powdered megass have been found very efficient for removing the large quantity of impurities contained in the juice expressed from the very vigorous but rank canes grown in that wonderfully fertile country, but unless constant care is taken in managing them, and in changing them at the proper time, there is great risk of inversion taking place, with consequent loss of sugar.

After the juice has been defecated or purified by any of the means above mentioned it is sent to the evaporating apparatus, hereinafter described, where it is concentrated to 26° or 28° Beaumé, and is then conducted in a continuous stream either into the service tanks of the vacuum pan, if dark, sugars are required, or, if a better colour is wanted, into clarifiers. The latter are circular or rectangular vessels, holding from 500 to 1500 gallons each, accord­ing to the capacity of the factory, and fitted with steam coils at the bottom and skimming troughs at the top. In them the. syrup is quickly, brought up to the boil and skimmed for about five minutes, when it is run off to the service tanks of the vacuum pans. The heat at which the syrup boils in the clarifiers, 220o F., has the property of separating a great deal of the gum still remaining in it, and thus cleansing the solution of sugar and water for crystalliza­tion in the vacuum pans; and if after skimming the syrup is run into separators or subsiders of any description, and allowed to settle down and cool before being drawn into the vacuum pan for crystalli­zation, this cleansing process will be more thorough and the quality of the final product will be improved. Whether the improvement will be profitable or not to. the planter or manufacturer depends, on the market for the sugar, and on the conditions of foreign tariffs, which are not infrequently hostile.

*Evaporation of the Juice to Syrup.*—The third operation is the concentration of the approximately pure, but thin and watery, juice to syrup point, by driving off a portion of the water, in vapour through some system of heating and evaporation. Since on an average 70% by measurement of the normal defecated cane juice has to be evaporated in order, to reduce it to syrup ready for final concentration and crystallization in the vacuum pan, and since to attain the same end as much as 90 to 95% of the volume of mixed juices has to be evaporated when maceration or imbibition is employed, it is clear that some more economical mode of evapora­tion is necessary in large estates than the open-fire, batteries still common in Barbados and some of the West Indian islands, and in small haciendas in Central America and Brazil, but seldom seen elsewhere. With open-fire batteries for making the syrup, which was afterwards finished in the vacuum pan, very good sugar was produced, but at a cost that would be ruinous in to-day’s markets.

In the best days of the so-called Jamaica Trains in Demerara, three-quarters of a ton of coal in addition to the megass was burned per ton of sugar made, and with this for many years planters were content, because they pointed to the fact that in the central factories, then working in Martinique and Guadeloupe, with charcoal filters and triple-effect evaporation, 750 kilos of coal in addition to the megass were consumed to make 1000 kilos of sugar. All this has now been changed. It is unquestionably better and easier to evaporate *in vacuo* than in an open pan, and with a better system, of firing, a more liberal provision of steam, generators, and multiple-effect evaporators of improved construction, a far larger yield of sugar is obtained from the juice than was possible of attainment in those days, and the megass often suffices as fuel for the crop.

The multiple-effect evaporator, originally invented and con­structed by Norberto Rilleux in New Orleans in 1840, has under­gone many changes in design and construction since that year. The growing, demand for this system of evaporation for application in many other industries besides that of sugar has brought to the front a large number of inventors. Forgetful or ignorant of the great prin­ciple announced and established by Rilleux, they have mostly devoted their energies and ingenuity to contriving . all sorts of complicated arrangements to give the juice the density required, by passing and repassing it over the heating surface of the apparatus, the saving of a few square feet of which would seem to have been their main object. In some instances the result has been an addi­tional and unnecessary expenditure of high-pressure steam, and in all the well-known fact—of the highest importance in this connexion— appears to have been disregarded, that the shorter the time the juice is exposed to heat the less inversion will take place in it, and therefore the less will be the loss, of sugar. But this competition among inventors, whatever the incentive, has not been without benefit, because to-day, by. means of very simple improvements in details, such as the addition of circulators and increased area of connexions, what may be taken to be the standard type of multiple-effect evaporator (that is to say, vertical vacuum pans fitted with vertical heating tubes, through which passes the liquor to be treated, and outside of which the steam or vapour circu­lates) evaporates nearly double the quantity of water per square foot of heating surface per hour which was evaporated by apparatus in use so recently as 1885—and this. without any increase in the steam pressure. That evaporation *in vacuo,* in a multiple-effect evaporator, is advantageous by reason of the increased amount of sugar obtained from a given quantity of juice, and by reason of economy of fuel, there is no doubt, but whether such an apparatus should be of double, triple, quadruple or quintuple effect will depend very much on the amount of juice to be treated per day, and the cost of fuel. Thus, supposing that 1000 lb of coal were required to work a single vacuum pan, evaporat­ing, say, 6000 lb of water in a given time, then 500 lb of coal would be required for. a double-effect apparatus to do the same work, 333 lb for a triple effect, 250 for a quadruple effect, and 200 lb for a quintuple effect.. In some places where coal costs 60s. a ton, and where steam is raised by coal, as in a beetroot factory, it might pay to adopt a quintuple-effect apparatus, but on a. cane-sugar estate, where the steam necessary for the evaporator is raised by burning the megass as fuel, and is first used in the engines working the mills, the exhaust alone passing to the evaporator, there would be very little, if any, advantage in employing a quadruple effect instead of a triple effect, and practically none at all in having a quintuple-effect apparatus, for the interest and sinking fund on the extra, cost would more than counterbalance the saving in fuel.

With the juice of some canes considerable difficulty is encountered in keeping the heating surfaces of the evaporators clean and free from incrustations, and cleaning by the use of acid has to be resorted to. In places where work is carried on day and night throughout the week, the standard type of evaporator lends itself more readily to cleaning operations than any other. It is obviously easier to brush out and clean vertical tubes open at both ends, and about 6 ft. long, on which the scale has already been loosened by the aid of boiling with dilute muriatic acid or a weak solution of caustic soda in water, than it is to clean either the inside or the outside of horizontal tubes more than double the length. This consideration should be carefully remembered in the future by the planter who may require, an evaporator and by the engineer who may be called upon to design or construct, it, and more especially by a constructor without practical experience of the working of his constructions.

*Concentration and Crystallization.—*The defecated cane juice, having lost about 70% of its bulk by evaporation in the multiple­effect evaporator, is now syrup, and. ready to enter the vacuum pan for further concentration and crystalliza­tion. In a patent (No. 3607, 1812) granted to E. C. Howard it is stated, among other things, that “ water dissolves the most uncrystallizable in preference to that which is most crystallizable sugar,” and the patentee speaks of "a discovery I have made that no solution, unless highly concentrated, of sugar in water can without material injury, to its colouring and crystalliz­ing power, or to both, be exposed to its boiling temperature during the period required to evaporate such solution to the crystallizing point.” He stated that “ he had made a magma of sugar and water at atmospheric temperature, and heated the same to 190° or 200° F. in a water or steam bath, and then added more sugar or a thinner magma, and the whole, being then in a. state of imperfect fluidity, but so as to close readily behind the stirrer, was filled into moulds and purged ” (drained). “ I do further declare,” he added, “ that although in the application of heat to the refining of sugar in my said invention or process 1 have stated and mentioned the tempera­ture of about 200° F. scale as the heat most proper to be used and applied in order to secure and preserve the colour and crystalliz­ability of the sugars, and most easily to be obtained with precision and uniformity by means of the water bath and steam bath, yet when circumstances or choice may render the same desirable I do make use of higher temperatures, although less beneficial.” Howard at any rate saw clearly what was one of the indispensable requisites for the economical manufacture of fine crystal sugar of good colour —the treatment of saccharine solutions at temperatures very con­siderably lower than 212°. F., which is the temperature of water boil­ing at normal atmospheric pressure. Nor was he long in providing means for securing, these lower temperatures. His patent (No. 3754 of 1813) describes the closed vacuum pan and the air pump with condenser for steam, by injection, the use of a thermometer immersed in the solution in the pan, and a method of ascertaining the density of the solution with a proof stick, and by observations of the temperature at which, while fluid and not containing grain, it could be kept boiling under different pressures shown by a vacuum gauge. A table is also given of boiling points from 115° F. to 175° F., corresponding to decimal parts of an inch of mercury of the vacuum gauge. Since Howard published his invention the vacuum pan has. been greatly improved and altered in shape and power, and especially of recent years, and the advantages of concen­trating *in vacuo* having been acknowledged, the system has been adopted in many other industries, and crowds of inventors have turned their attention to the principle. In endeavouring to make a pan of less power do as much and as. good work as one of greater power, they have imagined many ingenious mechanical contrivances, such as currents produced mechanically to promote evaporation and crystallization, feeding the pan from many points in order to spread the feed equally throughout the mass of sugar being cooked, and so on. All their endeavours have obtained at best but a doubtful success, for they have overlooked the fact that to evaporate a given weight of water from the syrup in a vacuum pan at least an equal weight (or in practice about 15% more) of steam must be condensed, and the first cost of mechanical agitators, together with the expenditure they involve for motive power and