UNITED STATES PATENT OFFICE.

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PROCESS OF MANUFACTURING SUGAR.

SPECIFICATION forming part of Letters Patent No. 557,642, dated April 7, 1896.

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To all whom it may concern:

Be it known that I, OTTO A. BIELMANN, a subject of the Emperor of Germany, residing at Amesville, in the parish of Jefferson and State of Louisiana, have invented certain new and useful Improvements in Processes of Manufacturing Sugar; and I do hereby declare that the following is a full, clear, and exact description of the same.

My invention relates to the process of manufacturing sugar direct from sugar-cane, beets, or sorghum or from any solution containing sucrose, the purpose thereof being to obtain a high-grade sugar suitable for direct consumption and to reduce the proportion of what are termed "second" and "third" sugars or, as they are sometimes called, "soft" sugars or "after-products."

It is my purpose also to simplify and improve the processes in common use without entailing the costly installations required with other processes; to reduce the quantity of apparatus, fuel, and labor used heretofore in the manufacture of sugar by recovering in high-grade sugar in one continuous operation a greater proportion of the crystallizable sugar contained in any given sugar solution than has heretofore been practicable, and to provide a process of manufacture by which all of the available crystallizable sugar is obtained by a continuous operation, avoiding the necessity of repeated shutting down and starting up of factories on plantations, as has been usual heretofore, to recover the seconds and thirds or after-products.

My invention consists, to these ends, in the art, process, or mode of procedure hereinafter fully explained, and then particularly pointed out and defined in the claims.

In order that those skilled in the art to which my said invention pertains may fully understand and be able to practice the same, I will now describe said invention in detail, beginning at that point in the usual process of manufacture at which my invention is introduced.

Premising that by the term "purity coefficient" is meant the percentage of sucrose contained in a given quantity of masse-cuite, in order to illustrate what is accomplished by my invention and to aid in distinguishing the same from prior methods I will mention at the outset that in every "strike" of masse-cuite there is a certain relation between the yield in dry sugar and the purity coefficient of the sugar solution from which the strike is made, which, each strike containing the same number of pounds of masse-cuite, may be represented substantially as follows: Fifty thousand pounds of first masse-cuite made from a sugar solution of the purity coefficient of seventy-five yields twenty-five thousand pounds of dry sugar. Fifty thousand pounds of second masse-cuite made from a sugar solution having a purity coefficient of fifty-five, which is derived from the uncrystallized part of the first masse-cuite, yields twelve thousand five hundred pounds of dry sugar. Fifty thousand pounds of third masse-cuite made from a sugar solution of the purity coefficient of thirty-five, which is derived from the uncrystallized part of the second masse-cuite, yields six thousand two hundred and fifty pounds of dry sugar, &c. These figures, though not absolutely correct, are approximately so, and serve to illustrate that second masse-cuite made from a sugar solution of the purity coefficient of 55, which is twenty points lower than the purity coefficient of the solution from which the first masse-cuite is made, yields only fifty per cent. of the quantity of dry sugar yielded by first masse-cuite. The same proportionate diminution in yield of dry sugar obtains in the third masse-cuite, which is made from a sugar solution of the purity coefficient of 35, which is twenty points lower than the purity coefficient of the solution from which the second masse-cuite is made.

The decreased yields between first, second, and third masse-cuite is attributable to the decreased purity coefficient of the solutions from which they are made, which is caused by the removal in each operation of the proportion of sucrose recovered in the dry sugar obtained and the consequent increase in the proportion of non-sugars of both organic and inorganic character contained in the original solution, as well as additional non-sugars which are created in the course of each operation of reboiling.

To overcome the difficulties of crystallization that present themselves on account of the decrease in the purity coefficient of each succeeding solution, I reduce by dilution the solution derived from the uncrystallized part of the first masse-cuite, and in turn the solution derived from the uncrystallized part of the second masse-cuite, and so on to as low a density as circumstances justify—say between 33° and 24° Baumé—because of the fact that all crystallized impurities formed by the treatment hereinafter described of a higher specific gravity than the specific gravity of the solution containing them will settle to the bottom of the vessel, while otherwise they would remain suspended in the solution. Having reduced the solution to the desired density, I add a suitable alkali or alkaline earth in excess, either in the form of carbonate or hydrate, the object being to render the solution distinctly alkaline in order to eliminate or render less obnoxious the non-sugars present. Heat being now applied the solution is brought to a temperature a little below the boiling-point, or to about 200° Fahrenheit, which causes the lighter impurities to rise and form a scum on the top of the solution, which is removed in the usual manner. This being done, I add to the remaining solution enough of any diluted acid to render the sugar solution neutral—such, for example, as phosphoric acid—and again apply heat to cause thorough mixing, whereby the heavier impurities are caused to settle to the bottom of the vessel in which the heating is done, which heavier impurities are removed by any desirable process, either by filtration of the solution or by decanting the clear liquid. This treated solution is now ready to be reboiled and evaporated to the point of crystallization in the vacuum-pan.

There is, as I have heretofore indicated, a certain definite relation between the purity coefficient and the yield or quantity of dry sugar produced from any given sugar solution. As the former increases the latter is similarly increased, and for the purposes of this description I speak of this relation between the yield and the purity coefficient as the "graining" capacity.

The second part of my process consists in the use of sugar crystals, either dry or wet, of different-sized grains, with each of the several sugar solutions hereinbefore described, in order to artificially increase the graining capacity of each.

In Patent No. 386,958, granted to me in 1888, I have described the use of sugar crystals for improving the granulation of sugar solutions. Since that patent was issued to me I have elaborated this process, of which the following is a full description.

To illustrate: To a strike of fifty thousand pounds of second masse-cuite made from a solution of the purity coefficient of 55 I use, as hereinafter described, about ten per cent. of its weight or five thousand pounds of sugar crystals, (either in a dry or wet state,) the average size of which crystals being, as an example, one-quarter of a millimeter in length to increase the graining capacity of the solution. To a strike of fifty thousand pounds of third masse-cuite made from a solution of the purity coefficient of 35 I use in the same way about ten per cent. or five thousand pounds of sugar crystals, the average size of which crystals being, for example, one-eighth of one millimeter in length, which naturally will increase the graining capacity of the solution, basing the calculation of graining capacity upon the amount of area presented by the different-sized crystals for the deposit of the sugar molecules contained in each solution. Upon the principle that the total area of surface presented by a sugar crystal having a length of one-eighth of one millimeter is about one-half of the total area of a crystal having a length of one-quarter of one millimeter five thousand pounds of the small crystals will present an area about twice as great as five thousand pounds of the larger crystals would, since it takes eight crystals of the smaller dimensions to make one crystal of the larger dimensions. Were sugar crystals perfect cubes, this would be the exact measure of the difference in area of the two sizes cited. The object in using the different sizes of sugar crystals is to present a greater area upon which the sugar molecules may be deposited in a sugar solution of low purity than in one possessing a high purity.

Sugar crystals of the required size may be obtained by boiling strikes of second masse-cuite in the ordinary way to different densities, the crystals being smaller as the density increases. The larger crystals can easily be brought to the desired size by mixing the dry crystals which are too large for the intended purpose with an unsaturated sugar solution. The unsaturated solution, having, for instance, a density of 45° Brix, will diminish and reduce the sugar crystals to the size desired for use in a strike having a purity coefficient corresponding therewith, which effect can easily be observed by the use of a microscope, and can be regulated by the use of more or less of the sugar solution to the given amount of sugar crystals. This mixing of the sugar crystals with unsaturated sugar solutions in order to diminish them to the desired size may be done in any suitable vessel, but I prefer to do it in a small tank, the bottom of which ought to be higher than the bottom of the vacuum-pan in order to facilitate the introduction into the pan.

The solution derived from the uncrystallized part of first masse-cuite, after having been diluted and treated as described, is drawn into the vacuum-pan and boiled down to about 42° Baumé. Then the sugar crystals, having a length, for example, of about one-quarter of a millimeter, are brought into the pan by any suitable arrangement, care being taken not to melt the crystals. This strike, being made from a solution derived from the uncrystallized part of first masse-cuite, is now boiled and finished like a strike of original first masse-cuite.

The sugar crystals used being nuclei upon which the crystallizable part of the solution is deposited as the process of evaporation progresses grow to a large grain, like first sugar. I prefer to drop these strikes of second masse-cuite into wagons, which are placed in the hot room for two or three days in order, by after cystallization, to get a higher yield; but they may be dried like first masse-cuite, if desired. When dried, the uncrystallized part is treated as hereinbefore described.

In reboiling this solution, derived from the uncrystallized part of the second masse-cuite, if the purity coefficient should be too low to make the sugar crystals grow in the vacuum-pan, the *modus operandi* has to be changed. I fill the pan in the regular way to about two-thirds of its capacity with masse-cuite having a density of about 42° Baumé, when I introduce into the pan the sugar crystals of the smaller size mentioned and finish the strike as usual, only taking care not to melt the crystals. This strike, which is third masse-cuite, goes into wagons or tanks and is put into the hot room; but instead of having to remain there for months, as is required by the ordinary process, it will be ready for drying in three weeks and will produce a sugar of well-developed grain, and the molasses from it under normal conditions is practically exhausted. Analysis of this molasses will show that the purity is about from ten to twenty per cent. lower than obtainable by the most skilful manipulation by the ordinary process—that is to say, after the crystals of the last strike of this kind of masse-cuite are dried I close the factory, leaving no material whatever for further operations until next crop commences.

It is not possible to state with absolute accuracy the diameters of the different sizes of sugar crystals used in strikes having different purity coefficients. These dimensions can only be given approximately. For example, in a strike of masse-cuite having a purity coefficient or percentage of sucrose of 55 I use about ten per cent. of its weight of sugar crystals having an average length of one-quarter of a millimeter or thereabout. In a strike made from a solution having a purity coefficient of 35 I use about ten per cent. of sugar crystals having a length of one-eighth of a millimeter or thereabout. If these dimensions are subtantially observed, the results I claim will be obtained; but of course I may vary the dimensions named within certain limits without departing from my invention. In like manner I do not confine myself to the use of ten per cent., by weight, of sugar crystals, as described, for the quantity may be varied, although I regard the proportions named as preferable.

What I claim is—

1. In the manufacture of sugar, the process herein described for obtaining a greater yield and better quality of high-grade sugar from a given amount of sugar-containing solution, said process consisting in adding to the uncrystallized part of a first, second or third masse-cuite, a suitable proportion, as for example, ten per cent. by weight, of sugar crystals of a length substantially proportioned to the purity coefficient of said solution, for example, a length of one-quarter of a millimeter in a sugar-containing solution having a purity coefficient of $55\frac{1}{8}$ millimeters in a solution having a purity coefficient of 35, or thereabout, substantially as described.

2. In the manufacture of sugar, the process described which consists in adding to a sugar-containing solution previously reduced to a density of between 25° and 35° Baumé, whereby the impurities of higher specific gravity are caused to settle, an alkaline earth in excess, to render the solution distinctly alkaline and to eliminate or render less obnoxious the non-sugar present, then applying heat to cause the lighter impurities to rise and enable them to be removed by skimming, adding a suitable acid, such as phosphoric acid, to render the solution neutral, again heating and thoroughly mixing the solution and the added ingredients to precipitate the heavier impurities, and finally separating the latter in any suitable manner, substantially as described.

3. In the manufacture of sugar, the process hereinbefore described, which consists in reducing sugar crystals to a size or diameter adapted to a sugar solution of a given purity coefficient, said process consisting in the mixing of said sugar crystals with an unsaturated sugar solution in order to reduce the said crystals to the required size, said unsaturated sugar solution having a density for example of 45° Brix, and finally adding said crystals to the uncrystallized part of a strike of masse-cuite having a corresponding purity coefficient, or thereabout, to promote the graining capacity and expedite the process of crystallization, substantially as described.

4. In the manufacture of sugar, the process described, which consists in diluting the uncrystallized part derived from a first or second masse-cuite to a low density to aid in eliminating the heavier impurities which have a higher specific gravity than the diluted solution, adding an alkali, or alkaline earth in excess to render said solution distinctly alkaline and to eliminate or render less obnoxious the non-sugar present, then heating to a point below boiling to cause the lighter impurities to rise, removing said impurities, then adding an acid to render the solution neutral, again heating to cause thorough mixture and cause the heavier impurities to settle, removing the latter, and then evaporating to crystallization, substantially as described.

In testimony whereof I have hereunto subscribed my name in the presence of two witnesses.

OTTO A. BIELMANN.

Witnesses:
WALTER H. COOK,
ROBT. E. RIES.