CHAPTER VI

IMPROVEMENTS IN SUGAR MANUFACTURE

IN the early part of the year 1849, I had formed an intimate acquaintance with a Mr. Cromartie, a Jamaica sugar-planter, and at many of our friendly meetings we had discussed the question of the sugar manufacture as then carried on in the West Indian Islands. The more I heard of the state of this important industry, the more astonished I became on finding out how rude, how unmechanical, and how unscientific were many of the processes then employed, not only in extracting the saccharine juices of the cane, but also in its after-treatment. By a curious coincidence, at this very period the imperfection of the Colonial sugar manufacture had attracted the attention of the Society of Arts, and his Royal Highness Prince Albert had taken a very special interest in this subject, and generously offered a gold medal to be awarded to the person who should, during the ensuing year, effect the greatest improvement in the mode of expressing the saccharine juice of the sugar cane. I was much interested on hearing this, and applied myself to the problem with great zest, for I heard that the contest was to be an unusually sharp one. I was informed that the manufacturers of Colonial sugar machinery looked on it as a question that would decide which firm was in future to do the bulk of the Colonial engineering work, and that powerful vested interests were supposed to be at stake. This rendered it the more necessary that I should make every effort to gain such a knowledge of the subject as would enable me to devise a machine capable of extracting, as completely as possible, the whole of the juice from the cane. I, therefore, in the first place, obtained from Madeira a bundle of sugar canes, and I may say that up to that time I had never seen a cane. Those I had ordered to be sent to London arrived fresh and full of juice, as

I had directed that their ends should be dipped in melted pitch, so as to prevent decay, and the escape of any juice from them.

These canes were from $1\frac{1}{2}$ in. to $1\frac{3}{4}$ in. in diameter, having dividing knots at from 5 in. to 7 in. apart, throughout their length. The cane consists of an outer tubular part of hard fibrous wood, thinly coated with very hard pure silica; the interior of the thin wooden tube is filled with a soft pithy matter, almost like a sponge, saturated with juice, of which the ripe mature cane contains about 88 to 90 per cent. of its

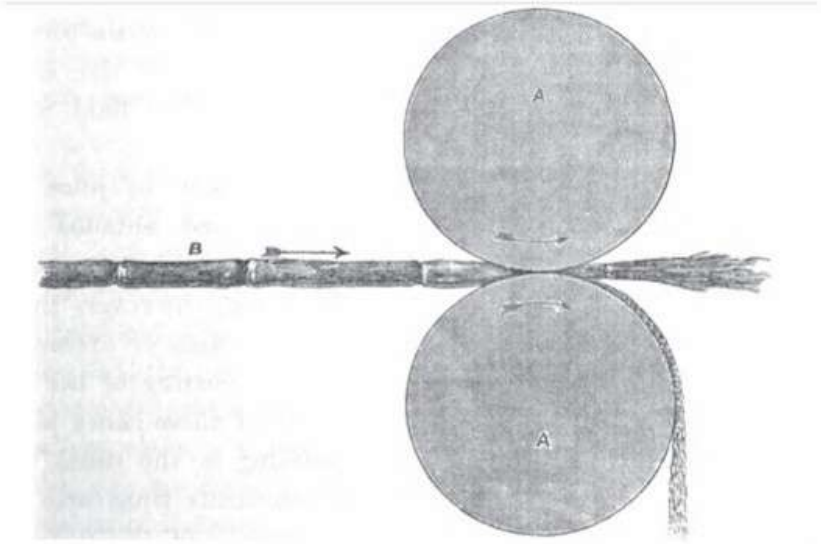


FIG. 17. SUGAR-CANE PASSING BETWEEN ROLLS

whole weight. I put short lengths of these canes to many tests in different ways, and especially noted their great elasticity; a 6-in. length, suddenly pressed between two flat surfaces, would lie in a complete pool of juice, and if the pressure were quickly released, the flattened elastic tube would again expand and as quickly reabsorb a very large portion of the fluid with which it was in contact. Here, I saw at a glance, was the weak point in the roller-mill, in which the cane quickly enters between a pair of rolls, and is for the moment collapsed. But as it emerges from them it again expands by its elasticity, drawing into the expanding spongy mass a large portion of the juice, which is

rapidly flowing in contact with it, over the lower roll of the mill. This will be readily understood by reference to the engraving, Fig. 17, page 87, showing in section a pair of iron rolls A, A, between which a cane B is passing in the direction shown by arrows. It will be observed that at the central part the cane is crushed very thin; but as it emerges, it, in part, recovers its former dimensions, and in doing so absorbs a very large percentage of the juice previously expressed.

These and other observations, carefully made and noted at the time, forced on my mind the conviction that no form of roller-mill could, from the inherent nature of its action, give satisfactory results; and that a slower and longer continued pressure on the cane must be resorted to, if the greater part of this valuable fluid was to be extracted.

By means of the hydraulic press, 86 per cent. of juice could be obtained; but this system was far too slow, and entailed so much labour as to render it impossible to deal with the enormous mass of canes grown on a moderate-sized plantation. Following, however, the general idea of the press, I designed an entirely novel system of extracting juice from canes, the main feature of which was the cutting of the cane into lengths of about 6 in., thus leaving both ends of these short pieces open for the escape of the juice, instead of operating in the usual way upon canes of 4 ft. to 6 ft. in length, having numerous transverse knots or partitions, which effectually prevented any escape of the juice endwise. The two convex surfaces of a pair of rolls of 2 ft. in diameter, pressed on less than 6 in. of cane, at any moment, and if they revolved as slowly as five revolutions per minute, the 6 in. of cane passing between them commenced and finished the period of pressure in just one second. In the cane press about to be described, every one of these open-ended 6 in. lengths would be subjected to intense pressure for a period of two and a-half minutes; in practice, it has been found that the juice was vigorously given out for the first minute, and then gradually declined; finally ceasing to yield one drop more of juice for about half a minute before it was discharged from the open end of the press tube.

In order that this new system of continuous pressure might be fairly tested, I erected a complete press and steam engine combined, at my

experimental premises at Baxter House. I also imported a large quantity of canes from Madeira and from Demerara, for the purpose of studying their structure, and making experiments with them, under varying conditions of pressure and time. The quantity of juice which this small apparatus was found capable of expressing exceeded 600 gallons per hour. The juice was much more free from pithy fragments than that which was obtained from the roller-mill, while the quantity of colouring matter and chlorophyl extracted from the knots was much smaller, because in the press these hard knots sank into the softer surrounding parts, while between the rolls they got far more pressure than the softer parts of the cane, because of their greater solidity. But the most important result, which was fully established, was the high percentage of juice obtained.

In our first experiment, made immediately after the arrival of the canes, the quantity of juice obtained exceeded 80 per cent.; in another experimental trial, when the canes had been four months cut, 73¾ per cent. was expressed; and, later on, in a public experiment, when the canes had suffered from drying, 65½ per cent. was expressed. In reference to the far smaller quantity of juice obtained in practice by the old system of rolling-mills, I may quote from the Seventh Report of the Parliamentary Committee on Sugar and Coffee Planting, where, at page 259, will be found a memorandum dated "Colonial Laboratory, Georgetown, 3rd February, 1848," from Dr. John Shier, Agricultural Chemist, who—speaking on Sugar Mills—says:—

> From numerous trials on various estates, I am satisfied that the average yield does not exceed 45 per cent.; the first of all improvements then seems to be to obtain a larger percentage of juice from the cane.

It is a curious fact that throughout this competition no one but myself came forward with any plans to do away with the roller-mill. There were plenty of improvements in this class of machine; two rollers and three rollers, new gearing, and combined engines and mills. In one case a magnificent mill had been patented. It was a combined engine and mill, weighing no less than forty tons—no light matter to pass over half-made Colonial roads—and it was designed by Messrs. Robinson and Russell, who were large sugar-mill manufacturers in London.

The extreme lightness of my cane press formed a strong, and from a Colonial point of view, a most important, contrast to this. The press was put to work, and publicly exhibited to dozens of persons who were owners of sugar plantations in our various sugar-growing Colonies, and great expectations were formed by them. They saw the canes weighed and operated upon, then the squeezed mass again weighed, the reduction in weight clearly showing the quantity or percentage of juice obtained by the press, which was admittedly at least 20 per cent. more than the average produced by the old roller-mills then universally employed. The juice obtained was very rich in quality, in consequence of a considerable evaporation from the canes which had gone on during the three or four months since they were first cut. As a matter of curiosity, I manufactured from the juice obtained about half a hundredweight of crystallised sugar of very good quality, which I presume was the first sugar ever produced direct from the sugar-cane in London, and was much prized as a matter of interest by some of my friends for that reason.

Without going into the minutiæ of detail, it may be interesting to give a short description of the cane press, which is here illustrated by engravings copied from drawings of the press, as erected at my experimental works, Baxter House.

The first engraving, Fig. 18, on Plate VIII, shows a side elevation of the press, and the steam-engine with which it was combined, on one large bed-plate. The second engraving, Fig. 19, on page 91, shows a vertical section through one of the gun-metal perforated pressing tubes; the interior of these was of rectangular form in cross-section, being 6 in. in height by 3½ in. wide.

In the centre of each of these tubes there was a massive plunger fitting accurately. A square steel bar passed through the two plungers, and also through slots made in the sides of the tubes for that purpose, the outer ends of these bars being rounded and fitted into the ends of two massive connecting-rods, which were actuated by a pair of short-throw cranks formed one on each side of the central crank of the steam-engine. This arrangement is best seen in Fig. 20, page 91, which is a plan of the cane press and engine.

From the upper surface of each of the pressing-tubes, two tall circular hoppers stood vertically, and were attached at their upper ends to a stage or floor on which the canes were delivered, and where two attendants were stationed, whose business it was to continually drop canes into these tubular hoppers. When the several parts of the apparatus were in the position shown in Fig. 19, page 91, the plunger had cut a 6-in. length off the lower ends of the canes in the left-hand hopper, and had pushed them against the compressed mass of canes occupying that end of the pressing tube, the result being that this mass was moved a little way further along, the fluid parts escaping from the numerous perforations in the tube.

While this had been going on the canes in the right-hand hopper had fallen down into the pressing tube, and the return stroke of the plunger would then cut off a 6-in. length from these canes, and force them up against the mass of canes occupying the right-hand end of the press tube, moving the mass of flattened canes a small distance forward, and discharging a portion of them from the open end of the tube. In this way every rotation of the crank cut off portions of the canes in each of the hoppers, and carried them forward, thus keeping the tubes always filled with a mass of compressed canes, which were jammed so tightly in the tubes as to offer an immense resistance to the plunger, governed by the length of the tube. The two cranks which actuated the plungers were at right angles to the crank operated on by the steam power; hence, when the engine was exerting its greatest power, the cranks actuating the plungers were passing their dead points and thus exerted an enormous force on the mass of canes, which moved forward but a very small distance at each stroke.

With the engine running at only 60 strokes per minute, each plunger cut off two 6-in. lengths from each cane in the hoppers; and as there were four hoppers with two canes in each, 4 ft. of cane were operated upon at each revolution, or at 60 strokes per minute only, some 240 ft. of cane were cut and pressed per minute. It was found that the canes thus passing along the tubes were forced out of the open ends of the latter adhering together, and looking like a polished square bar of wood; the juice of the cane passing through the numerous perforations and

falling into the square cistern formed beneath them by the massive bed-plate, was conveyed away by a pipe to the evaporating pans.

The committee appointed to judge of the various plans submitted in competition for the gold medal offered by his Royal Highness, Prince Albert, came in force to Baxter House, and witnessed the cane press in operation. Although the committee did not openly express their views to me, I could not doubt that their convictions were entirely in my favour, a natural result of the incontrovertible facts I had placed before them. In due course I received a notice that the prize so much coveted was about to be awarded to me, an entire outsider, wholly unknown to any of the sugar-mill manufacturers of this country.

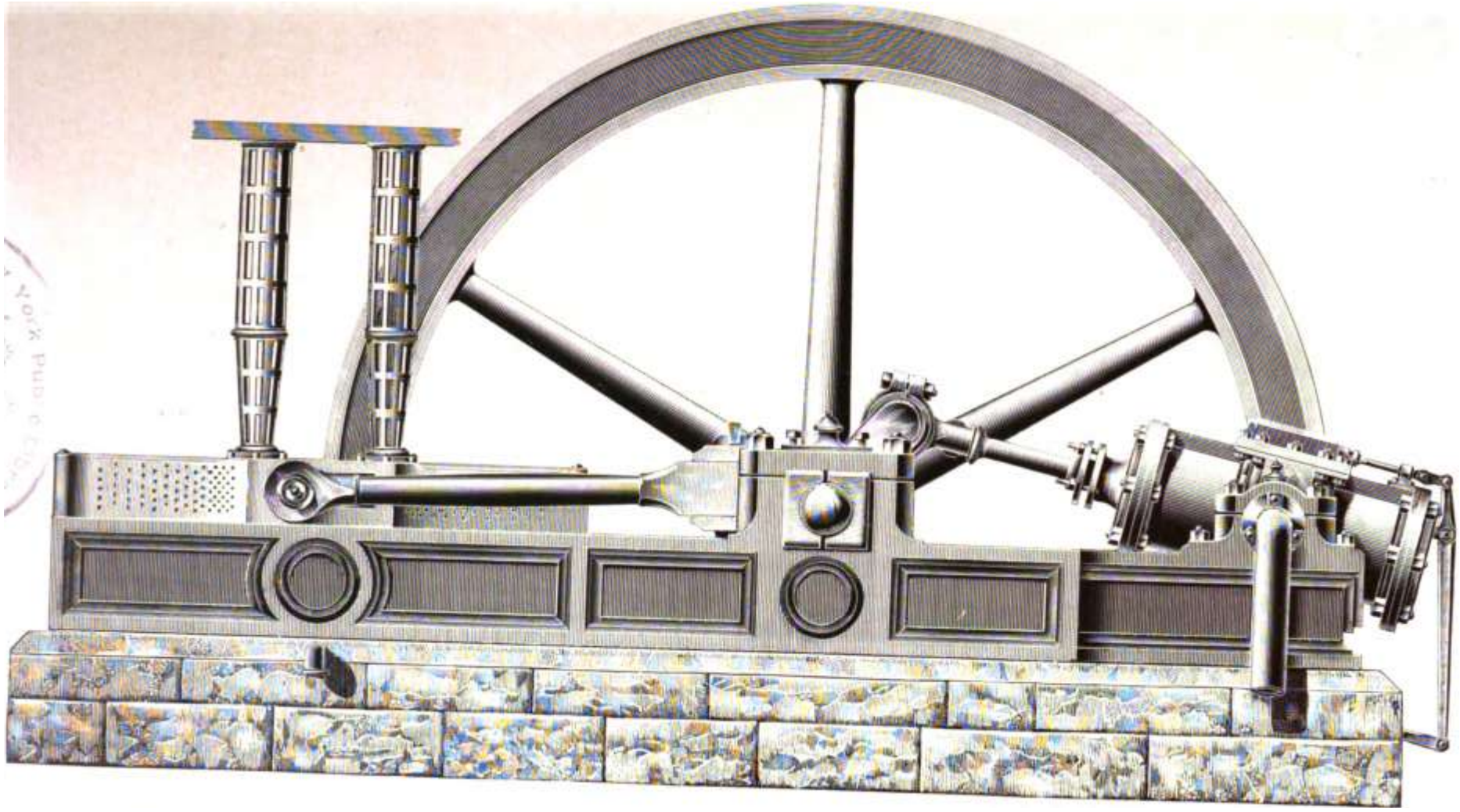
How often it has occurred to me, and how often have I expressed the opinion that, in this particular competition—as in many other previous cases—I had an immense advantage over many others dealing with the problem under consideration, inasmuch as I had no fixed ideas derived from long-established practice to control and bias my mind, and did not suffer from the too-general belief that whatever is, is right. Hence I could, without check or restraint, look the question steadily in the face, weigh without prejudice, or preconceived notions, all the pros and cons, and strike out fearlessly in an absolutely new direction if thought desirable. Indeed, the first bundle of canes I ever saw had not arrived from Madeira a week before I had settled in my own mind certain fundamental principles, which I believed must govern all attempts to get practically the whole juice from the cane; but of course, there were many circumstances that rendered it necessary to modify first principles, having reference to the cost of the machine, its easy transit across country, freedom from repairs in isolated situations, etc., etc.

In due course I had to attend a meeting at the Society of Arts, where I was much surprised to find the large hall crowded with spectators. At one side of the room was a raised daïs, on which his Royal Highness, Prince Albert, was seated at a small table, and at his side was the Chairman of the Committee of Mechanical Experts, who had reported to the Prince the result of their deliberations. In front of the platform occupied by the Prince Consort there was a long avenue covered with crimson cloth, and skirted on each side by rows of seats, occupied by

ladies, who added to their personal charms all that the milliner's art could accomplish to give grace and *éclat* to the occasion. It was, I found, my rôle to brave all the dangers of this double battery of youth and beauty; and, like the good St. Anthony, I had to keep my eyes fixed upon the crimson cloth, for I did not dare to look. If anything could add to the satisfaction of the moment, it was the presence on this occasion of the Chairman of the Committee of Experts, who was about to read his Report, for this gentleman was no other than that talented and well-known engineer, Mr. John Scott Russell, than whom no one in all Great Britain was more able to do justice to the subject reported on. His firm of Robinson and Russell were extensive manufacturers of Colonial Sugar Machinery, but they had refrained from competing on this occasion, thus allowing Mr. Scott Russell to add another to the many proofs of the high code of honour so conspicuous in the whole body of Civil Engineers in this country, by giving publicly unqualified testimony to the merits of what was, in fact, the scheme of a rival manufacturer. The honourable distinction received from such a source, while it was most gratifying to myself, was more than reflected upon the speaker.

Among many other things, Mr. Scott Russell, in addressing the Society and reading his report, said, "the new cane press of Mr. Bessemer has the merit of introducing a principle at once new and of great beauty into the process, while reducing the weight and cumbrousness of the machinery; much has been done by Mr. Bessemer towards removing the main obstacle to improvements in the working machinery of the Colonies in the Tropics, viz., the difficulty of transport." Mr. Scott Russell further pointed out that: "When these facts of facility of transport, simplicity of foundation, and other advantages come to be considered in reference to cost, it will at once be perceived that notwithstanding the great advantages it offers in respect of quality and quantity of juice, certainty and uniformity of action, and freedom from accident by wear and tear, the cane press, when placed in working condition upon an estate, will have cost less than the most ill-constructed mill and engine to be obtained from the cheapest and most inferior makers."

At the conclusion of Mr. Scott Russell's address there was a round of applause, and this was followed by the rising of his Royal Highness Prince Albert, who complimented me in the kindest manner on the success of my invention—an invention which I had taken such unusual steps to prove, by bringing, as it were, the Colonies to us, and by resting my claims to recognition on actually accomplished facts. His Royal Highness then placed in my hands a beautiful Gold Medal. In briefly expressing my thanks, I said that whatever advantages might in the future result from this invention, they would be entirely due to the encouragement held out by his Royal Highness; and amid the warmest recognition from the assembled spectators, I beat a retreat with the prize I had received.



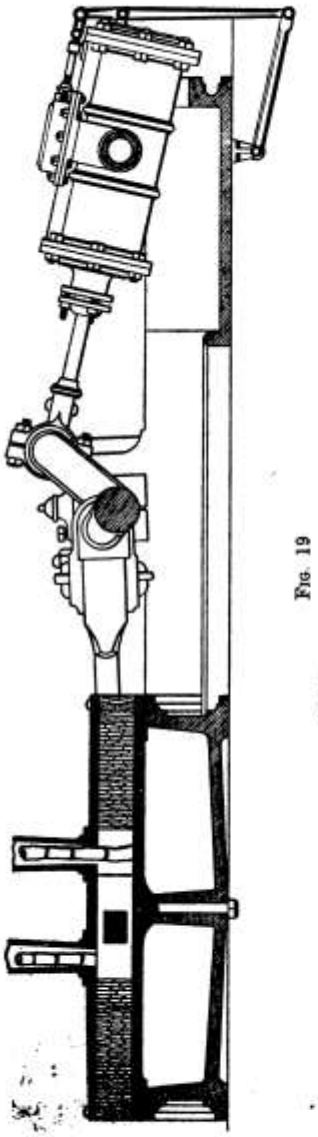


Fig. 19

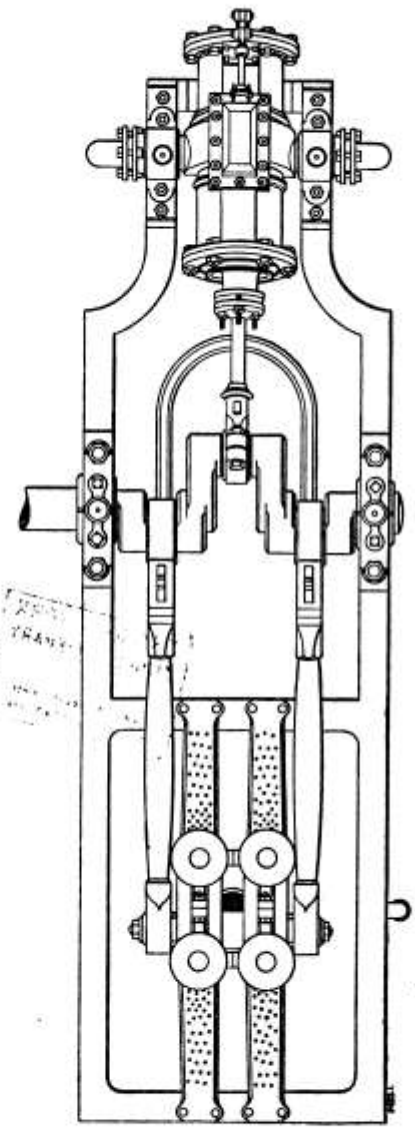


Fig. 20

Vertical Section and Plan of Bessemer Sugar-Cane Press, 1849