

Recueil Industriel, for August.

Bibliothèque Physico-economique, for September and October.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale, for July.

A communication from Col. J. L. Sullivan, on the subject of Winans' Friction Rail-way Carriage, was read, and after being discussed, it was, on motion, referred to the committees on publication and on inventions.

The discussion of explosion of boilers of steam engines being called up as the order of the evening, Professor Alexander D. Bache read a letter received by him, giving a further account of the explosion on board the steam boat *Caledonia*, together with remarks on the subject by the writer.

Other communications on the same subject, were received and discussed, after which they were referred to the committee on explosions, and the subject continued to the next meeting.

THOMAS FLETCHER, *Vice President*.

GEORGE W. PHIPPS, *Recording Secretary, pro tem*.

TO THE FRANKLIN INSTITUTE.

Remarks on WINANS' Rail-way Carriage. By JOHN L. SULLIVAN,
Civil Engineer.

SIR,—When I submitted to the Institute, in April, 1829, a description of the rail-way wagon, invented by Mr. Winans, depositing a model at your Hall, and soliciting a committee on this invention, I expected, of course, that its imperfections, as well as merits, would not escape their discernment. I considered the Franklin Institute as a tribunal of science, to which every inventor might bring the product of his ingenuity, and offer its *usefulness* to a fair and skilful investigation, in the hope, if not in the confidence, that a favourable opinion of it, by men competent to judge, might introduce it to the public under the *best* auspices; or, its defects being pointed out, be previously remedied. I was not, therefore, disappointed in the result of the report.

My attention had been drawn to this improvement as an instrument in the *public economy* of rail-roads. Experiments with models had given me quite as much confidence as its mechanical combinations warranted; and taking some small interest in its success, I felt that it was not only proper, but extremely desirable, that my own favourable judgment should be sustained, by the good opinion of perfectly disinterested parties.

When, therefore, the committee pointed out certain supposed liabilities to *peculiar* stress, and *unequal* wear, and in expressing the "wish to see a carriage on this construction of full size in operation," suspending their full approbation until this opportunity of mature judgment should arise, I perceived it would be incumbent on me, for the interest of the inventor, as well as for my own credit as a mechanic, to make a further communication when practice should

have tested the value of the machine, and due progress have been made towards its perfection; availing myself of the hints conveyed, with equal politeness and good will, in the report.

To do this, however, it was necessary to wait the slow progress of events; and now, though apparently tardy, I hope and presume a brief account of this invention, up to this time, will be acceptable to the Institute, not only as that of a new machine, but of an instrument concerned in the prosperity, possibly, of Pennsylvania, in the extensive rail-roads she is forming as part of the great line of commercial communication between her capital and the navigable waters of the west. The nature of all mechanical improvements very much depend upon the magnitude of the purpose to which they are applicable, and there are few greater than the cheap transportation of the materials of the internal commerce, together with the agricultural and mineral resources of this state.

In the combinations of mechanical principles, compound leverage in mills, for example, is well known; but I think it had not been usefully applied to carriages until that of Mr. Winans appeared, and with singular novelty and neatness in the mode of his subduing friction in wagon wheels.

It did not escape the notice of the committee, that the *occasional obliquity* of the main axle to the transverse line of bearing under the rim of the friction wheel, would cause the surfaces of it, and the rolling gudgeon of the main axle, to receive at such moments near the *end* of the latter, and the *edge* of the former, the whole weight due to that wheel; and they apprehend, therefore, that *these parts* would wear *most*: but did they not accidentally omit to state that the *ordinary* pressure and wear is *between* these points, and, therefore, if those parts wore down most at such times, still the surfaces must, *on the whole*, wear *equally*? so it seems to me.

Another inconvenience apprehended to be of consequence, was the *endwise* pressure of the axle against the friction wheel, making it operate with its axle as a bent lever to twist the side pieces of the frame out of place. But did not the committee lose sight of the fact, that on rail-roads there can be no considerable "swaying" of the load from side to side? that the moment there exist inequalities sufficient to produce this effect, there can be no *velocity*? that the road must be so out of order, or imperfectly made, as to fail of its purpose? that the two rails of the track must coincide in level? Indeed, so little precaution is required to be taken, that even on the temporary imperfect tracks at the Baltimore excavations, while other causes of injurious wear existed, this effect was not among them.

The accidental *injurious wear* above referred to, both explains the reason of another liability, to which the committee pointed, and in some measure supplies its *disproof*. They supposed the surface of the *rim* would, by the rolling at the gudgeon, not only wear away, but form into grooves, in one of which the rolling gudgeon of the main axle would at length make a permanent lodgment, and reduce the friction wheel to the condition of a common bearing box: it was not, however, adverted to, that before the rolling forward of the

gudgeon in the rim could stop, the friction at *its axle* must be a greater resistance than that produced at its rim. The almost impossibility of thus stopping, was shown in the instance of those first large wagons, put in operation; the friction wheels of these were, (in the absence of Mr. Winans,) cast of *soft iron*, in order to be more easily turned smooth and cylindrical; but they were *so soft*, that their surface crushed under the harder surface of the gudgeon, and wore away; but wore away *equally*: for their very roughness gave the gudgeon a stronger hold, and they would have continued to revolve till worn thin enough to break.

To remedy the defect of the *soft castings*, and this liability to wear as apprehended by the committee, Mr. Winans has now succeeded in casting the friction wheels, not only in very *hard iron*, but the interior of the rim perfectly cylindrical, thus attaining *economy, hardness and smoothness*. It is found that *chill castings*, in which steel gudgeons roll or rub, work as smoothly and durably as brass. The whole carriage *now* scarcely costs more than the common kind.

The rail-road being well built, the stress on the friction wheel rim must be perpendicular to its axle, (and liabilities to surge, if they exist, may be checked at the frame,) a further improvement on them has now been made. This is to enclose the friction wheel in an iron case, which at once sustains the ends of its axle, keeps off the dust, and serves as the depository of the oil. The case is circular, and is let into the *under* side of the timber, (now single,) far enough to bring the top of the inner surface of the friction wheel *level* with that of the timber. Arms here project from it, by which it is bolted on. In England, where iron is cheap, these arms prolonged and connected, form the sides of the frame. The inner side of the case has an aperture for the main axle gudgeon to enter and lodge under the rim of the friction wheel, and with room for some play. The friction wheel is cast so as to revolve *on* its axle, and not *with* it. The nave bearing, (five inches through,) is cast to a chill pin, which being removed, receives a *cast steel axle*, fixed firmly in its place by means of screw nuts at its ends. The oil being lodged in the case, the joints of which are tight, is taken up by the revolving rim of the friction wheel, and continually carried to its axle, and to the gudgeon of the main axle. All the surfaces that move upon each other are within these four cases, thus thoroughly oiled, yet without waste. Indeed, the same mode of oiling is now applied to the first method, with revolving axles. Both methods are approved at Baltimore. This manner of oiling, as well as the slowness of the movement at the rubbing axle, is very favourable to their use with the speed of locomotive engines.

Feeling assured that the candour of the committee will allow me to meet all their objections by such new facts as have arisen, as they can have no other aim than to guard and to serve the community, I ask leave briefly to notice the remaining one or two.

They thought that the rim of the friction wheel might not be *strong enough* for the stress outwards, from the centre, so as safely to hang the weight of the load by them, there being four on the ends of the

main axles, but that it would sustain the load better, if these rounded ends of the main axles were lodged on the *convex surface* of the friction wheel, then seeming to have the properties of the arch.

But may I not remind the committee that the purpose of the inventor was to avoid all *incidental*, and reduce by leverage the resistance of the *inevitable* friction? He tried the other, and thought the carriage thus more simple; and it is not really material whether the rim be one inch, or one and a quarter thick. *Not one has yet broken with even four tons load.* Besides, there is a peculiar advantage resulting from this lodgment, as I shall have occasion presently to show, in turning the curves of a rail-road.

In operation, the committee thought, too, that as the retarding force of gravity would be just as much against this wagon as against others, that it would, on the whole, be *more*; because the weight of the friction wheels would be superadded. I had, indeed, omitted to mention in my description, that the weight of the main wheels might be *at least* as much lessened, by a small diminution of their size, or otherwise, as lighter main wheels than usual will wear well with the friction apparatus. It is thus exemplified.

In practice at Baltimore, the four friction wheels with cases, weigh 100 lb. The large wheels, 700 lb. Their two axles, 236 lb. The average weight of several complete wagons, 1558 lb. One of the most complete Liverpool wagons tried in competition against one built there by Mr. Winans, both having three feet wheels, weighed 22 cwt. His 21 cwt. Besides, the objection of gravity would not apply, unless that of the friction wheels retarded the carriage more than their leverage helped it.

The committee justly observed that "nothing but actual experiment on a large scale, will fully develop the precise amount of the advantage of a machine of this nature, because it is not possible to foresee all the circumstances which will attend its construction and use." This is true of its use, because its performance does not depend alone upon itself, but also on the smoothness and solidity of the road upon which it is to run. For this reason it would be doing the invention injustice to decide on its ultimate excellence by its performance under the unpropitious concomitants of a new and rough rail-road. Indeed it can hardly be expected that our rail-roads will soon be as perfect as they are made in England, where iron is cheap. A comparison of one wagon or engine with another, to be conclusive, ought to be made on the same road.

At Liverpool, the wagon of Mr. Winans was tried, as before mentioned, against one of the wagons of the rail-road company, each loaded to weigh with the carriage $80\frac{1}{2}$ cwt. under the supervision of Mr. Charles B. Vignoles, one of the most eminent engineers in England. His report thereof was published in the *Mechanics' Magazine*, in February last. He states in that, and in a letter since printed, that he found the friction of the wagon of Mr. Winans, $2\frac{1}{2}$ lb. to a ton, and of Mr. Stephenson's, $9\frac{1}{4}$ lb. to a ton: both with 3 feet wheels.

It is well known that the usual friction of the common rail-way

carriages is $11\frac{3}{4}$ lb. a ton, and Mr. Stephenson was mainly indebted for the difference, to a part of the improvement of Mr. Winans, *the outside bearing*, for the outside projection of the axle permitted of *more reduction* of size, than the necessary strength of the axle *between* the wheels will allow of. This was Mr. Winans' first improvement.

But perhaps there can be no better method of comparing the friction of rail-way wagons, than by the elevation of the inclined plane down which they will respectively run by the force of gravitation. In the published report of the survey and location of the Baltimore road, this was, as on other occasions, considered by the engineers to be for the common carriage a little more than 30 feet in a mile. But Mr. Vignoles states that he found the friction wheeled wagon would descend by the force of gravity alone, an inclined part of the rail-road of only 5 feet $10\frac{3}{4}$ inches in a mile.

A superiority of 5 to 1 in principle thus conclusively demonstrated in full size, comes very near the original performance of the model. The best kind of wagon may be diminished in useful effect by newness, roughness, curves and ascents in rail-roads; but its superiority in principle over other carriages will still be maintained, though the power should fail to effect as much as it could, were the road smooth, hard, and level.

It is manifest, therefore, that the superiority of that with friction wheels will be great on descending ground, as well as on *level* ground. And especially so in this country, where the location of our greatest rail-roads are likely to be up and down the vallies of our rivers, for it is well known that 4-5ths of the tonnage is outwards.

It is certainly interesting to the public to see this principle in the rail-way wagon, carried in practice as far as it will bear.

Opportunities are likely to occur on the rail-roads between our great cities, which will be remarkably level. It is demonstrable, perhaps, that it is better to make considerable circuits rather than to cross high ridges. *That number of feet elevation in a mile*, whereon gravity alone will give motion, has been considered equal to a mile in the expense of power. But though the rail-road from Philadelphia to Columbia rises in some places 27 feet in a mile, it will be, notwithstanding, an advantageous run for locomotive engines, and this wagon will enable them to do much more service than they otherwise could. Because wherever the descent is above 6 feet to a mile, the loaded wagons will accompany the engine with all the speed it could alone attain.

It was a gratifying testimonial in its favour, at Liverpool, that Mr. Ericsson insisted on having these wagons for *his loading*, when proving the efficiency of his locomotive, the celebrated *Novelty*. And he took them rough from the quarries and excavations as they were: for the rail-road company, after the *test*, had agreed for a dozen or two of them. It was thus that the *Novelty* carried 28 tons at the rate of 8 miles an hour, as stated and published by Mr. Vignoles. And I have understood that this convinced the engineer of

the company of their superiority; so too the circumstance of their use on the works under his care is a strong fact.

Indeed the weight of the testimonial given by Mr. Vignoles, is fully equal to that of *any other engineer*, and certainly is very conclusive. His investigations were made with a wagon of full size, in the presence of many witnesses. His report is of careful and repeated trials, and the result is given to the world on the responsibility of his high professional character. It amounts to a recommendation of this improvement to all the rail-road companies in England.

It would be here a fair inquiry on the part of the committee, why the Liverpool company does not employ this kind of wagon wholly. The true answer is, that they had formed an establishment, before this improvement appeared there, to build the common kind, considerably improved in workmanship and proportions, under their skilful chief engineer, who therefore reluctantly yielded to the conviction that compound leverage had a good effect in carriages. And could Mr. Winans have accepted the company's offer to remain, more of the friction wheeled wagons would have been already in use.

It remains to give an account of the progress of this invention in our own country. If not so decisive, it will not be without some satisfaction; and useful and correct information is now wanted by the public on this subject. The Baltimore rail-road, it is generally known, commences on the present borders of the city, 66 feet above tide, and is carried level 7 miles, through and over hills and valleys: and then ascends the rocky valley of the Petapsee, necessarily following the indentations of the hill, along the slope of which it is led by a winding line, the alternate curves of which are often on a radius, (it is said,) of no more, if so much, as 400 feet. In England the radius of rail-road curves is always much greater than this, having probably a better choice of ground. Their roads are nearly straight, and the wheels may be without objection wedged upon the axles.

This location, therefore, appears to have been thought to demand a kind of compromise in determining the size of the wagon wheels. The model, you may recollect, permits the main wheels to turn on the axles, occasionally a little, though in operation actually fixed by the pressure of load, and the comparatively less resistance to turning, at the axles of the secondary wheels. It was expected that on turning curves, this would be a convenient property, because there could be no sliding; but the difference in the length of the rails of the curve, be made up by just so much turning of the outer wheels on the main axles; it might be only a few inches.

But on a large scale Mr. Winans found, while in England, that he gained something upon *the resistance* by wedging the wheels fast: and on straight roads there was no objection to it. It then became of less consequence on *which side of the rail the flanch worked*; and he found that by putting them on the inside, as usual there, it permitted of a slight degree of cone in the rim, which by means of the faculty of adjustment in the axle to resistances, was favourable to steadiness in the progress of the carriage.

This probably suggested the idea of an increase of the cone near the flanch to favour the passage of the wagon around those *short curves*: because, on entering them with speed, the wagon would have centrifugal force enough to incline it most to the outer rail, when the effective diameter of the wheel, being increased by running on the cone, while the other wheels run on the lesser diameter of the flat of the rim, measured by equal revolutions the unequal lines of rail; and on taking the reversed curve, with the like effect; their present engineer, Mr. Knight, having calculated the exact degree of conical swell to produce these effects, on the curves of *this road*. On reaching a straight course, or the change of the curve, the vibratory or adjusting action of the main axles takes effect, and establishes the line of steadiness, when otherwise there would be *sliding*, and consequent wear of both the rail-way and the wheels.

The various considerations which entered into the subject, it appears, fixed the diameter of the main wheels at 30 inches. The friction wheels, inside measure, are 9 inches diameter.

The present unfinished state of the first section of the road, does not yet permit of ascertaining the full benefit of the principle, there being but one track; because the heavy loaded wagons are compelled to travel in accommodation to the passenger carriages, a part of the distance ten miles an hour, and five miles ascending 13 feet in a mile. At present, therefore, they do not attempt to carry more than eight tons to a horse. The passenger carriages run with about 30 passengers to one horse, at 10 miles an hour, changing at half way.

But I intend, with your leave, to furnish for the Journal the further progress of practice, that the Institute and the public may have knowledge of the facts in this branch of rail-road economy, without the least reserve, wishing that only to be preferred which deserves preference.

Although the extent to which compound leverage might be carried, in rail-way wagons, is not at present determined by experience at Baltimore, still in another respect may be deduced from it, the very satisfactory result, that these carriages will run a long distance without any repairs. One of those for passengers was lately shown me at the rail-road, that had the last year and the present run loaded six thousand miles without requiring any expense upon it, and was said to be still in perfect order. And you may have seen in the Baltimore American, of the 6th inst., that one of those for heavy loads, which had run 1800 miles, was taken apart for examination, and its rubbing and rolling surfaces found in perfect order.

I do not, however, insist, from all that has been adduced, that the committee and Institute ought to feel perfectly satisfied that this improvement is of great consequence in rail-road economy. But will express the hope, that the day may not be remote, when they may see them here of *business dimensions*, and the principle carried as far as may then be found expedient.

Nor do I believe this a vain wish. There are in this state several routes where rail-roads might be beneficial to the public, and well

recompense proprietors. None are more obvious than from Harrisburg to Carlisle, and from the head of Schuylkill navigation to Sunbury, (spoken of in the papers of the day,) and from Philadelphia to Trenton, should one be made across New Jersey.

With acknowledgments to the committee for their attention to this subject, and to the Institute for the indulgence of so large a proportion of their time,

I remain, very respectfully,
your humble servant,

JOHN L. SULLIVAN,
Civil Engineer.

Philadelphia, December 17, 1830.

Postscript.—Since writing the preceding additional explanation, I have seen the article on Internal Improvement, in the American Quarterly Review, for December, on which, page 293, the subject of rail-roads is a topic, and wherein mention is made of this invention. “Winans, a citizen of New Jersey, has *proposed* a carriage with a new species of friction wheels; and Fleming, a European engineer domesticated among us, has contrived a means of substituting a motion of mere rolling for that of wheels. Both have succeeded completely in model, and in experiments upon the small scale, but practical men entertain doubts, which do not appear to be ill founded, whether either can be actually applied in practice.”

This passage, (I have no doubt the Editor himself will admit,) is objectionable, not only in coupling the two inventions, so essentially different, but in speaking *now* of that of Mr. Winans as it might have been spoken of *nearly two years ago*. He passes entirely over its establishment under patent, in use in England, and the account of it not only in an English publication, nearly a year ago, republished at Boston, and repeated in your Journal, in which it is certified by an eminent engineer in that country to have the mechanical advantage of nearly 4 to 1 over the best rail-way wagon before known and used, but also the *obvious practice* on the Baltimore road. The truth is, that the road itself has so absorbed admiration, that probably the Editor, or the writer of that article, may have himself rode on it without knowing that he was also on a friction wheeled wagon.

Now, with all due deference, I cannot see any use in the display of learning on such subjects, when facts so obvious and so pertinent to the very occasion, are not only passed over, *but a groundless prejudice disseminated*, as much at variance with the great interest of internal improvement, as with that of the inventor. For that article, after arguing *pro and con* the question between canals and rail-roads, comes to the conclusion that, “still upon the success of some *friction saving apparatus*, must depend the great question whether rail-roads can compete with canals.”

Now, certainly it would have been reasonable, if known, to have adduced in support of this side of the question, *the fact* that such apparatus had actually been put in practice in our own country to an *important extent*, and carried hence acceptably even to England.

Process for Expelling Molasses and Sirop from Sugar. 55

Perhaps the committee's report may have had some influence on the writer, and the cautious opinions of scientific and practical men, may have led him to do injustice, not only to the inventor, but to his subject, so immensely interesting to this country. It is not the value of the wagon to the inventor, that is of any comparative moment, but the *value of the machine to the public*. Besides that, if it has such effects in the economy of rail-roads, it must agreeably influence their location, on the very principles explained in the Review, and that will, therefore, greatly extend their benefits, not only where canals cannot be made, but where they already exist, as *tributaries* to their business, branching into districts otherwise incapable of cheap communication with the great navigable line.

The committee, it seems to me, are now invited by a sentiment of patriotism, to look further into the subject referred to their judgment. And I hope they will, in the spring, even make an excursion to Baltimore, and see the wagons of Mr. Winans in operation, and compare their performance with a simple wagon, and then make a supplement to their report, of whatever appears to them to be the practical advantage thus far attained.

Practical Observations on the Pneumatic Process for Expelling Molasses and Sirop from Sugar.

(Concluded from page 409.)

Incidental remarks on the manufacture of Sugar from the Cane Juice into Raw Sugar, and the subsequent products therefrom by refining.

In the manufacture of raw sugar from the cane juice, an expeditious and economical mode of effecting a complete separation of the heterogeneous matter in union with the saccharine, and of producing the greatest weight of crystals of the best quality, is the desideratum of the planter. But does he obtain these advantages by any of the processes now in use in the colonies? Certainly not. Improvements have been introduced in the colonies to a very limited extent, in comparison with those which have, of late years, been adopted in the refining of sugar in Great Britain. It is natural to suppose, that the first and chief aim of science would be to produce a good raw material; that such will eventually be the case, there can be little doubt; as, at this moment, a great excitement is produced in the minds of the planters, by the attempted introduction into the colonies, of various schemes and processes for improving their sugar. This has been particularly the case by Mr. Innes introducing this identical pneumatic process, which aims, not only at the discharge of the *real molasses*, or uncrystallizable matter, but also at the separation of the other impurities still adhering to raw sugar, an operation of refining which, has hitherto been effected by the refiners of sugar in Great Britain.

If this last mentioned separation is deemed of so much importance

56 *Process for Expelling Molasses and Sirop from Sugar.*

in the refining of sugar; and if, as it is admitted, greater and finer products are obtained, when the separation is effected before clarification and evaporation, with the least possible action of heat, surely similar advantages are desirable in the manufacture and crystallization of the cane juice.

Reasoning by analogy, the writer has been induced to believe, that many of the evils complained of by the growers of sugars, especially those of inferior qualities, might be obviated, not merely by an improved method of evaporation and curing, but by arrangements prior thereto. And if the writer's hypothesis upon this point should prove correct, and should be coupled with the recent improvements in evaporation, very superior raw sugars, to those now sent from the colonies, might be made, with less expense and very little increase of attention.

The hypothesis submitted is—

1st. That the sugar cane has its component parts divided, in a greater or less proportion, according to the place or distance from its root or stole.

2nd. That the earthy and denser particles, (and probably the chief portion of the impurities,) blended or united with the saccharine, are nearest to the root; and, in consequence, the saccharine juice is in a purer state progressively, from the root to the top of the cane.

If these positions are correct, would it not be advisable to cut the lower joints from the cane before it is taken to the mill, to separate the finer portions from the grosser ones, and separately to grind and manufacture their juices? The clarification and evaporation to the consistence required for granulation, would, in the ordinary way of operating, be facilitated, and yield products proportionably better. We know, that the finest fruit is plucked from the extreme bough of a tree; and that which is nearest to the root is more crude, although equally exposed to the influence of the sun's rays. Separation and selection of qualities is found to be essential in the making of wine, cider, and other vegetable productions; why then may not the same mode of practice apply to the cane juice? If it is found beneficial to separate the part of the cane next to the top, because the matter therein is less ripe than the other parts, surely, by a parallel reasoning, the bottom may contain other matter equally, or perhaps more injurious to the subsequent operations on the juice for the products obtained therefrom.

Under all circumstances, whether the foregoing surmises be correct or not, it must be admitted, that separation of the adventitious substances, intimately mixed and combined with the cane juice, is the first point to be obtained; and secondly, that such separation is best effected with the least possible action of heat, which, in proportion to its intensity and duration, carbonizes and coats the crystals of sugar.

The subsequent separation of this coating from the crystal is, at present, best effected by the pneumatic process; the utility of which in the colonies, for this purpose, would decrease as the improvements in growth, clarification, and evaporation, increased; and, eventually,

the pneumatic process might only be necessary to accelerate and complete the curing or drainage of the real molasses, or uncrystallizable part of the cane juice. Such drainage only, whether effected by this process or by any other, ought to be permitted by the legislature, for reasons before advanced.

In treating upon the refining of raw sugar, it is intended to select those systems which, by practice and analogy, bear upon the subjects under review, instead of attempting to discuss all the varieties existing, and almost daily starting into birth.

Every refiner, either from habit, prejudice, or economy of capital, adopts that system which he thinks best and most suitable to his trade. The opinions and modes of working are almost as numerous as the refineries worked: in some, clarification by blood, with or without a previous separation of the molasses, or colouring matter, is adopted, and evaporation effected by fire pans. Some use charcoal in the clarification, others chemical compounds; some clay the goods; others use magma, or sirop, in lieu thereof; some clarify and evaporate by steam heat, instead of fire, but the most opulent of the refiners have adopted the improvements made by the late honourable Edward Charles Howard, and their products possess a more brilliant appearance, and must rank as superior to those obtained by any of the former methods, with the exception of Mr. Kneller's,* which yields equally brilliant products.

The desiderata of the refiner and planter may be classed as follows:—

- 1st. The best separation of adventitious substances.
- 2nd. The separation, clarification, and evaporation, at a degree of heat not affecting the sugar.
- 3d. The greatest weight of crystals of good colour and brilliant appearance.
- 4th. The least quantity of molasses or treacle.
- 5th. The shortest period of manufacturing the products.
- 6th. The most economical mode of working.

The two first points may be considered as axioms in the art of manufacturing sugar; and, if adhered to, will effectuate the remaining objects; and their practice ought to be adopted, primarily in the colonies, where they would be of greater value than in this country.

Incidental remarks have been made as to the adoption, in the colonies, of a mode of separating impurities combined with cane juice, previously to its being submitted to the action of heat; and the pneumatic process has been descanted upon to prove, that its use would effect the separation of those impurities which still adhere to the sugar after it has been manufactured. The planter is interested in both operations, and especially so in consequence of the immense loss by drainage, and the permission which government, at present grant, to import sugar divested of a part of the impurities and the colouring matter, at the duty payable upon raw sugar, which has not undergone the process of separation; but the refiner's in-

* See page 163, of our last volume.

terest is more immediately confined to the working of raw sugar. Such as it now is, necessity compels him to make the separation therefrom of the impurities and the colouring matter, and this he best accomplishes by a low degree of heat applied throughout his manipulations.

Experience has demonstrated to the scientific refiner, that the admixture of the colouring matter *adhering* to the crystals of raw sugar, is disadvantageous to the refined products, and must be detached therefrom by the process of claying or siroping. The abstraction of the colouring substance, as a primary procedure, has been effected, both by mechanical and chemical processes, none of which have, as yet, been found equally efficacious with the pneumatic process; but with all its advantages, and like the other methods of pressing, claying, or melting, a portion of the finer part of each crystal is dissolved and mixed with the discharged or expelled colouring matter; and, however judicious the operations may be, to separate the crystallizable parts from this colouring matter, by subsequent and repeated operations, still some portion of the crystals remain in the molasses, or treacle, and are therein deposited by natural causes.

In any way, therefore, abstraction of the impurities and colouring matter, previous to clarification and evaporation, must be a positive benefit; because, by the subsequent application of heat, at the temperature required for those purposes, there is an increased tendency to carbonization in proportion to the increased degree of heat applied, its duration and repetition, which likewise operates in an increasing ratio, according to the decrease in quality of the sugar or sirop submitted to its action. The purity of the medium, or solution of sugar, also contributes materially to the abundance and beauty of the crystals.

These positions are exemplified by refining lumps into double loaves: the lumps are refined sugar, and contain a **very** inconsiderable portion of colouring matter; but it is necessary to separate that small portion, in order to obtain double loaves. Too much heat is applied to melt, clarify, and evaporate, in this second process; the crystals produced are very fine and white, but the residue is treacle; it must, therefore, be evident, that a high temperature, whenever applied to sugar, produces treacle, which invariably is combined with colouring matter; but still the medium in which the fine crystals are formed, is more pure than a solution of sugar not previously refined; thus heat engenders carbon.

In a previous part of this work, statements have been made as to the relative value of raw, pneumatic, and ordinary lump sugars, when used for refining: the advantages of separating the molasses or colouring substance from raw sugar, previously to refining it into loaves and lumps; and also the disadvantageous action of heat upon saccharine solutions, varying according to the degree of heat applied, its duration and repetition, and the quantity of colouring substance contained in them. It may be asked, can such statements and reasonings be substantiated by practice? Investigation is, there-

fore, necessary to ascertain whether such statements and reasonings are founded upon facts. It will be readily admitted, by those gentlemen who are conversant with the principles of refining, that such is the case; but to those who have not a knowledge of the art, it may be needful to prove more clearly, that the positions advanced are correct, by stating—

1st. That

112 lbs. of raw sugar, as imported, yield, by the old system of refining, by the use of a fire-pan, at a mean proof of 240° of Fahrenheit's thermometer,

28 lbs. of treacle.

2ndly. That

112 lbs. of raw sugar, in the same state, yield, by the improved system, by the use of vacuum-pan, at the proof of 155° , (afterwards raised, in the granulating vessel, to 180° .)

20 lbs. of treacle.

3dly. That

112 lbs. of raw sugar, (first partially cleared of the molasses by being made into meltings, and evaporated in the precise manner last mentioned,) yield

14 lbs. of treacle.

4thly. That

112 lbs. of raw sugar, operated upon or refined by the pneumatic process, to produce white crystals, of the quality of ordinary lumps, and the extracted sirops therefrom, evaporated at 245° of heat, will yield only

$12\frac{1}{2}$ lbs. of treacle or sirop.

By these comparisons it appears, that by the first method, about 28 lbs. of treacle are produced, when the molasses and colouring substance in union with the sugar, are operated upon by 240° of heat.

2nd method, when in the same state, and at 180° ,

20 lbs. of treacle.

3d method, a partial separation of the molasses, &c. having been effected by meltings, and the same heat of 180° applied,

14 lbs. of treacle.

And, by the fourth method, evaporating the extracted sirop and the colouring matter in a more concentrated state, even at 245° of heat, only

$12\frac{1}{2}$ lbs. of treacle or sirop.

Thus showing that the degree of heat, and the repetition thereof, engenders an additional quantity of molasses, &c. to that which the raw sugar contained when imported; and that a lesser quantity is engendered when a separation of the molasses, &c. has been effected previously to the action of heat; it may, therefore, be presumed, that raw sugar contains even less than $12\frac{1}{2}$ lbs. per cwt. of treacle, the *least* quantity obtained, at the highest degree of heat employed for one evaporation.

As such, the planter and refiners could not fail to obtain considerable advantages, if they adopted a better mode of evaporating

60 *Process for Expelling Molasses and Sirop from Sugar.*

the cane juice and solutions of sugar to that which is now generally employed.

Charcoal is injurious, because it destroys or weakens the crystallizing properties of sugar to a certain extent; it must, therefore, like lime, be classed as a disadvantageous agent in refining.

The French refiners use from ten to fifteen pounds of animal charcoal to each 100 pounds of sugar; their products possess colour, but are deficient in strength. Some compensation is obtained, by their evaporating to a lower proof than is usual in this country, in open fire-pans, and upon a less quantity for each skipping.

In conclusion, as to the best method of obtaining and applying heat to all purposes connected with the manufacture or refining of sugar, and with due deference to the opinions of those persons who have had a longer and more extensive experience than the writer, he submits that steam heat is to be preferred, and that simplicity in the combinations of the apparatus for that purpose is most desirable, and particularly so for the colonies.

Of all the varied schemes which have been presented to the refiners as improvements for evaporation, that of the late honourable Edward Charles Howard is the most celebrated: by his domed, or vacuum pan, as it is termed, solutions of sugar are evaporated to a proper consistence or proof, at about eighty degrees of heat below that which can be obtained in the open pans now in general use. In the domed pan a vacuum is not formed, but the evaporation of the aqueous particles is accelerated by condensation, in the absence of the atmosphere. After the discharge of the skipping, it is necessary to raise the temperature for granulation to about 185 degrees, which is effected by steam, under the receiving or granulating vessel.

The whole of Mr. Howard's arrangements are highly scientific; but his evaporating apparatus, although it has been much improved, and is less expensive than formerly, yet wants simplicity to render it generally useful, particularly in the colonies.

Many other plans have been devised as substitutes for this scientific and valuable improvement in evaporation; but none accomplishes the object so completely as that of Mr. William Godfrey Kneller, for which a patent has been recently granted.*

By this method solutions of sugar or sirops can be evaporated to proof in an open pan, by steam or other heat, at temperatures varying from 140 to 170 degrees of Fahrenheit's thermometer, consequently at from sixty to ninety degrees below the proof hitherto obtained in an open pan, and about the degree of heat required for granulation.

The apparatus attached is of trivial value, and the auxiliary employed so highly beneficial to the strength or crystallization of the sugar, that such a combination of advantages seems to be best suited to the purposes intended, but it remains to be proved, whether the refiners of this country, and the planters, will adopt this other pneumatic system.

* See page 163, of our last volume.