maintenance, must be put against the slight saving in the heating surface effected by their employment. On the other hand, the advocates of admitting the feed into a vacuum pan in many minute streams appeal rather to the ignorant and incompetent sugar- boiler than to a man who, knowing his business thoroughly, will boil 150 tons of hot raw sugar in a pan in a few hours, feeding it through a single pipe and valve 10 in. in diameter. Nevertheless, it has been found in practice, when syrups with low quotient of purity and high quotient of impurity are being treated, injecting the feed at a number of different points in the pan does reduce the time required to boil the pan, though of no practical advantage with syrups of high quotient of purity and free from the viscosity which impedes circulation and therefore quick boiling. Watt, when he invented the steam engine, laid down the principles on which it is based, and they hold good to the present day. So also the prin­ciples laid down by Howard with respect to the vacuum pan hold good to-day : larger pans have been made and their heating surface has been increased, but it has been found by practice now, as it was found then, that an ordinary worm or coil 4 in. in diameter and 50 ft. long will be far more efficient per square foot of surface than a similar coil 100 ft. long. Thus the most efficient vacuum pans of the present day are those which have their coils so arranged that no portion of them exceeds 50 or 60 ft. in length; with such coils, and a sufficient annular space in the pan free from obstruction, in order to allow a natural down-current of the cooking mass, while an up-current all round is also naturally produced by the action, of the heated worms or coils, rapid evaporation and crystallization can be obtained, without any mechanical adjuncts to require attention or afford excuse for negligence.

The choice of the size of the crystals to be produced in a given pan depends upon the market for which they are intended. It is of course presupposed that the juice has been properly defecated, because without this no amount of skill and knowledge in cooking in the pan will avail; the sugar resulting must be bad, either in colour or grain, or both, and certainly, in polarizing power. If a very large firm grain like sugar-candy is required the syrup when first brought into the pan must be of low density, say 20° to 21°Beaumé, but if a smaller grain be wanted it can easily be obtained from syrup of. 270 to 28° Beaumé. On some plantations making sugar for particular markets and use in refineries it is the custom to make only one class of sugar, by boiling the molasses produced by the purging of one strike with the sugar in the next strike. On other estates the second sugars, or sugars produced from boil­ing molasses alone, are not purged to dryness, but when sufficiently separated from their mother-liquor are mixed with the defecated juice, thereby increasing its saccharine richness, and after being converted into syrup in the usual manner are treated in the vacuum pan as first sugars, which in fact they really are.

In certain districts, notably in the Straits Settlements, syrup is Crepared as described above for crystallization in a vacuum pan, but instead of being cooked *in vacuo* it is slowly boiled up in open double-bottom pans. These pans are sometimes heated by boiling oil, with the idea that under such conditions the sugar which is kept stirred all the time as it thickens cannot be burnt or caramel­ized; but the same object can be attained more economically with steam of a given pressure by utilizing its latent heat. The sugar thus produced, by. constant stirring and evaporation almost to dryness, forms a species of small-grained concrete. It is called “ basket sugar,” and meets with a brisk sale, at remunerative prices, among the Chinese coolies; and as the sugar as soon as cooled is packed ready for market, without losing any weight by draining, this branch of sugar-making is a most lucrative one where- ever there is sufficient local demand. Very similar kinds of sugar are also produced for local consumption in Central America and in Mexico, under the names of "Panela” and “ Chancaca,” but in those countries the sugar is generally boiled in pans placed over special fire-places, and the factories making it are on a comparatively small scale, whereas in the Straits Settlements the "basket sugar ” factories are of considerable importance, and are fitted with the most approved machinery.

*Curing or Preparation of Crystals for the Market.*—The crystal­lized sugar from the vacuum pan has now to be separated from the molasses or mother-liquor surrounding the crystals. In some parts of Mexico and Central America this separation is still effected by running the sugar into conical moulds, and placing on the top a layer of moist clay or earth which has been kneaded in a mill into a stiff paste. The moisture from the clay, percolating through the mass of sugar, washes away the adhering molasses and leaves the crystals comparatively free and clear. It may be noted that sugar that will not purge easily and freely with clay will not purge easily and freely in centrifugals. But for all practical purposes the system of claying sugar is a thing of the past, and the balk of the sugar of commerce is now purged in centrifugals, as indeed it has been for many years. The reason is obvious. The claying system involved the expense of large curing houses and the em­ployment of many hands, and forty days at least were required for completing the operation and making the sugar fit for the market, whereas with centrifugals sugar cooked to-day can go to market to-morrow, and the labour employed is reduced to a minimum.

When Cuba was the chief sugar-producing country making clayed sugars it was the custom (followed in refineries and found advan­tageous in general practice) to discharge the strike of crystallized sugar from the vacuum pan into a receiver heated below by steam, and to stir the mass for a certain time, and then distribute it into the moulds in which it was afterwards clayed. When centrifugals were adopted for purging the whole crop (they had long been used for curing the second or third sugars), the system then obtaining of running the sugar into wagons or coolers, which was necessary for the second and third sugars cooked only to string point, was continued, but latterly “crystallization in movement, a develop­ment of the system which forty years ago or more existed in refineries and in Cuba, has come into general use, and with great advantage, especially where proprietors have been able to erect appropriate buildings and machinery for carrying out the system efficiently. The vacuum pan is erected at a height which commands the crystal­lizers, each of which will, as in days gone by in Cuba, hold the con­tents of the pan, and these in their turn are set high enough to allow the charge to fall into the feeding-trough of the centrifugals, thus obviating the necessity of any labour to remove the raw sugar from the time it leaves the vacuum pan to the time it falls into the centrifugals. For this reason alone, and without taking into consideration any increase in the yield of sugar brought about by “ crystallization in movement,” the system is worthy of adoption in all sugar factories making crystal sugar.

The crystallizers are long, horizontal., cylindrical or semi-cylin­drical vessels, fitted with a strong horizontal shaft running from end to end, which is kept slowly revolving. The shaft carries arms and blades fixed in such a manner that the mass of sugar is quietly but thoroughly moved, while at the same time a gentle but sustained evaporation is pro­duced by the continuous exposure of successive portions of the mass to the action of the atmosphere. Thus also the crystals already formed come in contact with fresh mother-liquor, and so go on adding to their size. Some crystallizers are made entirely cylin­drical, and are connected, to the condenser of the vacuum pan; in order to maintain a partial vacuum in them, some are fitted with cold-water pipes to cool them and with steam pipes to heat them, and some are left open to the atmosphere at the top. But the efficiency of all depends on the process of almost imperceptible yet continuous evaporation and the methodical addition of syrup, and not on the idiosyncrasies of the experts who manage them; and there is no doubt that in large commercial processes of manu­facture the simpler the apparatus used for obtaining a desired result, and the more easily it is understood, the better it will be for the manufacturer. The sugar made from the first syrups does not require a crystallizer in movement to prepare it for purging in the centrifugals, but it is convenient to run the strike into the crystallizer and so empty the pan at once and leave it ready to commence another strike, while the second sugars will be better for twenty-four hours’ stirring and the third sugars for forty-eight hours.’ stirring before going to the centrifugals. To drive these machines electricity has been applied, with indifferent success, but they have been very efficiently driven, each independently of the others in the set, by means of a modification of a Pelton wheel, supplied with water under pressure from a pumping engine. A comparatively small stream strikes the wheel with a pressure equivalent to a great head, say 300 ft., and as the quantity of water and number of jets striking the wheel can be regulated with the greatest ease and nicety, each machine can without danger be quickly brought up to its full speed when purging high-class sugars, or allowed to run slowly when purging low-class sugars, until the heavy, gummy molasses have been expelled and it can then be brought up to its full speed for finally drying the sugar in the basket, a boon which all practical sugar-makers will appreciate. The water forced by the force-pump against the Pelton wheels returns by a waste-pipe to the tank, from which the force-pump takes it again.

*Recent Progress.—*The manufacture of cane sugar has largely increased in volume since the year 1901-1902. This, apart from the effect of the abolition of the sugar bounties, has been mainly the result of the increased employment of improved processes, carried on in improved apparatus, under skilled supervision, and with due regard to the importance of the chemical aspects of the work.

Numerous central factories have been erected in several countries with plant of large capacity, and many of them work day and night for six days in the week. There were 173 of these factories working in Cuba in 1908-1909, among which the “Chaparra,” in the province of Oriente, turned out upwards of 69,000 tons of sugar in the crop of about 20 weeks, and the “ Boston ” had an output of about 61,000 tons in the same time. Of the 178 factories at work in Java in 1908- 1909, nearly all had most efficient plant for treating the excellent canes grown in that favoured island. (See *Jaarboek voor suiker- fabrikanten op Java, 13e Jaargang 1908-1909,* pp. 22-61, Amster­dam, J. H. de Bussy.) The severance of the agricultural work, *i.e.* cane-growing, from the manufacturing work, sugar-making, must obviously conduce to better and more profitable work of both kinds.