ten or twelve diffusers are employed, eight being in operation while the others are being emptied, cleaned, and refilled. These diffusers consist of large close upright cylinders capable of holding each two or three tons of sliced roots. They are provided with manholes above, perforated false bottoms, and pipes communicating with each other, so that the fluid contents of any one can be forced by pressure into any other. In working, pure water from an elevated tank is run into No. 1 cylinder, which contains the slices almost exhausted of their soluble contents ; it percolates the mass, and by pressure passes into No. 2, where it acts on slices some­what richer in juice. So it goes through the series, acquiring density in its progress and meeting in each successive cylinder slices increasingly rich in juice. Before entering the last cylinder the watery juice is heated, and under the combined influence of heat and pressure the juice within the cylinder becomes richly charged with sugar. No. 1 cylinder when exhausted is discon­nected ; No. 2 then becomes No. 1, and a newly charged cylinder is joined on at the other extremity ; and so the operation goes on continuously. The juice ultimately obtained is diluted with about 50 per cent. of water ; but it is of a comparatively pure saccharine quality, with less gummy, nitrogenous, and fibrous impurities than accompany the juice yielded by mechanical means.

If the juice obtained by any process were a pure solution of sugar the manufacturing operations would be few and simple. But beet juice is at best a very mixed solution, containing much gum, acid bodies, nitrogenous matter, and various salts. These adhere to the saccharine solution with the utmost obstinacy ; they attack the sugar itself and change crystalline into invert sugar, communicat­ing to it a dirty brown colour and a disagreeable acrid taste and smell. To separate as far as possible the non-saccharine con­stituents and to remove the colour from the juice are troublesome tasks. The preliminary purification embraces two sets of opera­tions,—first the treatment of the juice with lime and carbonic acid, secondly, filtration through animal charcoal. Under the old method of working the juice is first boiled in a copper pan with milk of lime to the extent of from 1/2 to 1 per cent. of lime to the weight of juice operated on. The boiling serves to coagulate the albuminoids, while the lime forms with certain of the other impurities an insoluble precipitate, and in part combines with the sugar to form a soluble saccharate of lime. The insoluble lime combination and the coagulum rise as a scum over the surface of the juice, and the latter, now comparatively clear, is drawn off by a siphon pipe, to be treated in another vessel with carbonic acid. The acid breaks up the saccharate of lime and forms insoluble carbonate of lime, which in precipitating carries down further impurities with it. After settlement the clear juice is drawn off and the precipitated slime pressed in a filter press, whereby it gives up the juice it contains. As now commonly conducted these operations—treating with lime and carbonic acid—are combined, according to the method devised by Jelinek. The juice to he purified is heated and treated with as much as 5 per cent. of lime, while carbonic acid is simultaneously injected into the mass. The juice meantime is raised to a temperature just under boiling-point. The addition of such a large amount of lime effects the precipitation of a great proportion of the non-saccharine constituents of the juice. The whole mass of turbid liquid formed by this treatment is forced into a filter press, and there the lime compounds and impurities are separated with great rapidity from the saccharine juice. Numerous other methods of purification have been proposed, and to some extent have met with favourable reception ; but of these we can only mention that of Dubrunfaut and De Massy, in which baryta is substituted for lime, thereby producing an insoluble barium saccharate, and the analogous process of Scheibler, in which strontia is employed in the same sense, producing likewise insoluble strontia saccharate. The juice, which still contains much saline and other non-saccharine matter, is next filtered through animal charcoal ; this largely removes colouring matter and carries away a further proportion of the salts. Charcoal filtering is an expensive process ; being, moreover, a feature of the subsequent refining, many attempts have been made to dispense with it, and the success of the Jelinek method in producing a comparatively pure and colour­less juice has given rise to hopes that it may at this stage be yet dispensed with.

The next operation consists in concentrating the comparatively pure but thin and watery juice,—a work formerly done in open pans by direct firing, hut now carried out in closed vessels, in which the vacuum pan principle of boiling is brought into play. The apparatus consists of a series of three closed vessels, hence called a “triple effect,” although in some cases a two-vessel apparatus or double effect is employed. These pans are provided internally with a series of closed pipes for steam-heating, the steam from the boiler of the first passing by a pipe into the worm of the second, and similarly the steam from the second into the worm of the third when a third pan is employed. The steam which rises in the third pan is drawn off by a condenser and vacuum pump, and, as the vacuum so created acts through the whole series, the juice is evaporated and concentrated at a comparatively low temperature

by the agency of the steam supplied to the first pan. Tho juice increases in gravity as it is drawn from the one pan to the other, till by the time it is run off from the third cylinder it has attained a concentration representing a gravity of about 25 Baume. This concentrated juice is while in a heated condition filtered through fresh charcoal, from which it comes ready for boiling down to crystallization. To bring the dense juice to the crystallizing point it is necessary to conduct the evaporation at the lowest possible temperature. High temperature increases the uncrystallizable at the expense of the crystallizable portion, and burns some proportion into caramel, which darkens the liquid and the resulting sugar crystals. Boiling down at low temperature is effected by the use of the vacuum pan, a closed globular vessel in which by the aid of a condenser and air-pump a vacuum is maintained over the boiling juice and the boiling-point is lowered in proportion to the decrease of air pressure. In vacuum pan boiling the thick juice may simply be concentrated to that degree of density from which, on cooling, the crystals will form, or the crystals may be allowed to separate from the mother-liquor in the pan while the boiling proceeds; these crystals, forming nuclei, increase in size from the concentra­tion of fresh charges of juice added from time to time. By this method the boiled-down juice as it leaves the pan consists of a grainy mass of crystals floating in a fluid syrup. After being allowed to cool, the mass is fed into the drum or basket of a cen­trifugal machine, which by its rapid rotation separates the fluid molasses from the crystals, driving the liquid portion through the meshed wall of the basket. For further cleaning of the crystals from adherent syrup a small quantity of either water or pure syrup is added to the drum, and is likewise forced through the sugar crystals by centrifugal action. Steam also is employed for cleaning the crystals whilst in the centrifugal machine. The syrup from the first supply of sugar is returned to the vacuum pan, again boiled, and treated as above for a second supply of less pure sugar ; similarly a third supply is yielded by the drainings of the second. The molasses from the third supply is a highly impure mixture of crystallizable and invert sugar, potash, and other salts, smelling and tasting powerfully of its beet origin. Many methods have been tried to recover the large amount of sugar contained in this molasses. That most extensively\* employed is the osmose process originated by Dubrunfaut, in which, by the application of a dialyser, it is found that the salts pass through the membrane more rapidly than does sugar. The elution process of Scheibler, which depends on the formation of a saccharate of lime, and the more recent strontia process of the same chemist, in which a strontiate of lime is formed, are also much employed. Another means of utilizing the molasses consists in fermenting and distilling from it an im­pure spirit for industrial purposes.

*Sugar-Refining.—*Sugar-refiners deal indifferently with raw cane and beetroot sugars which come into the market, and by precisely the same series of operations. The sugar is first melted in charges of 5 or 6 tons in *blow-ups,—*cast-iron tanks fitted with mechanical stirrers and steam-pipes for heating the water. The solution called *liquor* is brought to a certain degree of gravity, from 25 to 33 Baumé, and formerly it was the practice to treat it, especially when low qualities of sugar were operated on, with blood albumen. The hot liquor is next passed through twilled cotton bags encased in a meshing of hemp, through which the solution is mechanically strained. From 50 to 200 of these filters are suspended in close chambers, in which they are kept hot, from the bottom of a per­forated iron tank, each perforation having under it a bag. These bags have from time to time to be taken off for cleaning out and washing. From the bag filter the liquor is passed for decolorizing through beds of animal charcoal enclosed in cisterns to a depth of from 30 to 50 feet, the sugar being received into tanks for con­centration in the vacuum pan. In that apparatus it is “ boiled to grain,” and the treatment is varied according to the nature of the finished sugar to be made. To make loaves small crystals only are formed in the pan, and the granular magma is run into steam- jacketed open pans and raised to a temperature of about 180° to 190° Fahr., which liquefies the grains. The hot solution is then cast into conical moulds, the form of the loaf, in which the sugar as it cools crystallizes into a solid mass, still surrounded and mixed with a syrup containing coloured and other impurities. After thorough settling and crystallization, a plug at the bottom of the mould is opened and the syrup allowed to drain away. To whiten the loaves they are treated with successive doses of saturated syrup, ending with a syrup of pure colourless sugar. These doses are poured on the upper side of the cone, and, percolating down through the porous mass, carry with them the impure green syrup which still may adhere to the crystals. The liquor which obstinately remains in the interstices is driven out by suction or centrifugal action , the loaf is rounded off, papered, and placed in a stove tor drying. The syrup which drains from the loaves is sold as golden syrup. When refined crystals are to be made the contents of the vacuum pan are passed into the centrifugal machine ; the syrup is then driven off by rotation, and the crystals purified either by adding pure syrup to the revolving basket or by blowing steam through it.