On a new system of manufacturing sugar from the cane, and its advantages : as compared with the method generally used in the West Indies : also, some remarks on the best mode of insuring its general and simultaneous introduction into the British colonies / by Henry Bessemer.

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OF
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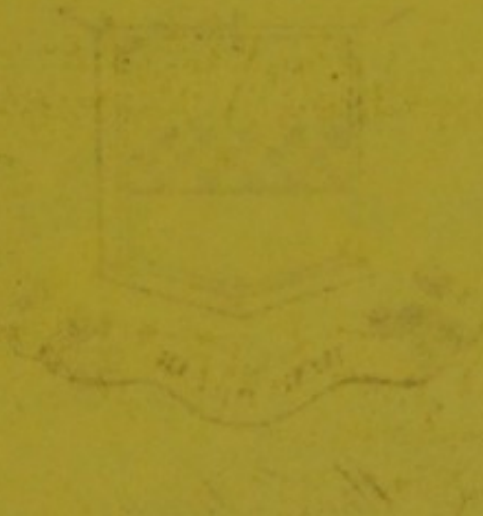

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INTRODUCTION.

In submitting the following brief description of my recent improvements in the manufacture of sugar to the attention of those who are interested in West India property, I must beg the favour in this instance of that kind attention and consideration which has so liberally been accorded to me on former occasions.

I wish it to be clearly understood, that I have not the most remote intention of giving to these pages the character of a work on the manufacture of sugar, as they are written solely for the purpose of communicating a *general idea* of the principles on which my invention is based, and as the most ready means at my command of communicating with those who are interested in this important subject.

In the course of these remarks I have found it necessary to give a brief sketch of the mode of manufacturing sugar at present in general use, in

order that those who have not hitherto given their attention to the subject, may form a more correct idea of the nature of my invention, and in what its peculiarity consists. In doing this, I unavoidably impose on the practical Planter the tedium of going through matter as familiar to him as household words. At the same time, I find myself compelled to make comparisons which may seem invidious, and to speak in such terms of my own invention, as may possibly be construed into mere egotism; but the omission of any important truth on this score, in a pamphlet intended for private circulation, I feel would be little better than a ridiculous affectation. In my observations on the inventions of others, I have no other end or aim than to elicit truth, and, if possible, arrive at that great desideratum—namely, a correct knowledge of the most productive and economical mode of obtaining sugar from the cane.

Baxter House,
Old St. Pancras-road, London.
July 20*th*, 1852.

A NEW SYSTEM

OF

MANUFACTURING SUGAR.

THERE are few manufactures to which the enterprise of the British nation has been directed, more interesting in its operations, more important in a commercial point of view, or one which has added more largely to the comforts and luxuries of the community, than the production of sugar in the West Indies; but, at the same time, it must be admitted that there is not a single branch of British industry so deplorably behind the age as it now is, nor is this to be wondered at, when we reflect on the difficulties by which the planter is surrounded—carrying on a manufacture within the Tropics, for which the most powerful engines and machinery are required, in connection with apparatus in which the most delicate chemical operations are carried on; all his numerous implements, utensils, and machinery have to be brought from the mother country at

a great expense; and when breakage or derangement of any part takes place, it causes the most serious delay; and it not unfrequently happens that a large portion of the crop is lost before it is possible to obtain new machinery from England. Need we wonder, then, that the planter contents himself with the roughest and most crude apparatus, which, although it is wasteful and imperfect in its operation, is far better suited to his peculiar case than many of the elaborate attempts at improvement which have so frequently been made here, and which, from their liability to derangement and the scarcity of intelligent operatives in the colonies to superintend and work them, are altogether useless. It must also be borne in mind that the planter has few of the advantages of the home manufacturer, whose operations come daily under the observation of the thousands of talented men who surround him, and who are constantly improving the minutest details of his operations. Not only is he without these advantages, but he is necessitated to employ a class of workmen vastly inferior in intelligence to the operatives of this country, and from whom he has no hopes of improvement in any department of his business. The proprietors of a vast number of estates in the West Indies are English gentlemen of birth and education, but they are neither chemists nor mechanics, and must trust to the reports and opinions of others on the subject

of all improvements. This unfortunate circumstance has led to their spending large sums on impracticable schemes, and has rendered many of them sceptical of all future improvements, and proved a serious obstacle to the advancement of the manufacture. There are, however, a great number of proprietors who are sound practical men, possessing an intimate knowledge of the principles and practice of the Colonial Sugar-house, and who have, for the most part, availed themselves of every substantial improvement that has from time to time been presented to their notice, and who are fully alive to the errors of the system under which they are at present working. The most incontestable proof of the great disadvantages under which the colonies are labouring, owing to their complete isolation, is shown in the manufacture of sugar from the beet; a root containing generally from 7 to 10 per cent. of saccharine matter, combined with a far larger quantity of saline impurities than the cane, and is confessedly in every way more difficult of treatment. Notwithstanding these disadvantages this manufacture fostered at home, under the immediate observation of intelligent men, has rapidly risen, and improvement has followed improvement, until nearly the whole saccharine matter of the beet has been extracted and converted into sugar; while the cane, which contains about 17, and

sometimes 20 per cent. of saccharine matter, yields a less quantity of sugar than the beet. This fact, though it gives but a melancholy retrospect of the past, opens a most encouraging view for the future. It shows us, at least, that with the canes already cultivated an immensely increased product in sugar may be obtained, and that if the hand of science has done so much for the production of sugar from the beet, we may look with confidence to the same source for a means of elevating, to a much higher position, the colonial manufacture of cane sugar.

A deep conviction of this important truth has led me to devote, for the last four years, the whole of my energies and no inconsiderable sum of money to the development of a new system of manufacturing sugar, simple in principle, certain in operation, and with a considerable reduction of manual labour, using only such apparatus as workmen with the smallest share of intelligence will most readily understand, the first cost of which will be, below that of the imperfect apparatus at present in general use. The great success that has attended my labours, has induced me further to proceed, with plans for the more perfect and spontaneous introduction of these improvements throughout the whole of the British colonies, which will, I trust, meet with the cordial co-ope-

ration of the planter, and result in rescuing this most important branch of British industry from the almost hopeless condition into which it is rapidly sinking.

In order that the nature of my improvements may be fully understood, I find it necessary to give a brief outline of the process at present in general use in the colonies, and have divided the subject into different heads, under which both the old and the new method of working are considered. In commencing with the mode of expressing the juice from the cane, I will refrain from any lengthened observations on roller-mills, as the enormous loss entailed by their use has been fully discussed in my former pamphlet on the Cane Press; nevertheless, as I have just invented some most important improvements in that apparatus, it is desirable that it should not be passed over in silence.

ON THE MODE OF OBTAINING THE SACCHARINE JUICE FROM THE CANE.

The cane, when ripe, contains, according to the most eminent writers, 90 per cent. of juice, the whole of which cannot possibly be obtained by pressure. The roller-mills in general use are capable of yielding from 45 to 60 per cent. of juice; the most liberal estimate would not give more than 55 per cent. as an average of all the mills in use in the British colonies. With the cane press which I put up in London, we constantly obtained from 72 to 75 per cent. from canes imported from Madeira (which had lost some of their juice on their passage to this country), and, by artificially drying the magas, and carefully noting the loss of weight by evaporation, we proved satisfactorily that 80 per cent. of juice had been obtained less the quantity lost by evaporation from the canes in transitu.

Numerous experiments have lately been made with the cane press, which have resulted in several

important improvements, for which I have just obtained patents in Great Britain and the colonies, &c., &c.

In the improved apparatus, the pressing-tubes are reduced from thirty inches in length to twelve, the first four inches of which are parallel and three inches wide; the next four inches of their length being taper, and terminating with a width of one and a half inch only. This contracted part also extends four inches, and is parallel as far as the exit-end of the tube. The result of this alteration in the form of the tube, was the entire removal of that elasticity in the magas occupying it, which, in some cases, prevented the entire disruption of the cells containing the juice, and consequently the removal of all the juice from them. This object in my new press is, however, greatly facilitated by the contraction of the tube. A cane, after it has collapsed by pressure, occupies in the tube a width of three inches by one-eighth of an inch in thickness, and in this state it progresses towards the contracted part, where its breadth is gradually lessened, and its thickness is in like manner increased. This change of form taking place while under severe pressure, causes all the fibres and cells of the cane to assume new positions with reference to each other, precludes the possibility of a single cell remaining unruptured, and

consequently insures the displacement of every drop of juice; the shortening of the tube has also the effect of lessening the engine-power required to work the press; and by an alteration of the general arrangement of parts, the length of the small press, No. 1, is reduced from twelve to four feet, and weighs about two tons less than the old press.

The mode of feeding has also been considerably improved; the elevated feeding stage is dispensed with, and the feeder has not to stoop to pick up the canes, as heretofore, but merely to direct them into the hoppers. So simple, in fact, is now this operation, that a single day's practice will render the most stupid person perfectly capable of keeping the press regularly fed The difficulty of feeding the press on the original plan has been raised by a few persons as an objection to its use; but even before that defect was remedied, it simply resolved itself into this:—If a man did not continue to put in canes as fast as they were required by the press, all the power of the engine would not be consumed; and to meet this difficulty it would have been only necessary to put double the number of tubes in one press, and employ two feeders instead of one; so that the result would be precisely the same in effect, as if a smaller number of tubes were used with an expert or industrious feeder, with the ex-

ception of the wages of the extra feeder during crop time, and a small addition to the first cost of the press. As far as the principle of the press is concerned, there clearly cannot be any limit to its power or size any more than there is to the power and size of a steam-engine; and if the capabilities of the press were reduced even to one half, by the idleness or stupidity of the feeder, this certainly could not be held as a sufficient reason for continuing the use of the roller-mill, and thereby wasting 25 per cent. of the entire produce of the estate. The only other improvement of great importance in the cane-press is the more equal distribution of power throughout each revolution. In a cane-press with six tubes of the original construction, three of them would be acted upon at one time, at each alternate backward and forward motion of the machine, whereby a strain equal to the combined resistance of three tubes must be sustained by the framing and the whole of the working parts; but in the improved press having six tubes, the cranks are so arranged around the centre at equal distances, that at no one moment of time is there more than *one* tube in action, so that all the parts of the press are relieved from two-thirds the amount of strain they would otherwise have to be subjected to, thereby increasing the safety and efficiency of the press, and rendering its action much more smooth

and uniform. There are several minor arrangements in the new press which I must pass over, having pointed out the more important ones, which I doubt not will be fully understood by those who are acquainted with my original invention.

ON THE PROCESS OF DEFECATION AND FILTRATION.

Cane juice, as it flows from the mill, is mixed with numerous minute fragments of cellular tissue, albumen, and other extraneous matters, which it is most desirable to separate therefrom as speedily as possible, as their presence promotes the acidification of the juice. To effect the removal of these substances, the following process is generally used: the juice is first pumped up into the "clarifiers," to which heat is applied by the direct action of fire or by steam. As the vessel fills with juice, the temperature is gradually increased to about 150° F., when a small quantity of milk of lime is put in and well stirred, which has the effect of neutralizing the free acid of the cane juice, and assists in the coagulation of the albumen; the heat is increased until it arrives at about 180° F., which is indicated by the cracking of the scum that has risen to the surface; the heat is then withdrawn, lest ebullition should commence, and the whole of the thick mass of scum be mixed with the liquor; it is then left to repose, in order

that the liquor may become clear before letting it down into the evaporating pans; a considerable quantity of cane juice is removed with the scum that rises to the surface, and also with the heavy deposit which falls to the bottom of the vessel. The liquor cannot be drawn off very close without some of this mud accompanying it; in fact, the gradual appearance of muddiness in the liquor is the signal to cease to draw it off; so that even with the nicest attention you either get a large quantity of mud in the evaporating-pan, or lose a large quantity of juice. As soon as it is let down into the "grand" copper, it is subjected to a rapid ebullition, which has the effect of separating further portions of albumen and other feculent matter, which are imperfectly removed, by a laborious operation of skimming, accompanied by a considerable loss of juice. The presence of these matters obstruct the free granulation of the sugar, and permanently injure its colour and brightness. The more completely removing these impurities, and correcting the injurious effects produced by them, are the main objects which render the expensive process of refining necessary. Let us now see how far a more perfect system of defecation may be made to remedy these evils. For this purpose I place a pair of clarifiers close beneath the spout of the cane-press, so that the stream of juice may be directed into either of them, intercepted only by a double brass-

wire strainer to separate the debris of the cane. The clarifiers are sunk a few feet below the floor-line, access to them being obtained by a few steps on one side; they are enclosed in thin brickwork, which prevents loss of heat by radiation, and at the same time protects the workmen from it. The clarifiers are heated by steam, and lime or other defecating agents are added as usual. By means of a large valve the mouth of the vessel is closed, a smart ebullition is then allowed for about three minutes, a small cock is then opened by which steam is admitted to the interior of the clarifier, and by pressing on the surface of the juice, rapidly elevates it through a pipe into a small cistern placed some three or four feet above the level of the evaporating pan. While this process has been going on in one clarifier, the juice from the press is directed into the second one. There is no time required for subsidence in this mode of working, and the vessels are consequently made much smaller and less expensive than those in general use; they also serve the purpose of a mont-jus, and render liquor pumps unnecessary. This mode of treating cane juice will have the effect of coagulating the whole of its albuminous constituents, and of separating chemically all the feculent matters which will, however, remain mechanically mixed with the juice entangled in the coagulated albumen in the form of light flocks which pervade the entire bulk of fluid. When ordinary

filtration by bags is attempted, it is found scarcely possible to remove the enormous mass of feculent matter which coats the interior of them, and soon stops the process; they also entail much labour in cleansing, waste the juice, and are in other respects a source of so much inconvenience, that the very imperfect mode first described is almost universally used, notwithstanding its great and obvious defects. The difficulties attendant on filtration have led to its abandonment in most cases where it has been tried. Dr. Shiers, of Demerara, who has taken great trouble to remedy this evil, proposes the use of subsiding vessels in connection with the clarifiers, and also to assist this process by introducing a large quantity of clay-batter, in order to assist in bringing down the light floculent matter; but still it is found that much time is wasted in this operation, that great care is required in drawing off the clear liquor from the subsiding vessel without disturbing the mud, and that much juice is wasted by being combined with the accumulation of matters at the bottom of the subsiding vessel; it is nevertheless a great improvement, inasmuch as the juice that is taken off clear will remain so, and the labour and loss of skimming will be prevented.

In my system of defecating, the difficulty of separating the floculent matter is entirely removed by a self-cleansing and rapid filter, which will be perhaps better understood by referring to an analogous

process which has been most successfully used for many years in the manufacture of paper. The fibres of cotton which constitute this fabric are torn to minute atoms, and are then dispersed through a large body of water, from which they are separated by a revolving drum, immersed about four-fifths of its diameter in the water; this drum is covered with fine wire-cloth, through which the water forces its way into the interior, leaving a coating of minute atoms of cotton on its surface, which are kept back or filtered by the wire cloth; as the drum revolves, this coating rises with it out of the water and is removed, the pulpy mass thus forming a sheet of paper, which may be made of any length; the uncovered part of the drum again descends below the surface of the water, presenting a new filtering surface, and becomes again coated as before, and thus the operation continues hour after hour, for whole weeks, without interruption. The axis of the drum is hollow, and from it flows the clear water that has been separated from the pulp. It will be readily understood, that such a simple system of filtration might be readily adapted and arranged for separating the feculencies from cane juice. This I have done with great success. A drum of two feet in diameter, and four feet and a half in length, revolving at the rate of one revolution per minute, in a small semicircular tray, is sufficient to render as clear as sherry 600 gallons of cane juice per hour. The

feculent matter which coats the drum comes in contact with a fixed scraper, which removes it from the revolving surface, and allows it to fall into a receptacle in a state of nearly dry mud, from which it may be emptied at the end of the day. The operation requires no attention on the part of the workmen, and is in every way self-acting, taking in its own supply of foul liquor from the elevated cistern before referred to, and delivering the clear juice into the evaporating pan, and discharging the impurities into a separate cistern. Before passing on to the next stage of the manufacture, let us briefly recapitulate, and see what has been accomplished in this :

Firstly. We receive the liquor from the press direct into the clarifier, without waiting for an accumulation of it, and thus altogether dispense with liquor pumps.

Secondly. The clarifiers are much smaller and less expensive, in consequence of their not requiring to be used as subsiding vessels.

Thirdly. There is no loss of juice by the removal of the scum, or heavy sediment at the bottom of the clarifiers, as in the old mode.

Fourthly. The clarifiers serve also the purpose of a mont-jus, without the expense of a separate vessel for that purpose, and without the loss of steam, which the mont-jus entails by cooling

between the times of successive charges, when the steam so condensed adds to the quantity to be evaporated.

Fifthly. We gain the all-important object of coagulating the whole of the albuminous matter by boiling the juice for three minutes.

Sixthly. The small size of the new clarifiers and filter enables the evaporating process to follow immediately upon that of the pressing of the canes in the morning, and allows the completion of the day's work to take place very soon after the press is stopped at night. And

Lastly. The self-cleansing filter removes all the feculencies, renders unnecessary the watchful attendance in letting down the juice from the clarifiers into the pans, and prevents the smallest atom of feculent matter from entering the evaporating vessel, whereby the grain, colour, and brightness of the sugar is greatly improved, and the laborious, wasteful, and imperfect operation of skimming is rendered entirely unnecessary.

ON THE BOILING AND CONCENTRATION OF CANE-JUICE.

The great influence which this process exercises both on the quality and quantity of sugar produced, renders it highly important that the most perfect method of concentration should be adopted. The plan most generally in use consists in placing in a long furnace, a series of semi-globular pans of cast iron, varying considerably in size, the fire being made under the smallest one, and passing in an undulating line beneath the larger ones, until it arrives at the chimney; the cane-juice is let down from the clarifiers into the largest pan, and is boiled until it is reduced in bulk sufficiently to admit of its removal into the smaller pan beside it, where the boiling is continued; the first, or "grand copper," is then again filled, and the process continued. The liquor is transferred by ladles from pan to pan in this manner until it arrives at the last, or smaller one, which is immediately over the fire. In these successive boilings the juice is considerably reduced

in quantity, and acquires a very dark colour, from the extreme heat to which it is exposed; when it is found to be sufficiently dense, it is transferred to large shallow wooden coolers, in which it crystallizes. This form of boiling apparatus is a servile copy of the ancient method of making "goor" in semi-globular clay pots, practised by the Hindoos more than 900 years ago, without even the merit of its original, for the makers of these pots could not have selected any other known form so perfectly suitable for a large earthen vessel; the equal shrinking of the clay in its original formation, the safety in burning it in the kiln, owing to the regular and equal contraction of all its parts, and from the same cause its perfect adaptation to the changes of temperature to which it is continually exposed when in use, evince an amount of knowledge and skill in the application of such means as these rude people had at command, that should excite our admiration. But what must we say in passing from the ninth to the nineteenth century, and finding still the same form of apparatus in common use, when we have so long had the power of making in metal vessels of all conceivable shapes and dimensions?

The rate at which evaporation goes on in any vessel (at a given temperature), is directly as the superficial area it presents to the heating media, and is in no way dependent on the depth or quantity of fluid acted upon. Now a sphere presents a less

superficies than any other geometrical form, for the quantity of matter it contains; it therefore follows that the semiglobular pan in common use is, of all others, the worst form that could have been chosen as an evaporator; for while the fluid in it presents so little surface to the action of the fire, the latter, from this very want of surface to act upon, passes off into the chimney, and is wasted. Nor is this all; for it is now well known that a solution of sugar becomes rapidly darkened if exposed to a high temperature; the same effect being also produced by exposure for a length of time to a comparatively low temperature, and that this chemical change produced by heat also destroys the power of crystallization in the particles so acted on. When the liquor is somewhat reduced in each pan, and prior to its being ladled into a smaller one, the fire acts on the sides of the pan above the level of the fluid, and consequently raises the temperature of the metal fearfully high. The motion caused by the rapid ebullition of the fluid has the effect of constantly bringing fresh portions of the liquor in contact with the overheated parts, where they become blackened and destroyed. The same thing takes place during the ladling from one pan to the other; and hence the formation of the enormous quantity of black molasses, which so much diminishes the quantity and reduces the value of the whole product.

Many attempts have been made to remove these

prolific sources of loss, and with some success. The first that may be mentioned consists in the use of high-pressure steam, which is conveyed by pipes from an ordinary steam boiler to the evaporating pan, where it is made to circulate through coils of pipes placed in the liquor to be evaporated, which is much less injured by this means than by the direct application of the fire to the evaporating pan; but the apparatus is complicated, very expensive, and consumes about double the fuel that is required for pans exposed to the direct action of the fire. The next important improvement is Howard's Vacuum-pan, so well and so deservedly known. In this apparatus the steam-coil is also used to transmit heat to the fluid to be evaporated. The main object of this invention being the reduction of temperature at which ebullition takes place, and which object is attained by the removal of the atmospheric pressure from the surface of the fluid by using an air-pump and condenser similar to that used in Watt's condensing-engine, it is evident that Howard fully recognized the importance of a low boiling point; because, to attain this one object, he vastly increases the first cost, and adds greatly to the complication of the former mode of boiling by steam; so much so, in fact, as almost to neutralize the advantages it possesses, at any rate, as far as its use in the colonies is concerned, where a sufficient supply of water, and men sufficiently skilled to work it advantageously, are difficult to obtain.

In the latter part of last year, I obtained patents for an improved evaporating-pan, which consists simply of a Cornish boiler, with the upper side (as it were) cut off and inverted, so as to form a long shallow pan; thus the top of the steam boiler and the bottom of the sugar-pan are one. In this form of apparatus we prevent entirely the loss of heat by radiation from the top of the boiler, nor have we the loss of heat from the pipes and "jacket" of the evaporating-pan, as in both the last-named modes of evaporating. The steam acts on the whole surface of the bottom of the sugar-pan, becomes condensed, and falls in drops of hot water back again into the mass below, from which it again rises in the form of steam, and imparts its heat to the liquor as before. This direct transmission of heat without loss renders this form of steam evaporator most efficient and economical, while the entire absence of pipes, jackets, sluices, etc., give it a degree of simplicity peculiarly adapted to colonial use. That part of the apparatus which contains the juice is divided into compartments, which have communication with each other at opposite sides of the pan; so that if any liquor is let into the end one, a portion of its former contents will pass through into the next space, the liquor in which will rise slightly, and a part of it will flow into the third compartment; and so on throughout the whole series: and as evaporation is going on in each, it follows that in every compartment the liquor becomes more dense, and is

finally drawn off from the end or last one in a proper state for crystallization. A very small depth of liquor is used in this pan, the time required to evaporate which is consequently much diminished, being in general about thirty minutes, to effect the requisite amount of concentration. This apparatus will be found to be far more economical in its action, more easily managed and kept in repair, and less expensive, both in first cost and in erection, than either of the other modes of boiling by steam before mentioned.

The next class of evaporating apparatus deserving attention, is that in which surfaces wetted with the liquor are exposed to the atmosphere to assist evaporation. Of these contrivances that most in use is Gadsden's pan, which consists of a semi-cylindrical pan, having a drum or cylinder working in it, formed of bars or tubes, somewhat like a squirrel-cage. The slow rotation of this drum, causes the bars of which it is composed to rise up out of the liquor, and to become exposed for a short time to the atmosphere, in order to assist evaporation, and again to descend to be recharged with fluid. It is stated that the frothing produced by their immersion and emersion is highly disadvantageous, but that the concentration of the fluid is effected at a much lower temperature than in the common "Teache." Here again we have an instance of a thoroughly practical

refiner directing his attention to a means of evaporating at a low temperature, suitable to colonial use. With these objects in view, it is somewhat difficult to account for the strange anomaly presented by this invention, which, while it affects to evaporate at a low temperature, is actually heated by the naked fire. I can only attribute this to the inventor's anxiety to render his apparatus as simple and cheap as possible, rather than to make it perfect.

Since the period of this invention, a patent has been obtained by Mr. Schroder, whose name has long been identified with refining operations in this country; his object being, to produce the same general results as are obtained by Gadsden's pan, for which purpose he uses a series of flat discs of metal, which have *long been known*, and have before *been used*, but which discs Mr. Schroder combines with certain zig-zag steam-pipes; and it is *simply this peculiar combination of pipes and discs*, and *not* the discs, which constitutes his invention. These discs of metal are mounted on a solid revolving axis, and have pipes passing between them, for the purpose of boiling the liquor by the steam from an ordinary boiler, with which they are in connection. This mode of heating is a manifest advantage over the application of the naked fire, and the discs are far less liable to froth the liquor than the cylinder of bars mentioned in the former invention; but they

will not produce so complete a circulation in the pan, and at the same time do not admit the steam which hangs about their surfaces to pass off so freely as it does from the bars in Mr. Gadsden's apparatus, and hence much of their evaporative power is lost. I have been thus particular in defining the limits which Mr. Schroder has *himself* assigned to his invention, because, to a superficial observer, there may appear some similarity between it and my invention, but which will totally disappear on an investigation of the principles on which my invention is based.

An attempt has been made by Mr. Crosley to reduce the temperature at which evaporation takes place in vessels heated by steam, by forcing air to the bottom of such vessels, and allowing it there to escape through numerous small perforations in the pipes. To effect this object, it would be necessary to use an air-pump of large dimensions; but it will at once be perceived, that no considerable amount of evaporation could be produced by this means, without a most expensive and cumbrous apparatus. Dalton, by most careful experiment, has ascertained that a cubic foot of dry air can absorb ten grains of water at a temperature of 64° F., and that it then becomes perfectly saturated. Now if Mr. Crosley were to employ a pair of double-acting air-pumps, of one foot in diameter and three

feet stroke, and make with them thirty double strokes per minute, they would deliver 300 cubic feet of air in that time, which, if absolutely dry, would be capable of absorbing ten grains of water per cubic foot, at 64° F., but at the temperature of the hot liquor, an increase in its absorbing power would take place. Now suppose this increase to amount to 200 per cent., we should then have an absorbent power of thirty grains per cubic foot. Now 30 × 300 = 9,000 grains per minute, or 18¾ ounces; say, in round numbers, seven imperial gallons per hour evaporated. How far this is an useful effect I leave others to judge, to say nothing of excessive frothing that must be produced by forcing air into concentrated syrup, and the great amount of power required to keep such large pumps in action.

At the close of the year 1851 I commenced an extensive series of experiments on the effects of heat applied to saccharine solutions, when I discovered that in all cases where steam was employed as a heating medium, that a rapid destruction of sugar took place, and that temperatures far below the boiling point of water were proportionably injurious. A heat of 140° F. did not, however, effect any visible change for two or three hours, and may be safely used. I also found, that the more concentrated the syrup becomes, the more easily it is injured by heat; because, in its more fluid condition,

the particles in contact with the heated pipes no sooner acquire a temperature of a few degrees above that of the general bulk of the fluid, than their diminished specific gravity causes them to rise to the surface, and allows other colder and more dense particles to take their place; by this beautiful law of nature the fluid is protected from any excess of heat. It is however far different with solutions of a density of 30° or 35° Beaumé, for in this case the diminished specific gravity of the particles in contact with the heated surface, have not sufficient floating power to produce motion in the viscid mass, and hence they remain so long in contact with the heated surface, as to be totally changed in colour, and become almost, if not perfectly, uncrystallizable. These are the discoloured portions that mix with and darken the whole bulk of fluid, and give rise to the enormous quantity of molasses invariably obtained by the ordinary process in boiling sugar.

In the course of these investigations, it soon became evident to me that some totally different principle of action must be resorted to, for separating the water from the sugar, than had before been attempted, and that boiling under any form whatever, or the use of surfaces or pipes heated by steam, must be totally excluded from all concentrating apparatus, in which the formation of molasses is sought to be prevented. The most ready means that I could discover for accomplishing this object,

was the absorption of the water by contact with warm dry air. The only practical difficulty which presented itself, was, how to bring such a vast body of air in contact with the fluid, as to take off the water with such rapidity as to render it commercially effectual. This point has since been fully investigated by practical experiment, and the result has been, the arrangement of an apparatus, in which this desirable object is most fully accomplished, and the concentration of saccharine fluids can now be effected without the slightest injury to colour or quality (while the quantity of sugar is much increased.)

It is most desirable that it should be perfectly understood, that when steam is used as a means of heating solutions of sugar, the temperature indicated by a thermometer placed in such solution furnishes *no indication whatever* of the temperature to which it may be exposed; for all fluids absorb a vast amount of latent heat in their formation into steam, and this heat having to be abstracted from the solution from which it rises, it follows that its temperature in all cases must be considerably below that of the pipes or surfaces from which its heat is obtained. This circumstance seems to have led to a fatal mistake by many, who have flattered themselves that they were deriving the full benefit of the low temperature indicated by the thermometer placed in the saccharine fluid under operation. As

an example of the fallacy of this opinion, I will take the vacuum-pan in which we have a thermometer, and also a large coil of steam-pipe, containing generally steam of twenty pounds' pressure. The temperature of the syrup during ebullition is frequently as low as 175° or 180° F.; and all those who have vacuum-pans in daily use seem perfectly satisfied that they are exposing their sugar only to that very moderate temperature; but, let me ask, what is the temperature of the large *copper-worm, against* which the sugar is in *close contact?* It is just 235° F. (at twenty pounds' pressure), or 18° above the boiling point of water in the open air! This is actually the true heat to which the sugar is exposed, and which destroys its colour and impairs its powers of crystallization.

If we were to take a pailful of cold water and plunge a mass of red-hot iron into it, the temperature of the water would probably rise from 60° to 100° F.; and if we satisfied ourselves by placing a thermometer in it that this was the actual temperature of the water, should we the less acknowledge the undeniable fact, that certain portions of the water must have been in actual contact with red-hot iron, and would, if the water had contained any saccharine matter, have produced such a chemical change in the particles so acted on as would have utterly destroyed them? If any one is still sceptical of the

fact, that the heat of steam will injure sugar, I will ask him this simple question, How is it that a refiner who fills his vacuum-pan with a colourless solution of sugar from his charcoal filter, draws off from that pan a brown discoloured mass? and if this discoloration does not weaken or destroy the crystallizing property of the sugar, how is it that the crystals are white as snow, and the uncrystallized part is brown? If the discoloured portion of the sugar was as easily crystallizable as the other part of it, the crystals would be brown also, and the drainage or mother liquor would not be darker than the crystals. In addition to these facts many other proofs could be afforded equally unquestionable. And further, I am prepared to show, by actual working on a large scale, that water may be separated from sugar in any quantity by my new apparatus, which, by way of distinction, I call a "Hot-air Evaporator," and that with it colourless solutions may be evaporated until they arrive at the highest pitch of concentration, without any perceptible change of colour, and without, in the smallest degree, affecting their crystallizing properties.

This apparatus consists of a tank made of thin plate-iron, ten feet long by eight feet wide, and two feet six inches in depth. It has a false bottom, which is curved so as to form two parallel segments of a cylinder, and coincident with these cylindrical

parts are two hollow drums, of eighteen inches in diameter, which are mounted on an axis. These drums have a broad spiral blade formed upon them in such a way as to form a screw or "creeper," the thread of which is of considerable depth (about fifteen inches), and each convolution is three quarters of an inch apart. Between each of the blades or threads of the screw there is a row of holes made in a spiral line from one end of the drum to the other, each hole being about an inch and a quarter apart, and a quarter of an inch in diameter. On one end of each drum there is a wheel, by means of which motion is communicated to the screws, so as to cause them to move in opposite directions, by which means a most perfect circulation of the fluid is kept up. The opposite end of the hollow drums communicate with a blowing-fan, by means of which about 10,000 cubic feet of air per minute are forced through each of them. The air previous to entering the fan is brought up to a temperature of 150° F., by passing along a flue so arranged as to transmit to it the waste heat from the boiler used to generate steam for the cane-press. The space below the false bottom of the tank is filled with water, and through it pass a series of pipes, which receive the steam from the engine after its motive power has been made available. The heat thus transmitted is for the purpose of keeping the water warm in the lower part of the tank, no portion

of the steam coming in contact with any part of the vessel containing the cane juice, which fills the tank to a depth of about one foot, motion is communicated to the air fan and to the screws, which make about eight revolutions per minute; thus their extensive surfaces are exposed to the rapid current of air which escapes through the numerous holes in the drum, in a radial direction, and sweeps like a simoom over the wet surface, absorbing the moisture thus exposed to its action, and passing off as a totally invisible vapour. As the screws revolve, the more concentrated portions of the fluid are washed off in passing into the fluid below, while fresh portions are constantly rising out of it upon the screw, to be acted upon in the same manner. As the fluid increases in density, additional portions are added from time to time to keep up the quantity. The solution thus becoming supersaturated, deposits sugar in a solid form, which has a tendency to sink, owing to its superior gravity, but is prevented from forming a concrete mass on the bottom of the vessel by the action of the screw, which slowly moves laterally over its entire surface, removes it, and thus allows the free transmission of heat from the warm water below. The screw has also the great advantage of constantly and quietly skimming the whole surface of the fluid, and admits of being cleansed, by the attendant placing a small scraper at one end of it, of just sufficient breadth to fit freely

in between the threads. This scraper will be carried by the screw from one end of it to the other, and in so doing will scrape off any accumulation of sugar that may have formed upon it. Another peculiarity of the screw is, that without frothing the liquor, it is perpetually moving and intermixing it by a slow and quiet motion, acting at more than a hundred parts of the fluid at one time, keeping it of perfectly equal density throughout, bringing every part of it under the absorbent action of the air, and exposing it in like manner to the heating surface of the tank. As soon as the liquor is sufficiently concentrated, the screw is made to perform another important function, viz., the discharge of the semi-crystalline matter from the pan, which is effected by causing the screw to revolve in the opposite direction, when the whole will be expelled by an open sluice into the heater.

In this process of evaporation the hottest surfaces to which the sugar is exposed do not exceed 140° F. No ebullition takes place, and no steam is formed, but the vast body of warm dry air is made rapidly to sweep over the extensive surface of the screw, wet with cane juice, which absorbs the aqueous portions that are thus exposed to its action without burning it, or converting one grain of crystallizable sugar into molasses. The great economy of fuel which results from this mode of evaporation, will be readily understood, when it is remembered that the whole of the

heat applied to the water in the tank is derived from the waste steam of the engine, which is required to work the cane press, and the remaining portion is abstracted from the products of combustion after leaving the steam boiler, on their way to the chimney. Where this apparatus is used no coals will be required, and at least one half of the magas may be returned to the soil as manure. To those who are accustomed to see a huge range of coppers of forty or fifty feet in length, with a roaring furnace beneath, and the cane juice foaming over the tops of them, and filling the boiling-house with dense volumes of steam, it must appear almost incredible that evaporation can go on with sufficient rapidity in a small pan of ten feet by eight, in which the liquor is so cool, as to admit the hand being held for any length of time in it, and from which the eye can detect not the slightest appearance of the escape of vapour.

The more prominent advantages to be derived from my improvements in this branch of the manufacture, are

Firstly. The entire cost of fuel for evaporation is saved by using only the heat which is now lost in the chimney, and the waste steam of the engine.

Secondly. Saving the labour of drying, storing, and

bringing from the magas-house, at least one half of it, and also saving the labour of attending the copper fires.

Thirdly. Having half the magas left for manure.

Fourthly. Preventing the formation of molasses by the use of a low temperature, and consequently obtaining three hogsheads of sugar where now only two are produced by the use of the common battery.

Fifthly. The increased value of sugar per cwt., owing to its superior colour, purity of taste, and perfect freedom from molasses.

Sixthly. The small cost of this apparatus as compared with the vacuum pan, and the perfect ease with which it may be managed by native labourers.

Lastly. It can be worked with a small amount of wind or water power, and in consequence of its requiring no water for condensation, it may be erected in hundreds of situations where the vacuum pan cannot possibly be used.

ON THE CRYSTALLIZATION AND CURING OF SUGAR.

The mode most commonly practised in the British Colonies is to "skip" the concentrated juice at a temperature of about 245° F. into shallow wooden coolers, each skip or charge of sugar occupying about two inches in depth in a vessel of six feet square; the extensive surface thus exposed to the atmosphere has the effect of rapidly cooling the syrup, and as rapidly forming a confused mass of minute crystals, from which the drainage of the molasses, or mother liquor, is a difficult and slow operation, and which is imperfectly effected by transferring the semi-crystallized mass by buckets into hogsheads, which are arranged on beams in a large building called the curing-house; the molasses are allowed to drain from holes bored in the bottom of the hogsheads during several weeks, the floor of the building being sloped to a well, or receiver, in which the molasses are collected, carrying with it the flies and cockroaches that swarm in this favoured spot. This exposure of the molasses for a considerable

time not unfrequently produces fermentation, and in all cases an amount of acidification, highly destructive of its saccharine properties. The hogsheads when drained are sent to the nearest port, and shipped. The heat and motion of the vessel promotes a fresh drainage, and an average of 120lbs. of molasses is drained from each hogshead in its homeward voyage. Since the price of sugar in the market chiefly depends on the largeness of the crystal and the paleness of the colour, it is a matter of astonishment that so thoroughly unscientific a mode should have been so long practised. A superior kind of sugar is produced by the process known as "claying," which consists in filling a number of conical moulds with syrup, where it is allowed to crystallize; and after the molasses have drained from it, clay, in the form of batter, is put upon the sugar in the moulds; water is then put on to it, and by its slow percolation through the clay, carries down the film of molasses which adheres to the crystals, and greatly improves their colour. Fresh portions of water are added from time to time, until the cleansing is judged to be complete; when the clay is carefully removed, and the sugar is taken into the open air, and dried by the sun, or it is dried in large rooms heated by stoves. A great quantity of the sugar is dissolved in this process, which is afterwards re-boiled, and produces an inferior sugar.

Some idea may be formed of the vast labour and expense of this process when it is known that in Cuba, where it is chiefly used, as many as 12,000 to 15,000 moulds are in constant use in a moderate-sized establishment, each of which requires to be attended to in turn several times during the process.

All fluids containing saline matter become saturated at a given temperature; the higher the temperature, the more salt will be held in solution. It therefore follows, that whenever we lower the temperature of a saturated solution, we must cause as much matter to be deposited in the form of crystals as is due to the reduction of temperature. If this reduction takes place with great rapidity, as in the ordinary coolers, crystallization commences at an almost infinite number of points at the same moment; but if we cool the fluids slowly, equally minute crystals will commence to form at comparatively few and distant points. Now the natural tendency of all crystalline bodies is to be attracted to any nucleus that is formed, and to arrange themselves symmetrically upon it in preference to commencing a new and independent formation, and thus add to the size of the crystals originally formed. A sufficiently slow action is obtained by using a cylindrical wooden vessel as a cooler, whose depth and diameter nearly coincide, and which consequently presents a very

limited cooling surface in proportion to its cubic contents. These vessels I mount on three small wheels, for the purpose of readily bringing them up to the evaporating pan, and drawing into them a charge of concentrated syrup; they are afterwards wheeled away to cool slowly. These coolers are provided with an agitator for the purpose of equalizing the temperature of the mass while cooling, and of bringing fresh and crystallized portions in contact with the crystals that have been formed in the early stage of the process. The agitator also has the effect of preventing a hard crust of cold sugar forming at the top, and the formation of other concrete masses in the angles of the vessels, which by the old mode of cooling are the cause of those dark, ill-drained lumps which so much disfigure the ordinary samples of Muscovado sugar. The cylindrical cooler on wheels has also the advantage of serving as the hopper, from which the sugar is supplied to the curing machine, so that the waste and labour in transferring it from one vessel to another is entirely avoided.

When the crystallization of sugar is effected, it then becomes necessary to separate these crystals from the mother liquor in which they are formed; for this purpose I use a hollow circular table of three feet in diameter, covered with brass wire gauze, which should be placed in a room the floor of which

is three feet below the floor of the concentrating house;* so that the cooler, containing about one ton of sugar, may be wheeled on to the curing table; an opening in the bottom of the cooler is then unclosed, and the semi-fluid mass is allowed to flow on to the table, while the latter revolves at the rate of six or eight revolutions per minute. The apparatus is so arranged that the sugar is spread upon the table about half an inch in thickness; the table is also provided with a suction pipe, in connection with an air pump, by which a partial vacuum is made below the thin stratum of sugar, whereby the whole of the fluid part is drawn through the wire gauze, leaving the sugar sufficiently clean and dry for immediate shipment. On one side of the table there is fixed a scraper, in such a position as to plough off or remove the cured sugar from the revolving surface, and discharge it into a hogshead placed alongside the table to receive it. This apparatus is perfectly self-acting, and saves much of the labour and waste of other machines designed to produce the same effect, and from the slowness and steadiness of its operations, is peculiarly adapted for colonial use.

* If this is rendered inconvenient by local circumstances, a small portion of the floor only may be sunk of sufficient size to contain the machine and its attendant, or the curing-table may be put on the level of the other rooms, and the cooler wheeled up an incline rising three feet.

It will be found, that owing to the perfect clarification of the juice, the entire prevention of burning and blackening in the evaporating process, and the consequent greater fluidity of the mother liquor, that the curing without liquoring will leave a beautifully pale straw-coloured tint on the sugar, which is due to the minute film of molasses which is left adhering to the surface of the crystals. If it be desired to remove this small remaining portion, and thereby produce white "crushed lump," a small addition is made to the curing-table for the supply of water. It is in this latter and more perfect form of apparatus that its advantages become most prominent. As an illustration of the principle involved in this process, and to show how purely it is a question of *time*, I may mention the perfectly successful mode by which the minute filaments of cotton are removed from bobbin-net lace, known as "gassing." For this purpose a gas-burner is constructed in such a way as to produce a flame of a yard in breadth, and through this flame the delicate fabric is made to pass with a quick and steady motion, so that the flame may enter every mesh of it, and burn off the innumerable minute filaments which project from every thread; yet the speed is so regulated that the thread itself is in no way injured or scorched in the operation. The cause of this is obvious; since all substances acquire the heat to which they are exposed in times varying in proportion to their bulk;

thus while the minute filaments of cotton acquire a temperature sufficient to produce combustion, the thread itself is not heated sufficiently even to discolour it: but a moment's pause in the operation, and the whole fabric would be destroyed. In like manner, every yard of cambric before it is fit for the market, is made to pass in close contact with a large mass of red-hot iron, to singe off the filaments formed on its surface in the process of weaving.

A few moments' reflection will show that there is a strong analogy between these processes and the operation performed on the crystals of sugar in my curing apparatus. In the latter, we have to treat a substance, on the exterior surface of which there is a thin film of objectionable matter to be removed, by bringing it in contact with water, which is as perfectly able to destroy the whole crystal by dissolving it, as the flame in the former case was capable of burning the whole fabric, if subjected to its action for a sufficient time; but it will be obvious that, as the solution of the exterior portion or coating of molasses must of necessity precede the action of the solvent on the solid crystal, so it will be also understood, if we bring the water in contact only for the short period necessary to produce this effect, that the crystal itself will remain unscathed, and the whole of its coating be removed without

diminishing its bulk; the entire operation, as before stated, resolving itself into a mere question of *time*.

In carrying these principles into practice, I use a table of three feet in diameter, or, in round numbers, nine feet in circumference. If this is made to revolve only eight times per minute, its surface, and consequently the half-inch coating of sugar upon it, will move over a space of seventy-two feet per minute. Now, if at one part of its revolution it is made to pass under a pipe, from which a shower of water is falling, and if the breadth of that pipe is two inches, it follows that it must pass under it at the rate of seventy-two feet per minute; and as its breadth is one-sixth of a foot, it will only be retained one-432nd part of a minute, or one-seventh of a second under the action of the water; in which time the semi-fluid coating of molasses will be entirely removed, and drawn into the vacuum-chamber below, while the crystal will remain entire. When the apparatus is in action, this transformation from a brown to a pure white sugar in one-seventh of a second, presents a most striking and interesting spectacle.

This process completes the manufacture of sugar, which is delivered by the machine into the hogshead in a state fit for shipment, in a few hours from the

time of the canes entering the mill. All parts of the apparatus are so arranged and placed with reference to each other, that the different processes are combined, as it were, in one; the entire system being followed out on self-acting principles, so that the manual labour of the sugar-house is reduced at least two-thirds, notwithstanding the greatly increased product in sugar obtained by the new system, while the first cost of the whole apparatus is less than that which is now in common use.

It is extremely difficult to ascertain the precise amount of saving effected by the new apparatus; because, the canes hitherto used in this country are (as every person acquainted with the subject will readily admit), so extremely unfavourable for the purpose, as to give results greatly inferior to that which must follow its use on new canes in the West Indies; but the actual quantity and value of sugar obtained by the patent process under this severe disadvantage, is still so immensely important, that I cannot refrain from mentioning the result of some experiments on canes, about a month after they had been cut, the juice from which was much deteriorated both in taste and colour, and required so much lime to neutralize the acidity, that a small degree of grayness was communicated to the sugar; but the spontaneous evaporation of a portion of the

juice while in the cane had left the saccharine matter more dense than it was originally, the saccharometer indicating 21 per cent. of sugar present in the juice, which was concentrated without the application of fire or steam to the vessel as before described, and yielded 1 lb. 10½ ozs. of sugar per imperial gallon of juice, and which sugar in Mincing-lane was prized at 8*s.* per cwt. above the average of Muscovado in the market on that day. From this and other trials, I find that each gallon of juice from a fair average sample of fresh canes, will yield not less than 1½ lbs. of sugar per gallon, the usual colonial estimate being 1lb. per gallon; although, this is not always obtained. Taking these results as data, I will now show what will be the difference in the value of the produce of 250 acres of canes, worked by the ordinary means, and by the new system respectively.

By the Common Mode.

250 acres of canes, yielding 20 tons per acre, is equal to a gross produce of 11,200,000 lbs. of cane. If the roller-mill averages 55 per cent. of juice, we have 616,000 imperial gallons, and if each gallon yields 1 lb. of sugar, there will be a gross return of 275 tons. Now taking the value of this to be £1 per cwt., exclusive of duty, we

have as the value of the produce, in sugar . . . . . £ 5,500

In addition to this, there will be about one-third, or 140 tons of molasses, worth £5 per ton, equal to 700

Gross Return . . £ 6,200

By the New Process.

250 acres of canes yielding 20 tons per acre, equal to 11,200,000 lbs. of cane; assuming that the cane-press yields no more than 75 per cent. of juice, equal to 840,000 imperial gallons, and as each gallon will produce 1½ lb. of sugar, there will be a gross return of 561½ tons. Now taking the value of this to be £26 per ton, we have as the value ofthe produce in sugar . £14,599

and about one-tenth, or 56 tons of molasses, at £5 per ton . . . . . £ 280

£ 14,879

It will be observed, that in the comparative statement just given, the quantities are by no means exaggerated on either side,—for we have the positive statement of Dr. Shiers and others, that the average produce of juice in Demerara is only 45 per cent., which I consider as too low for a mean average.

I have therefore assumed that 55 per cent. is obtained, and I also give 1 lb. of sugar per gallon as an average produce; although, I have heard planters of indisputable veracity affirm that they have known instances in which 2,500, and even 3,000 gallons of juice were required to produce one hogshead of sugar; on the other hand, it will be observed, that I have assumed that only 75 instead of 80 per cent. of juice is obtained by the cane press, and an addition of every 6*s.* per cwt. for improved quality, when an advance of 8*s.* had been declared under the most unfavourable circumstances; but it is by no means necessary, as an argument in favour of the new system, that such a vast difference should exist between it and the old one; a gain far less than that which I have shown would render an entire change in the system imperative; and as all startling improvements on their first presentation to the world find numerous objectors, who exaggerate the advantages of old systems under which they have long worked, and at the same time underrate the results obtained by the new one, I will endeavour to anticipate all that may thus be said, and enter into a second calculation, in which I will give the old system credit for far more than it can prove to be an average produce, and at the same time cut down the results of the new system far below that which I am prepared publicly to show can be obtained

from canes that have suffered much on their passage to England.

As in the former case I will take 11,200,000 lbs. of cane. Say the roller-mill varies from 55 to 65 per cent., and in extreme cases from 50 to 70; we shall then get a mean average of 60 per cent., which would give 672,000 gallons, at 1 lb. per gallon, precisely 300 tons, at £1 per cwt.	£	6,000
150 tons of molasses at £5 . . .		750
Nett . .	£	1,750

With the new system let us then assume that the cane-press will vary from 65 to 75 per cent., giving a mean only of 70 per cent. This on 11,200,000 lbs. of cane will be 784,000 gallons. We will also assume that only 1¼ lb. of sugar can be obtained per gallon; this gives a return of 437½ tons, which we will take at an increased value only of 4*s.* per cwt., or at £24 per ton .	£	10,500
but with this assumed reduction in sugar we get an increase in the quantity of molasses, say 120 tons, at £5 per ton . . .		600
	£	11,100

It must be borne in mind that in this estimate no mention is made of the decreased cost of production, which is not only less per ton on the gross produce, but is actually less for the larger than the smaller quantity of sugar produced. This arises from the great reduction of manual labour. In the new system we have no stokers for the coppers, no people employed bringing magas for that purpose, no men employed skimming the coppers, and less men in the curing-house; there are no coals required, and at least one half of the magas will be left for manure, which will increase the production of cane, while the whole of the magas not being required as fuel will lessen the cost of stowage and the risk from fire. But entirely excluding these important advantages, and taking the last unfavourable estimate, we have an increase of £4,350 on a sum of £6,750. But I will go further, and ask any planter this simple question, If this gain was reduced to one-half of what is here shown, and the whole apparatus by which that gain could be secured could be obtained for £2,500, can he hope to compete with his neighbour, unless he at once adopts it and wholly abandons his present wasteful and expensive mode of manufacture? Let me also ask, if he discourage the strenuous efforts that is now being made to secure the immediate and sole advantage of this system to the British colonies, and thereby force it into operation against him in

other countries, what he conceives must be the immediate effect on his present income and the ultimate effect on the value of West India property? These are matters of grave consideration, and will, I doubt not, be fully considered by those whose present and future interests are so deeply involved.

In the early part of these remarks, when speaking of the backward state of the Colonial Sugar manufacture, I mentioned several circumstances which have tended powerfully to keep it in this state; and I now beg again to call attention to that subject, which presents one of the great difficulties to be overcome in any plan for the amelioration of the West Indies; for it is useless to invent and perfect a new system of manufacturing, if we have no means of carrying it into effect. It is useless to say to persons whose large properties have dwindled down (under extraordinary political changes) to less than a tithe of their former value, "Here is a remedy for your financial difficulties, but you must first pay down some two thousand pounds for new machinery." As these difficulties have presented themselves, I have endeavoured to arrange plans to avoid them; and I now beg to lay a brief outline of such plans before the parties most interested therein, and to solicit their earnest attention to the subject, which is one involving the whole prosperity of our Sugar Colonies. For if we once admit the fact, that by a new system

of manufacture we can more than double the commercial value of the entire produce of an estate, then such manufacture will inevitably be carried into practice sooner or later. Interested parties may obstruct its onward progress; petty jealousies or private interests may make a bold and resolute stand against it; but we live in an age when truth cannot be concealed, and in which public good ever prevails over petty private interests. Those who first avail themselves of improvements are the first to profit by them; but the extremely slow rate at which all improvements are introduced into these distant lands, prevents us, as a nation, from reaping that advantage in our colonies which our manufactures never fail to insure to themselves at home. The chances are now in favour of the more wealthy foreigner, who has more capital at command, and people equally intelligent to carry out his views. In the common course of events, such an invention as the present would begin only to be known in some five or six years, and at the end of twenty something like one in five of the best plantations would probably have it in use, both in the British and other sugar-growing states; and thus the great advantage that might have resulted from its exclusive use in our own colonies will be entirely lost, even if we were not worse off from its more extensive use out of our possessions. To meet this difficulty, and to insure the rapid and simultaneous introduction of

my new system exclusively into the British Colonies, I propose to form a Company, having for its object the supply of the entire plant of a Sugar-house to all Planters in the British Colonies, free of charge, and subject to the stipulations hereafter mentioned :

Firstly. I propose, That the Company shall erect near London a Model Colonial Sugar-house, in which the most perfect arrangement of all the apparatus shall be carried out, and in which, during the first three days of every month, 150 tons of canes shall be pressed, and the juice made into sugar, and sent into the market; the house being open to the inspection of all persons connected with our colonies, who will see the whole operation of sugar-making, note the quantity of canes weighed and sugar produced, and may thus form their own estimate of its value, by a comparison with their own private returns.

Secondly. That the Company shall also erect in ten or twelve of the principal British Colonies, a Model Sugar-house, identically the same as the one in London, or only varying in size so as to suit the estate which is to be hired or purchased by the Company, for the purpose of affording all resident proprietors ample means of judging of the new system, and also for the purpose of

allowing the managers or superintendents of estates to make themselves fully and practically acquainted with the process, while the apparatus is in course of erection on the estates under their charge.

Thirdly. Each Model-house is to have a depôt in connection with it, in which will be kept one or two complete sets of apparatus, ready for delivery on receipt of order, and also a duplicate of *every single piece* or part of machinery supplied by the Company in that island, made accurately according to templates, or gauges, kept on purpose, and which are to form an universal standard for all such parts; so that by referring to the proper letter and number stamped on each, a broken part of any apparatus may be supplied at the depôt at all times.*

Fourthly. The Company shall appoint a skilful practical engineer to every depôt, who shall superintend and be responsible for the substantial and proper erection of all the apparatus supplied by the Company.

* This is a matter the importance of which can scarcely be appreciated to its full extent; for with this plan fully carried out the planter would no longer feel the enormous disadvantages of his present isolated position; he would, in simple truth, be better off than our manufacturers in this country, who have to wait while repairs are being done, or new parts made; but these will be kept for him in readiness, awaiting only his order, and could be sent off to the estate with the delay only of a few hours.

Fifthly. The Company shall supply the entire plant of the sugar-house, consisting of steam-engine, boiler, cane-press, clarifiers, evaporating-pans, curing-machine, pump and cistern, &c., &c., and erect the same on the estate of any planter who may require it, free of all immediate charge, the planter paying the Company in sugar according to the following rates:—It having been ascertained that the estate has averaged a given quantity during the last five years, this quantity shall first be laid aside for the planter's own use; and on the first two crops after the new apparatus shall be erected, one half the surplus produce shall be paid over to the Company; and on the next, or third year, the planter shall pay the mere cost of the apparatus; or he may continue to hire the whole apparatus for any period, paying only one third part of the extra produce to the Company for its use. And,

Lastly. Those persons who are desirous of purchasing for cash direct from the Company, shall be supplied at a moderate rate, free of all royalty for patent right.

It is also proposed to sell to the Company all patents for these improvements which have been obtained in England, Ireland, Scotland, the Colonies, France, Belgium, Holland, Spain, and the United

States, and thus afford them every facility to introduce in a few years the whole process throughout our possessions long before any amount of individual enterprise could possibly spread it to any extent in other countries, and thus afford the British planter an ample opportunity of retrieving his past losses by so vast a monopoly as this would give him. The advantage also which the different depôts offer in case of accident will remove much of the risk now involved, and will save in all cases much expense and trouble whenever an accident may happen, while the model house will serve as a school in which every person putting up the new apparatus may get his workpeople thoroughly instructed in its use and management.

It may be said that this great increase of produce will so lower prices as to give ultimately no advantage to the planter. This will not be the case; for if by the new system only 50 per cent. extra were obtained it would admit of a reduction of 25 per cent. in price, and still leave him 25 per cent. more profit than he has at present. The immediate result of such a reduction would be an immensely-increased demand for sugar, and the entire stoppage of the beet-root manufacture, which is only able to keep its false position by the gross mismanagement of the cane, and thus a much wider field would be

opened, to say nothing of its increased use by the brewer and distiller.

I trust that the brief outline here given of my improvements in the manufacture of Sugar, and the way in which I propose to carry it simultaneously into operation throughout the British Colonies, will have been sufficiently understood to enlist the attention of those who are so deeply interested in their prosperity. Up to this period I have fought single-handed against all the difficulties that lay in the way of new inventions. Far removed from the seat of the cane-sugar manufacture, I have and am still importing many tons of canes to make experiments with, and furnish juice to test the practicable working of the new system, for which purpose I have erected apparatus on a scale equal in magnitude to that used on many sugar estates, and which I shall be happy to show to those who are interested in the subject. These labours have now extended over a period of four years, during which time the successive stages of my improvements have been patented from time to time in this and other countries, amounting in all to sixteen separate grants, with their respective specifications and copies of drawings, requiring almost incessant toil and anxiety. These labours, engrossing almost my whole attention for so long

a period, and involving an outlay of several thousand pounds, are now drawing to a close; and it is with no small amount of pleasure, that I feel myself in a position to announce the entire success of my process, which I doubt not will be fully appreciated by those numerous friends who have kindly taken an interest in my inventions, and of whom I now take leave, in the confident expectation that the best days of the West Indies may yet return; and should I have been in any degree instrumental in producing so desirable a change, I shall have the satisfaction of feeling that I have not laboured in vain.

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