accelerating the centrifugal from loading speed to a speed of at least 1500 R. P. M. in less than 1 minute, and applying a spray of hot water to the material in the centrifugal after more than 90% of the syrup has been purged therefrom.

EUGENE ROBERTS.

CERTIFICATE OF CORRECTION.

Patent No. 2,175,995. October 10, 1939.

EUGENE ROBERTS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 33, for "unproved" read improved; line 37, for "accure" read accrue; line 45, for "motor" read mother; page 3, second column, line 3, for "massecuite refinery" read refinery massecuite; page 5, second column, line 12, claim 10, strike out the words "or magmas" and insert the same after "massecuites", line 11, same claim; line 21, claim 11, strike out "or magmas" and insert the same after "massecuites", line 20, same claim, and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of December, A. D. 1939.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)