THE

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OF THE HAWAIIAN ISLANDS.

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The latest quotation of sugar, given Dec. 15, was 6⅝ cts. for 96 Cuban test, with every prospect of the market remaining firm at or about this figure for some months.

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The cargo of sugar imported from Java by the American Refinery at San Francisco, which was seized for undervaluation, has been released and surrendered to the refinery, which has paid the additional duty demanded by the government.

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The steamship Takasago Maru brings another shipload of Japanese immigrants, 940 men and 203 women, who have arrived after a quick passage of eleven days and eighteen hours, with no case of sickness of any kind. So far as we can learn, those who came in November have given satisfaction to their employers, and promise to be the best men on the plantations, being used to hard work in the farming districts of Japan. The arrival of so many women is also a good feature of this immigration.

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"Coffee Cultivation" is the topic of an interesting article from Mr. William Kinney, of Honomu, Hawaii, which will attract attention. Mr. K. has had experience as a coffee planter both on Kauai and Hawaii, and is probably as well qualified as any man on the islands to make a proposition such as he has done in his article, on page 545. It is no credit to our islands that, with the capital that is now lying idle, no effort is made to commence this industry on a scale which should insure success. Coffee will do well in Hilo and Kau districts, where so far the blight is unknown, or at least, does no perceptible injury.

We call attention to the article on fertilizers, on page 537, by Mr. Lydgate. The time is coming when most of our cane lands will require some kind of fertilizers. Fields that have been cropped for twenty or thirty years, with little or no attention paid to the restoring of the substances which have been taken from them, cannot be expected to yield heavy crops. The great question is to determine what is the best fertilizer to use. If four or five tons per acre can be secured with the use of suitable manures, where only two or three tons can be had without them, as has been demonstrated the past two or three years—this fact is sufficient to prove the advantage of providing them. Mr. Lydgate discusses the subject from a practical standpoint, and furnishes the results of his own experience.

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The Mongooses which were recently taken from these islands to San Francisco, for the purpose of exterminating the rats in that city, have been drowned by order of the Collector of that port. This was probably the best solution of what might have been a very troublesome affair, as there is no question that these animals are quite as fond of poultry as of rats and mice. At the same time, it is equally certain that they have been the means of saving to the planters in the Hilo district alone, more than a hundred thousand dollars worth of sugar, since their introduction three years since. A considerable part of the increase of sugar in that district is justly credited to the extermination of the rats by the mongooses. It is doubtless true that when rats cannot be obtained by them, they will feed on poultry; and for this reason, we trust they will not be domesticated in Honolulu or San Francisco.

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Among our exchanges there is no more welcome visitor than the Louisiana Sugar Planter and Manufacturer, which is filled with information for all engaged in the cultivation and manufacture of sugar. We frequently find articles in it which we should be glad to copy in full, but are compelled to curtail or omit, for lack of space. This publication has become the organ of the Louisiana Planters' Association, of which the Hon. John Dymond is President. In a recent letter to Col. Spalding, Mr. D. writes: "We are trying to make this paper a success here. We have never had a competent journal before, in the English language, and if those interested will now do what they can to support this journal it will be a permanent thing. We have most of the best-informed sugar men of the State writing for it, and should like you to give us a lift out your way as far as you can. We ought to circulate a thousand copies in the Islands, and want to get the paper into the hands of every planter, overseer, sugar maker and engineer. We are now sending sample copies, from a list of names that appeared recently in the *Sugar Cane.*"

We cheerfully commend the above paper to our patrons, and advise all who wish it to send direct to the publishers of that journal in New Orleans, a foreign postal order for $4.00, made payable to them.

CLOSE OF ANOTHER VOLUME.

The present number ends the seventh volume of the PLANTERS' MONTHLY, which covers 580 pages including the title and index, which are sent with this number on a fly sheet. A glance over the table of contents will show a large variety of topics, embracing almost every branch of agriculture and horticulture, as well as the sugar interest, to which it is primarily devoted. It forms a book, when bound, well worth preservation; and should any of our subscribers wish their sets for one or more years bound, we will attend to such orders at any time. Missing numbers of the past two or three years can be supplied on application, and also a few copies of bound volumes of 1887 and 1888.

THE WATSONVILLE BEET SUGAR ENTERPRISE.

We find the following paragraph relative to the above, in the California correspondence of Willett & Hamlen's circular, which contains some items of interest, that have not before been published here:

"The new beet sugar factory of Claus Spreckels at Watsonville, Cal., has been in operation for just a month. Work is being conducted day and night, and the result is in every way proving satisfactory. The saccharine contents of the beets range from eighteen to twenty-four per cent, and the farmers receive from $6 to $9 per ton for their beets. The sugar polarizes at 97 deg. and, up to date, almost 1,000 tons of the raw product have been received at the California refinery in San Francisco, The capacity of the factory will be doubled for the next season, and it is probable that two crops of beets may be grown during the year, but not off the same land. The first crop would be picked about the end of June, and the second one three months later, thus keeping the factory in full operation for six months of the year. The yield per acre and the saccharine contents of the beets have been proved, from an area of 2,400 acres, to be higher than in Germany. The machinery in use is the best obtainable in the world, and several new economic methods have already been adopted which tend to reduce the cost of manufacture. It may be taken as an assured fact that beet sugar culture in California is even a greater success than was ever anticipated, and that, within very few years, sufficient beet sugar will be manufactured in California alone to supply the whole requirements of the Pacific coast trade. The Hawaiian sugar season has commenced earlier than usual, because planters are anxious to secure the benefit of the high prices that usually exist at the close of the year. Small shipments of the new sugar have already come to hand, and full cargoes may be looked for within the next fortnight. A new feature in the San Francisco sugar market will be the arrival of three cargoes now on the way from Java. These are for the American Refinery, and were expected to arrive before the new Hawaiian crop. One sailing vessel has been delayed at Hongkong for repairs and one cargo is coming by steamer, but all will arrive later than was intended."

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PROGRESS OF THE SUGAR INDUSTRY IN THE HAWAIIAN ISLANDS.

No one who is familiar with the history of the sugar industry here, can have failed to note the very rapid progress that has been made during the past ten or twelve years. Up to about 1875 or 6, some twelve or thirteen years ago, the old style of making sugar in open pan and endless manipulation was the rule, while now there is probably not a sugar-house that is not supplied with double or triple effect, and many of them are in addition furnished with all the modern improvements, designed to simplify, hasten and perfect its manufacture. The result is that the product has been more than doubled from the same amount of cane ground.

So too in the field, by the introduction of the best variety of cane, which has proved admirably adapted to our soil and climate—the Lahaina cane; and by improved methods of plowing, planting, irrigating and fertilizing, the average yield has been increased from about one ton to over three tons per acre, while instances are common of fields turning out five, six and more tons per acre. Indeed, some of our more progressive planters are not satisfied unless the field and mill produce an average of ten thousand pounds of sugar to the acre of plant cane. One planter maintains that his field of eighty-six acres produced an average of 17,500 pounds per acre. If this has been done in one instance by the application of the most approved mode of cultivation and the most perfect machinery known, it can be and will be done by others. Indeed, if as great progress is made during the next ten years, as has been accomplished in the past, it is not impossible that some of our lands and mills may yet reach a product of 20,000 pounds of sugar per acre.

The question of diffusion is still an open one, but we confidently believe that some method will yet be found to reduce the increased cost of fuel, by which the trash will supply all the fuel that is required. It may take many experiments and much close thinking, but "where there's a will there's a way," and the result may be that, before the close of this century, all of our sugar will be made by the diffusion process, thereby extracting all the sugar from the cane, as all the sugar is taken from the beet.

We have been led to these remarks showing the unexampled results attending the efforts of our planters, to illustrate what may be done when such efforts are combined with an intelligent application of the best means and methods known to insure success. This can only be secured by becoming conversant with what is being done in the same industry in other countries, by frequent interchange of thoughts and methods in this and other periodicals, and by reading the best periodicals devoted to sugar published abroad. And in this connection we would call special attention to Mr. Young's article describing his superheater, which may prove to be one of the links in the solution of this problem.

In a recent number of the Louisiana *Sugar Bowl*, we find an excellent article on the progress of the sugar industry in Louisiana, written by W. J. Thompson, from which we cull two or three paragraphs applicable to this subject:

"I doubt if, since 1879, any industrial establishment has exceeded the rapidity of our improvement, either in America or abroad. That year we made ninety-three pounds commercial sugar from a ton of 2,000 pounds raw material, which was quite equal to the average of the industry, and some ten pounds advance on our own work of the year previous! The season just passed we reached a full and honest 177 pounds of finished product from equal amounts of cane. That is, since 1878 we have doubled the yield from the raw material, and while increasing the net land under the plow by less than 100 per cent, have increased the sugar product from this nearly 700 per cent. Gov. Warmoth has done yet better, while all may hope to do at least as well.

"Our progress indicates the success of our efforts. And all this, both at Gov. Warmoth's and here, without the diffusion process, by which alone I anticipate, within three or four years, if not previously slaughtered by Congress, another gain of thirty-five pounds commercial sugar per short ton of cane.

"We have organized a strong association of planters to push, not our political, but primarily our industrial interests. This is now seven or eight years old and shows greater vitality and usefulness at each monthly meeting. Its papers are, not infrequently, reproduced, after translation by the technical press of Germany, France and the Spanish colonies. We have established an agricultural and mechanical experiment station of our own, which is doing more than, and as faithful work as any of its kind in America. We have now just established a technical journal to further assist in disseminating such knowledge as will continue to advance us towards perpetuity."

YOUNG'S SUPERHEATER APPARATUS.

EDITOR PLANTERS' MONTHLY:

Please allow me space to bring before your subscribers a mention of what promises to be a most important improvement in the manufacture of sugar, viz: A method whereby the waste heat of the gases escaping from our chimneys may be harnessed and made to perform much of the work in evaporating the cane juice and cooking the sugar.

It is a well known fact that the gases passing off through the chimneys of our steam boilers, range in temperature from 600 deg. to 750 deg. F. at the point where they leave the heating surface of the boilers, and the fact that the contents of the vacuum cleaner, multiple effect and vacuum pan boil at temperatures ranging from 140 deg. to 212 deg., is equally well known. And this shows a great margin of heat wasted.

The knowledge of this loss of heat and the increasing need of more fuel to enable us to carry out maceration to a point that will be profitable, as well as the probability of the introduction of the diffusion process, has been the means of leading me to seek for better results from the fuel produced by the cane itself.

I have therefore invented and constructed, at Waiakea Mill, means for utilizing the greater part of the waste heat constantly being carried off at a great velocity through our smokestacks.

The method is a simple one and the first step is to collect the exhausts from all the live steam users and convey them through a pipe to a tubular drum or drums or any other vessel of suitable shape, and having ample and suitable heating surface, set at the end of the steam boilers where the gases start on their way to the chimney, so that said gases may pass through the tubes, while the spent steam or vapor is circulated amongst the tubes. As the temperature of the steam around the tubes is less than say 220 deg., and the temperature of the gases passing through the tubes is over say 600 deg., it will be easily seen that the heat of the gases, which could not readily be transmitted through the heating surface of a boiler containing water and steam of a high temperature and pressure, will be rapidly absorbed by the steam of low pressure and temperature constantly rushing through said superheaters and constantly in contact with the walls of the tubes through which the hot gases are as constantly passing; by this means the gases are robbed of about 200 deg. of their temperature, or if water is sprayed into the superheaters, as will be the case in some instances, even 300 deg. of heat may be taken from the gases and imparted to said spent steam.

The result at Waiakea, from the device in actual practice, without the spray of hot water is, that the revived spent steam, still at atmospheric pressure or less, after passing from the superheaters and through eighty feet of ten-inch cast-iron pipe, has a temperature of from 375 deg. to 430 deg., and this includes every pound of steam that has been used throughout the works as live steam. It should also be noticed, that the mill engine which uses most of the live steam, is located over 300 feet from the superheaters, and that the superheated steam has also to travel over 100 feet from superheaters to where it is used; and yet said superheated spent steam is capable of running vacuum cleaner, double effect and vacuum pan, besides doing most of the work in the clarifiers—in fact, when we get a partial vacuum on hot well so as to drain the clarifier drums, the whole of the clarifier work will be done by the superheated spent steam, direct steam being used for engines and pumps only.

I am well aware that some plantations do not burn any fuel other than trash at present; but at Waiakea, since the superheaters have been put in, enough hot water can be put on the trash before it reaches the second crushing to dilute the second mill juice to three degrees Beaume or less, mixed juice, cold, standing not more than seven degrees Beaume, and yet all the trash is not needed for fuel.

There is not the slightest doubt in my mind of the chips in the diffusion process being ample fuel for the whole of the work, when this method of utilizing the waste heat is taken advantage of.

This invention is not yet caried out in full at Waiakea, however, or the results would be more surprising still. Part of the method is to take the vapor rising from first cell of multiple effect and pass it through a second superheater through which the gases of reduced temperature pass and impart valuable heat to said vapor before it returns to the drum of second cell of multiple effect, and the same thing may be done with the vapor rising from second cell also, if desired.

There will be a good draught in the chimney, if of ample size and not less than 100 feet high, so long as the gases are not reduced below 250 deg. temperature. But should it be found advisable to use the waste heat still beyond that point, a forced draught will be used, in which case twenty or thirty feet of chimney will do. Yours very truly,

Honolulu, Dec., 1888. ALEX. YOUNG.

DARKENED SUGARS.

In connection with the darkened sugars from Java, which were lately seized by the customs authorities in San Francisco, on the ground of their having been colored by some foreign substance, which may or may not have been the case, the following extract from the New Orleans *City Item*, written by Santiago Dod, possesses interest:

Editor of the Item:—In the article upon Mr. Stubbs' operations at Kenner, you have fallen into the common error of supposing that the dark colors of sugars made abroad for the American markets, is obtained by leaving the impurities in the juice. A few words will suffice to show that the lowering of the "standard" of these products cannot be attained by any such perversion of the process of manufacture.

Produce them as you may, all sugar crystals are virtually white, and consequently in dark sugars, the color is practically due to the thin film of molasses which envelopes the grains. In order then to augment the color, darkening the molasses and increasing the thickness of the coating, are the only requisites. This is done very simply by cooking the masse cuites as much as possible—using an excess of lime in the juice, which, uniting with a portion of the saccharine matter, blackens the syrup, and being careful not to leave the sugar too long in the centrifugals.

A diametrically opposite course would be the only way by which, in the ordinary methods of manufacture, the impurities could be retained by the juice—or, in other words by using too little lime and avoid coagulation thereby. Sugar made upon this system would, besides a very poor yield, give a low polarization and a soft grain which, by absorption of moisture from the atmosphere, would deliquesce before reaching the refiner, while the color would be little affected, or if at all, in many cases be made too light yellow to escape the high duties at the Custom House. If these impose the necessity of making dark sugars, they do not prevent the refiner insisting upon a hard grain and a high polarization—upon a class of sugars in fact, often superior in these respects to that he himself gives the consumer.

To state the facts concisely, if the refined product were mixed with the molasses yielded by the imported, and then passed through a centrifugal, it would become just as dark and often inferior in other properties. Furthermore, if foreign producers were obliged to leave the impurities in the juice in order to avoid the higher impost, they would have, as a rule, been ruined long ago by the low prices their sugars would have brought.

REPORT OF COMMITTEE ON FERTILIZERS.

To the President of the Planters' Labor and Supply Company:

There is probably, in the Hawaiian sugar business, no question of more vital and growing importance than that of fertilizers.

Already many estates have reached the condition from which they say, "we must fertilize if we would get a crop," and very many others contemplate this condition at no distant stage, while for all, save perhaps, a few favored places where nature redeems the wear by special means, the use of fertilizers is merely a question of time.

The requirements of a successful fertilizer for us are: 1st, effectiveness, it must, of course, make the cane grow. 2d, economy, it must make the cane grow profitably, and perhaps, 3d, is portability, it must be cheaply and easily handled. There are certain undoubtedly good fertilizers which are out of the question for many plantations because of their bulk.

Just what this ideal fertilizer is, and how it should be applied we hardly know as yet, but a good many of us are experimenting, and hope, before long, to arrive at some definite and satisfactory conclusion. In the meantime, probably, we cannot do better than make a brief survey of the more probable applicants for public favor, and draw such conclusions as our limited knowledge and experience may suggest.

PHOSPHATIC FERTILIZERS.

Probably the most commonly used of all prepared fertilizers is bone-meal in some form. In this country it was the first to secure any general attention, and is yet largely used, with, it is stated, very good results. In its simple form, however, that is, bone more or less finely ground, I am convinced that it is practically useless for us, for the reason that the particles of bone do not readily decompose, but lie inert in the soil for years, long after the crop, which they were to benefit, has been grown and harvested. I am satisfied from my own experience, as well as that of others, that such bone-meal is of very little more value for any immediate crop than so much ground glass or iron borings. The phosphoric acid that the plant needs is on the land, but so securely locked up in the hard particles of bone that it is not available in time to be of any benefit to the cane. For this reason bone-meal has fallen into general disfavor throughout the world, and is very little used by intelligent farmers. The difficulty has been obviated to a great extent by grinding the bone to an impalpable powder, so fine that it could be readily assimilated by the plant. This so-called floated bone, however, proved to be very expensive, difficult to keep from putrefaction and very difficult to apply, it being a rare thing to get a day still enough to prevent its dissipation in the air. For these reasons, I think, we should not use simple bone-meal.

The bone should be softened so that the phosphoric acid will be in a more soluble condition, and thus rendered available for plant use. This is generally done by treating the bone-meal with sulphuric acid, which reduces the bone to a crumbling, soluble state, from which phosphoric acid is immediately available. This super-phosphate is undoubtedly one of the most valuable of fertilizers, proving its worth under varying conditions the world over, and I fancy that much, if not all the credit which has been given in this country to bone-meal, is really due to bone super-phosphate, people not distinguishing properly between the two articles.

Other sources of phosphoric acid, and consequently of super-phosphate, are the so-called phosphatic guanos of the South Sea Islands—Baker's, Howland's, Fanning's, etc.—and the phosphate rocks of various countries. The South Sea guanos, or at least those from Baker's and Howland's Islands, are of an excellent quality as phosphates, and merit our attention as a cheap and valuable fertilizer close at hand.

The phosphate rock from South Carolina and Navassa in the West Indies, is of much inferior value, and for this reason as well as distance of transportation, scarcely merit our attention. The phosphatic guanos and rocks, ground and treated with sulphuric acid in the same way as bone-meal, give a super-phosphate similar, and equal in value, to that made from bone. The same may be said of the raw phosphatic guanos that is said of raw bone-meal, they are of comparatively little value because they are comparatively insoluble.

Bone-meal and these guanos may also be utilized to advantage by composting them with stable manure, filter-press mud, mill refuse, waste trash, etc., so that the bone or guano shall be disintegrated and thoroughly mixed. This, of course, requires considerable time, but will probably yield a valuable fertilizer at a small cost, and will, at any rate, be a much wiser way of utilizing the bone-meal or guano than applying it to the land in a raw state.

NITRATES.

The principal available sources of nitrogen for plant growth are nitrate of soda, nitrate of potash and sulphate of ammonia, which yield from 15 per cent to 20 per cent of nitrogen. A decided preference is given to the nitrates over sulphate of ammonia, and in some parts of the world they are freely used, mostly in conjunction with some other fertilizer; and only in this way, I fancy, should they be used by us. So far as I know, they have never been tried to any extent in this country, so that we can form very little idea of their value. I am experimenting with nitrate of soda, but without any very definite results as yet. Nitrate of potash would probably be better, since potash is more desirable than soda. Sulphate of ammonia I have been unable to get. It is a product of the gas works, and seems of late to have been diverted to some other use. Nitrate of soda is worth about $70 a ton, delivered on the plantation. Sulphate of ammonia probably about $120.

Under the head of nitrates may very properly be classed Peruvian guano, one of the most complex and valuable of all fertilizers. Besides nitrogen, its most important element, it contains considerable quantities of phosphoric acid, lime, potash, soda and organic matters; and while nitrogen may be the most important element, the others have their value. For this reason Peruvian guano is generally considered a sure and safe fertilizer for almost any conditions, at the same time it is a very concentrated fertilizer, being efficiently worth sixty-five or seventy times its weight of good stable manure, and therefore economical in the matter of transportation and application.

Of course, no one will confound Peruvian guano with the phosphatic guanos of the South Seas, which are of much inferior value, and as different in character and appearance as bone-meal and stable manure.

It is now no longer easy, or perhaps possible, to obtain the genuine first quality of Peruvian guano, owing to the exhaustion of the supply; furthermore, it is expensive. But if half is true that is claimed for it, it should at least be worth a thorough trial. So far as I know it has not been used on the Islands, although Ohlendorff's dissolved Peruvian guano, of which the original article is the base, is being tried with hopeful results. Peruvian guano, such as is obtainable, will probably cost about $75 or $80 a ton.

In Europe and Eastern America fish-scrap can be bought at from $10 to $15 a ton, and at that figure proves an efficient and economical fertilizer. It has been used in this country, at Lahaina, with good results, and a similar article, viz: shrimp hulls, is favorably reported on from Pepeekeo Plantation. It is very probable that further experience may demonstrate the value and fitness of fertilizers of this class for us.

Oil-cake of various kinds contains a very considerable quantity of nitrogen, as well as some potash and phosphoric acid, but as a rule this material is worth so much more as a fodder, that it is poor economy to use it as a fertilizer. This condition, however, does not exist in the case of the *Kukui* nut, or the *Pandanus* nut, and possibly, where available in quantity, they might prove to be a cheap and valuable fertilizer. Of course, they would need to be thoroughly ground.

POTASSIC FERTILIZERS.

One of the most important elements of plant food is potash, and a pretty general experience in this country has developed the common opinion that it is one of the most essential elements to be supplied to our soils for the culture of cane. Potash for this purpose is available principally in three forms, viz: wood ashes, Stassfurt salts and commercial "potash."

Wood ashes have long been used in all agricultural countries, and experience is unanimously in their favor in this country as well as elsewhere. They contain, on an average, 8 per cent or 10 per cent of potash, as well as small quantities of phosphoric acid, magnesia and carbonate of lime, and should be worth from $15 to $20 a ton. At this rate probably they would be of more value than any other form of potash. Of course, this applies only to fresh or unleached ashes. Leached ashes are very much inferior, though often used. Coal ashes have little or no value. The Stassfurt salts come from a mine in Germany, and consist mainly of forms of chloride and sulphate of potash, in varying degrees of impurity, combined with each other and with magnesium. The common forms are characteristically chlorides of potash, and as such are probably objectionable for sugar cane—whatever value they may have for other plants—for the same reason that salt spray or brackish water is injurious to cane. The chlorine prevents crystalization and makes molasses. This Stassfurt salt does not, as a rule, contain more than half its weight of real potash, and I very much doubt if what we get contains that amount.

Another form of these Stassfurt salts is the so-called "Kainit," which purports to be a sulphate instead of a chloride of potash, and therefore free from the objection in regard to crystalization, but in point of fact it is said to be a combination of both forms of potash with other impurities, so that it is not much better than the ordinary chloride.

I believe it is the result of general experience that Stassfurt salts do not repay their cost, even in Europe, where they are close at hand, so that it is probable that at this distance from the mine, and with the special objection in regard to crystalization, it will not pay us to use them extensively. It is important that those who are buying potassic fertilizers should know what they are buying, and not be misled into supposing that

Stassfurt salts and potash are equivalent. I believe the Stassfurt salts are largely used in the manufacture of fertilizers claiming a large percentage of potash, and purchased on the strength of this claim.

Concentrated lye or crude potash is probably, on the whole, the best thing for us to use for this purpose. The question of transportation is such an important one for us, that we naturally seek for concentrated forms in all fertilizers, even though they be more expensive. This crude potash is in an extremely concentrated form, and is so powerful that it is corrosive, and must be handled with care. Of course, it cannot be applied in a raw state to the cane; nor is it desirable, even if possible, for it would soon leach out of the soil with surface drainage and be lost. It is best used with some other fertilizer, to give it body and duration. Probably the best combination is with bone-meal or phosphatic guano, in which case, in addition to its direct value as a fertilizer, it serves the further purpose of "cutting" the bone-meal and rendering it soluble. For this purpose the bone-meal should be put into a tight tank, and a strong solution of the potash poured over it, and the whole allowed to stand for two or three weeks, or until the hard particles of bone are thoroughly reduced to a soft, pulpy state. Such a fertilizer will cost $50 or $60 a ton with bone-meal at $28 and potash at $140. This, I believe, both in theory and practice, is one of the most valuable fertilizers we have tried. Theoretically it should have all the advantage of the bone-meal super-phosphate in addition to the admitted value of the potash. Experience elsewhere is strongly in favor of this combination, and a limited experience on my own part indicates it as probably the best chemical fertilizer, for the money, that we have tried.

Similar combinations may be made of potash with manure, filter-press mud, or other material which shall absorb and hold the liquid potash.

The evidence in regard to lime is very contradictory, the world over, as well as here in our midst. In old farming countries, for instance, some farmers use lime in large quantities, while others will not allow it to be put on the land. Here, some few plantations consider it very valuable, while others in the same region condemn it as worthless. In view of this questionable value, the expensiveness of the materials, and the prodigal manner in which it should be applied—tons to the acre—we had better do little more than experiment with it for the present.

As the result of two or three years' experimenting, it seems to me nothing is so uniformly certain of giving good results as stable manure, filter-press mud and ashes. My motto for the present is, "experiment with chemical imported fertilizers, but depend on manure and mill refuse." The trouble is, they are limited in supply and bulky in transportation. To undertake to manure 500 acres, and do it properly, means the exhaustion of the whole available supply of the country, and a herculean task of transportation and application; but it will give you a good crop, which is more than you can say for *certain* of almost any other fertilizer.

Plantations having tramways, or other cheap methods of transportation into the fields, might do something to advantage in composting, especially if they have spare trash which might be composted with filter-press mud, press-washings, waste molasses, etc., and much be saved that is now lost.

In regard to the rate of application of fertilizers, of course, very much will depend on the degree of concentration and chemical value as plant food, but I fancy, that as a rule, we err on the side of too sparing an application. I doubt very much whether there is anything, which applied at the rate of $10 or $15 to the acre, will give us any very valuable results. Even those fertilizers, which are assuredly good, will give us very little satisfaction if applied with a stinting hand in small quantities, and I think we must make up our minds to spend $50 or $60 an acre, instead of $10 or $15, if we would secure lucrative results.

One word in conclusion as to the purchase of fertilizers. Heretofore we have bought singly, in small quantities, and I may say blindly, in accordance with the representation of some "agent," perhaps. That we have, in all cases, got what we paid for is altogether unlikely. Fertilizers are subject to the grossest fraud, and very often the price bears no relation whatever to the value of the article, and its pretended analysis none to its real composition. What we bought may have been first-class fertilizers, or it may have been worthless street sweepings. Consequently no fertilizer should be bought without a definite knowledge of its composition, or a chemical analysis. But such a chemical analysis is somewhat expensive, the individual planter, buying in small lots, may think it scarcely worth while, and buy on faith, trusting to looks, smell or common honesty—all uncertain factors in fertilizers. Now, what might be done in this country, and what is done elsewhere, is this: A committee of one or more persons, fairly familiar with the subject, might be appointed by the planters, and all those proposing to purchase fertilizers might send their orders to this committee, who would then make arrangements to fill these combined orders to the best advantage and according to reliable chemical analysis. In a short time this committee would be in a position to give valuable advice as to the kind of fertilizer most likely to give satisfaction, and would probably become a repository of information gathered from various sources, and available to all who cared to use it. At the same time, cheaper and purer and better fertilizers would be the result.

J. M. LYDGATE,
Chairman Committee on Fertilizers.

October 28th, 1888.

COFFEE CULTIVATION—A PROPOSITION FROM A COFFEE PLANTER.

EDITOR PLANTERS' MONTHLY:

SIR:—I had promised to write something definite about coffee-growing in Hilo for a gentleman who is trying to establish a syndicate for prosecuting this as well as sugar-cane and other tropical industries on a large scale. Some time previous I had also promised to write something on the same subject for the PLANTERS' MONTHLY, and after getting into the job to fulfil my promise to the gentlemen in question it occurred to me that I might "kill two birds with one stone." Hence this rather disjointed paper, but, although it may not cover very much of the main subject, it may, at least, add somewhat to the growing interest in coffee culture.

There has been a great deal written, and a considerable done in this group, as to growing coffee, but its history, so far, is but a history of failures. Witness the struggles of Bernard, Rhodes, Wondenburg, Wyllie and Titcombe—all of them in a swamp in Hanalei Valley, but a few feet above salt water—fitted for rice and some sorts of taro, and possibly even for edible bull-frogs, but unsuited for coffee (or even for silk worms, as one of the men tried to his heart's content), while within five miles of them was plenty of as good coffee-ground as ever lay out-doors.

Scores of other, but smaller, attempts could be named, but exactly the same number of failures must be recorded; and every one of them that I know of were failures for other reasons than the unfitness of this country for the growing of coffee.

I might give you a history of another of my own experiments —a three years' one in Kauai—and its failure; but, at present, I will keep it back, and, perhaps, some day polish it up a bit *a la Jules Verne*, and make a living peddling the book on passenger trains.

If you see fit to publish this and the coffee paper therewith, and not charge for it as an advertisement, you are welcome to do so.

COFFEE.

Between the years 1871 and 1884 I proved to my own satisfaction, as also to that of some fair judges from abroad, that the coffee-tree can be grown to full bearing, and, in every way a good tree, and at moderate cost, in this district of Hilo, Hawaii.

There is a belt of excellent coffee land running through this district a length of twenty odd miles, and a breadth of from one to three miles, at an altitude of from 1,000 to 3,000 feet above salt water—now in timber and undergrowth. There are spots, however, of this belt not well suited to coffee culture. My experiments in growing some eighty acres of coffee trees brought me to the following conclusions:

1. That only the undergrowth and the smaller forest trees should be removed, leaving at least half the ground partially shaded; and to this end the limbs and foliage of the larger forest trees should be kept thinned out. The coffee trees should be planted from 8 to 12 feet apart each way, according to difference in soil and other conditions; the spaces to be as nearly exact as practicable, but losing more or less land near clumps of heavy timber by not planting the same.

2. The ground should be kept thoroughly clean from grass and weeds by weeding at least once a month the first year, or till the primaries (the first and second pair) are about three feet long, and always afterwards as the ground becomes weedy. The trees should be topped at some eight to twelve feet high, and, at the same time, the lower primaries, or main limbs, removed, so that there shall be from three to four feet of trunk before coming to the first remaining primaries. This treatment must be followed by frequent "handling," *i.e.*, rubbing off with the thumb the new start that the tree will take from beneath some of the upper primaries; and, after a time, if this work be diligently followed, these growths called "gormandizers" will cease to spring out, thus confining the sap to the support of trunk primaries and secondaries, beyond which there should never be in the life-time of the tree any other growth than leaves and berries. Topping at lesser heights will do, and, in fact, will give larger and better crops; but, for ultimate convenience and profit, the greater heights are best here where the tree, in some instances, will spread so as to shade seventy or eighty square feet.

3. Trees planted ten feet by ten feet give about 430 to the acre, and these will bear a maiden crop, so-called, the third

year of about a pound to the tree, and increase to from four to six pounds at full bearing—say the sixth year; otherwise, from 1,800 to 2,400 lbs. to the acre.

A PROPOSITION.

Now, I will make the following offer: I will clear and prepare the ground, and plant the same with good nursery-grown plants, any breadth from fifty to five hundred acres, in any part of this coffee belt substantially as above described, and care for the same till the trees are three years old, deliver them in clean ground and in a healthy condition, topped and handled, at a price not to exceed one hundred and twenty dollars per acre—making my own preparatory roads, and furnishing my own employees with quarters and implements.

Lesser or greater distances apart, or whether topped higher or lower, shall be for you to say, for if you choose more trees to the acre for one to plant I will have less cultivation to do, because the closer plant will shade the ground sooner. I shall want one-half the price when the trees are one year old, one-quarter at two years, and the remaining quarter at three years, when they will be in bearing. At the time of first payment, if any of the plant is not up to contract, it shall be deducted. So at two years; but if the formerly-accepted part shall have failed between its first and second year, I am not to refund the first payment, but I will lose the second. And so with the third payment; I will forfeit the same to the extent of the bad trees, but I will not refund either of the back payments. In short, I take in stages part of the risk as to the growth to its bearing.

I reserve the right at the start in selecting ground to throw out spots indicated by the native growth and other signs that my experience has taught me to be unpromising.

I estimate that, taking almost any square of 100 acres throughout this belt, there will be two-thirds good land and one-third bad. Those spots, many of them, can be utilized as homesteads for laborers. Moreover, with some years' experimenting as to treatment, many spots might prove to be good coffee-ground.

The quality of Hilo coffee, when properly cured, compares well with any coffee known in general commerce. Some competent judges of coffee have pronounced it equal to the very best. It is held by some experienced growers that the tree left to its natural inclinations will last much longer than the dwarfed and cultivated one, and, in its life-time, will bear as much, and hence, perhaps, the reason why Kona coffee has acquired its reputation. This sort of coffee is, much of it, shaped like pearl barley, being a single scroll instead of dividing into two parts, and is, when sorted, what is known in commerce as peaberry, commanding always a higher price than that which is gathered from the well-cared-for tree of the same region. The tree is dwarfed and pruned in order that the blossoming and ripening may be uniform and in knots so that the gathering can be done profitably by hired labor. Picking peaberry by single berry is slow work, and will only do for a small proprietor.

I cannot say exactly what it will cost to keep the tree in good order after it comes to full bearing—not so near as I can to the picking. The gathering from good trees is at the rate of about two bushels of berries to the hand, or say 20 lbs. dried coffee; the pruning each year is about as much work as gathering the crop.

The pruning consists mainly of removing each pair of secondaries soon after the berries are gathered therefrom (the sooner the better), leaving the new pair already a year old to make bearing-wood for the following crop, and so on from year to year. This method, which is followed in many, if not all coffee countries, I have followed here for several years—confining it, however, to a few hundred trees—proving that mainly the rules holding good in other countries hold good here. Putting wages at 40 cents a day, it will cost about two-and-a-half cents a pound to gather and flume to pulping-house, and two-and-a-half cents for the year's pruning and weeding. Cost of land, flumes and other means of bringing the berries to the pulping works, etc., I leave out at present, as also of pulping and curing; but no one of these items is large as applied to the coffee business on a large scale.

There are many places in these Islands where coffee-culture might be conducted by small, independent holders; but I am quite confident that it cannot be done here in Hilo to any great extent. Forty years ago the greater part of the coffee used in Honolulu was grown in Hilo, and not a tithe of what was grown was ever gathered. There were scores, if not hundreds, of small patches in Hilo and Hamakua, scattered from Hilo Bay to Waipio. Blight, Hilo grass and neglect have long ago wiped them nearly all out, decrease in population being the main-spring; the pulu and fungus industries, in their time, being more attractive to the fast-decreasing native people, because those products needed neither planting nor care.

If you were to plant a small holding in this coffee belt, all at once there might appear just alongside of you *some other* horny-handed son of toil intent upon running a goat-ranch or butter dairy, and, in ruining himself, would probably ruin *you* by introducing coffee blight.

Why did I give up the business? Well. I started it some two years before the Treaty, when I could hire men for forty cents a day, and women and boys for twenty-five. As soon as the sugar industry took its new departure, wages began to rise;

and, when I quit, I could not depend upon free labor, even for a dollar or any other price. And any other labor than *free* cannot be applied successfully to coffee culture, unless it be absolutely *slave.*

Any hermaphrodite system, such as has tided us through our earlier sugar troubles, cannot be used to trim a coffee tree.

At the time I quit (except experimentally on a few hundred trees), I could perhaps gather and clean by hand enough to pay the man who did it, especially if I could have afforded to stand by half the time and help him, besides giving the total proceeds of the coffee; but, seeing that coffee was falling in price from year to year, and that there was no benefit for that article in the Treaty, there seemed nothing left but to peg away at the favored article—sugar.

A system of land tenure could be devised whereby this coffee belt might be permanently peopled in comfort, furnishing labor of such cheapness and reliability as to give a profit to the proprietors. Some legislation to this end could also be devised, and not interfere with sugar or any other interest—premising, of course, that the landholders take hold at the same time. But I am trenching on new ground—new to this writing, but yet so very old—the Labor Question, so I will close.

Should any person, or body of persons, wish to inquire earnestly into this matter, I will cheerfully answer to the extent of my knowledge.

An estimate of cost of a 500-acre coffee plantation in Hilo district:

Five hundred acres forest land at $5	$ 2,500
Planting, road-making, etc., at $120	60,000
Flumes	3,000
Pulping and drying works	30,000
Overseers' and laborers' quarters	10,000
Incidentals	4,500
	$110,000

Running expenses per annum, with yield at 1,500 lbs. per acre, wages 40 cents per day per man:

Gathering 750,000 lbs. at $2\frac{1}{2}$ cents	$18,750
Pruning, hoeing, etc. (even with gathering)	18,750
*Fluming, pulping, etc	12,000
Manager and overseers	5,000
Repairs and wear and tear	5,000
Incidentals	2,500
	$62,000

Which is $8\frac{20}{75}$ cents a pound. The items marked * I gather from publications and from conversations with coffee men. The other items will be found to be near the mark, with men's wages at 40 cents a day.

Wm. Kinney.

Honomu, Hawaii, November 4, 1888.

CORRESPONDENCE AND SELECTIONS.

STEAM BOILERS.

Read before the Louisiana Sugar Planters' Association by Frederic Cook, Sept. 13, 1888.

The subject selected by the Association for discussion at this meeting is certainly one of the most important connected with the sugar interest, and whether the steam user be a planter or refiner, the steam boiler forms the basis of the manufacture and refining of sugar. In it is generated the steam that does the work—that mighty power that has revolutionized the civilized world since the last 100 years have passed away—that element that can be made our servant and our labor saver under proper restrictions, with careful management made to advance civilization, comfort and nearly everything tending to make life more endurable and happy. But also that same element that sometimes breaks loose from the curb and hurls destruction on life and property everywhere within its reach.

There is probably no part of a plantation sugar house that is more behind the march of modern improvement than the steam boilers. While the double pressure mills, the double and tripple effects and the filter press receive their share of attention, the poor boiler and its accompanying coal pile, would, no doubt, if they had feelings, think themselves very much neglected.

It seems to me that a safe and economical steam boiler should be the very first provision, no matter what the kind of apparatus to be supplied with steam.

The first consideration in a steam boiler, is safety, for human life and property are concerned.

The second consideration is to produce the greatest amount of steam with the least possible amount of fuel.

The third point is to be able to keep a clean boiler inside where the water is, and outside where the soot strikes the iron, and also ease of repairs.

The description of boilers to be now considered, are those the best known:

1—The plain cylinder boiler.
2—The double flue boiler.
3—The tubulor boiler.
4—The multitubular water tube boiler.

The above boilers are numbered as they have come into use, and will be considered separately.

THE PLAIN CYLINDER BOILER,

that relict of ages ago, from its antiquity requires respect. It was the first boiler used, and no doubt is the simplest and cheapest in first cost, but is the dearest in the end, for it makes the least steam with the largest consumption of fuel. This is a well known fact to all who have made comparative tests of the amount of water evaporated to the pound of coal by this description of boiler, and by others of an improved form.

The cylinder boiler may be considered as obsolete, and no longer purchased by any steam user who is at all informed in modern progress in the art of generating steam cheaply.

The double flue boiler comes next in order, and is probably more in use in this Southern country than any other kind. It is not as safe as a plain cylinder, but by having a double flue boiler made of sufficient strength and with careful management, it may fairly be put down as an improved form over the plain cylinder. The flues, however, are elements of danger; if the water should fall below the top of the flue and remain so beyond a short time, the iron will heat and the flue probably collapse. The thickness of the iron in flues should not be less than the thickness of the shell. The strain is on the inside of the shell of this kind of boiler, but a crushing or collapsing strain is on the flues.

It is undoubtedly true that a large loss of life is continually taking place from explosions, a great number of which are known to begin from a collapse or giving way of the flues of double flue boilers. This question might remain until the ideas of each manufacturer of boilers settled the point to suit his own interests, but as it is one of those questions that ought not to be left to the judgment of mere practical men, so called, it should be settled by law which ought to enforce the necessity of having all such structures stronger than amply strong, for all boilers and parts of boilers wherever to be used.

Taking this view of the case, there can be no objection to making the flues of even thicker iron than the outer shells.

THE DOUBLE FLUE BOILER

although an improvement on the plain cylinder, still is a wasteful boiler, and it is found, with ordinary firing, allows 900 to 1,000 degrees of heat to escape up the smoke stack. In most cases not enough heating surface is found for the work to be done, so that more steam is needed from the boilers than they are able to economically yield; then follows hard firing, the evils of which are many and familiar to some of this Association, and are to numerous to describe in this paper. One of the first results of two or three weeks hard firing, is that the boiler becomes burnt out in that part of the bottom which is nearest the back part of the fire grate.

This result is generally produced sooner or later when a shell boiler of the cylinder or flue type is too small for its work and is no more than is to be expected when it is pushed to get steam enough for the work, with a fire urged to act with great intensity on too small a heating surface, rather than with a larger one at a lower temperature acting on a larger heating surface, When a boiler bottom is burnt out, as it is called, by hard firing, it seldom or perhaps never happens that a hole is burnt through the plates, for if so, an explosion would likely take place in shell boilers.

The meaning of the phrase "burnt out," is that the quality of the iron is destroyed, or in other words, certain parts of the boiler bottom against which the flame strikes with greatest intensity, are changed from tough, malleable iron into a state that is brittle and weak.

It generally occurs in this way: When from some cause the engineer finds steam going down, the firemen are told to crowd the fires a little more, which can only be done by firing up more frequently. This, however, has its extreme limit in the greatest possible evaporating power of the boiler, or that point at which the generation of steam will be as much set back by the increase in the number of times the fire-doors are opened and cold air let into the furnace, as it would be increased by the more frequent supply of coal. The resource, then, is larger charges of coal at a time, producing what is called "heavy firing," and its accompanying evil of frequent stoking. When a furnace is thus pushed to its greatest intensity for a few days or more, serious injury is likely to show itself by what is called "bagging" or "blistering of the boiler bottom," a circular projection or dish is formed, which, as it is termed, comes rapidly "to a head," from the fact of its tendency to collect any deposit or pieces of loose scale that may be in the boiler.

The fact of these dish-like cavities being generally found with dirt or sediment in them, seems to have misled many persons as to the cause of their origin, ascribing their first formation to the presence of such matters, instead of regarding them as the effects produced from causes before described.

It seems to be very clearly pointed out by the fact that when a plate is thus overheated, the production of steam has been so increased at that special place, as to some extent repel the water from the surface of the plate, or at least such a degree of repulsion of the particles of the water takes place, as to prevent that intimate contact which is required to preserve the iron as cool the water. The consequence is not that the iron will get red hot, which is in fact not necessary to produce the effect in question, but examination of the iron will show that a "blue" heat has been produced—a temperature somewhat greater than what is called the maximum evaporating point, and largely exceeding the degree of temperature of the iron that will produce the repulsion of the water, which may be and doubtless is of a lower temperature. This repulsion may continue for a very short space of time only, while the injured plate is subjected to the steam pressure, which forces it down as before described, at the same time from the movement and boiling of the water over it, thereby heating and cooling the part alternately, which we finally find "burnt out."

When a boiler bottom is "burnt out," it sometimes happens that the planter, instead of looking into the circumstances of the case and remembering possibly his own orders to "fire up stronger," sends for a boiler-maker, when, after a consultation about bad iron, bad or low water, or any cause but the right one, the burnt plates are taken out and the boiler repaired. The masonry is replaced precisely as before, when, as the same causes still exist, a similar rupture takes place. Again the same process is resorted to, and, after a few repetitions of this sort, when the expense has amounted to about as much as would have bought a good boiler, to say nothing of the expense of a serious detention in taking off the crop, besides the confusion as well as the interruption necessarily attending such jobs in a sugar-house in sugar-making season, the wearied proprietor at last sends for another boiler expert; the old boiler is then condemned, bids are called for, and the lowest bidder gets the order for a new boiler, probably of a similar description.

All boilers with cylindrical shells, fired underneath, are liable to this burning out of the sheet at or near back end of grates; and while on this point it may be suggested that this tendency of the lowest part of the shell to become burnt out or bagged, may be somewhat remedied when soft coal is used by lowering the grates and by a better construction of the bridge walls.

It is generally the case that bridge walls are put in straight across, so that the narrowest part of the opening is exactly at the lowest part of the shell. The bridge-walls should be put in curved to the shape of the boiler shell, and slightly deeper immediately under the shell. This will cause the flame to more evenly distribute itself around the boiler shell, and effect a better distribution of the heat, care being taken always to preserve the necessary area enough for a good draught.

Expansion and contraction of shell-boilers fired underneath must now have some consideration. On first firing under such boilers, and before there is any pressure of steam, each of the plates from furnace to back end of boiler acquires some intermediate temperature between that of the fire outside and the water inside the boiler. These temperatures may be estimated to average about 1,500 to 150 degrees respectively, shortly after the fire is started. The external surface of the boiler-plates where single, and the whole of the outside portion of the plates where double or lapped over the other, acquires the higher, and the inside surface of the boiler bottom tending to the lower temperature. The effect of this is that the expansion of the outer being greater than that of the inner surface, the boiler-bottom becomes slightly convex towards the fire in a longitudinal direction each time steam is raised. Some one or other of the seams of rivets are less able to afford resistance to the enormous force of expansion than the other seams, and these parts, therefore, will be the first to yield. If there be any pressure of steam in the boiler, and the plates should be of equal strength and acted on the same by the heat, the point of the most depression will be near the middle of the boiler. However, the greater heat being near the bridge-wall, the depression will likely take place therefore at the first seam of rivets nearest to the bridge-wall.

As to the extent of the depression likely to be produced from this cause, if we take the difference of temperature between the external and internal surfaces of the plates forming the boiler bottom, to be about 500 degrees, the authorities give about one inch of expansion in the boiler bottom externally on a boiler about 30 feet long. The tendency of the fire is to bend each plate separately, if the plates are clean. But generally a boiler has some sediment deposited from the water in it which settles on the bottom, and, being a very bad conductor of heat, allows the temperature of the plates to rise higher. The heat then reaches through the whole thickness of the metal, and expands the plate to sometimes twice the amount supposed above, so that the plates become more lengthened, and the convexity of the boiler downward is added to. Therefore we often find a very considerable deflexion of bottoms of shell boilers downwards. The depression generally admits of measurement, and by placing something incombustible, as for instance a brick, on the bridge near the bottom, it may be seen what the deflexion consists of.

It takes place in all these kinds of boilers to a greater or less extent every morning before the steam is up, and before there is any pressure, excepting what arises from the weight of water inside the boiler.

Careful observation will show that expansion does affect a boiler as described.

Many persons know that frequently boilers leak more or less when the fire is started, and generally these small leaks can be seen when there is a clear fire under the boiler. When the water inside the boiler begins to get hot the leaks partly stop, and by the time it is boiling and steam begins to rise, every leak closes.

The reason certainly is that the heat, as soon as the water begins to boil, is carried off by the generation of steam from the inside surface of the boiler-plates as quickly as it is transmitted through them from the furnace, and in consequence the temperature of the plates falls or becomes more uniform, and therefore they assume more nearly their original sizes.

Then it is said that the leaks have closed and the boiler is perfectly tight; but the fact is, that the boiler-bottom has contracted, and a more even temperature has taken place on both sides of the plates.

Some persons contend that sediment has been forced into the joints of the plates by the steam pressure, but the closing of the leaks begins before the steam is up, and the same thing sometimes takes place on new shell-boilers which contain no sediment.

Continuous daily repetition of this, however, produces oxidation of the metal around the leaks and causes a weakness at some point across the plates of the bottom, which finally produces openings between the joints that may cause at any time a rapid large loss of water and end in an explosion at or about the time any sudden demand for steam takes place.

The yielding of a small part of such boilers, which would not be of itself an explosion, but which would be enough to let out a large quantity of steam or water, and produce a sudden falling of the water level, probably exposing the tops of the flues in a flue boiler, an immediate rise in the temperature of the steam will result, and an explosion may ensue.

It has been proved that the effects arising from overheating the sides or flues of a boiler, are now known to be, first, the repulsion of the water from the overheated surface producing a reduced quantity of steam, but directly afterwards, when the temperature of the metal falls down to the point of greatest evaporation, or a little below 400 degrees, by anything that causes the water to flow over the overheated parts, a rapid and greatly increased quantity of steam takes place. Any sudden liberation of the steam from any cause whatever, would probably produce the same effect, when a boiler is in the described state. Anything producing a disturbance of the equilibrium or water level might produce the result and cause the water to flow over the exposed, overheated metal and produce a sudden volume of steam, too large to escape in time from the safety valve or otherwise, through legitimate channels, so that on excessive sudden pressure, more than ordinary shell boilers can stand, the weakest part would give way, and a probable explosion ensue.

It may not be out of place here to state that the ordinary cylinder and double flued and other shell boilers, as generally furnished this market, are single riveted unless ordered double riveted, which should always be demanded from makers on the longitudinal seams.

Taking the results of Fairbairn's experiments as to strength of boiler plate joints, say the strength of the plate is 100. The strength of the double riveted joint is 70, and the strength of the single riveted joint is 56, so that we see that a boiler constructed with single riveted joints is 44 per cent. weaker than the boiler plates. And if it has double riveted joints, they are 30 per cent. weaker than the plates. So that a boiler with double riveted joints is much stronger than a boiler with single riveted joints.

The next in order comes the

CYLINDRICAL FIRE TUBE BOILER,

a very popular boiler, generally made short, and of a large diameter of shell. This boiler admits of a large heating surface, and in consumption of fuel is much more economical than either of the before mentioned boilers. The fire is made under the shell, the heat passes under it and returns through the tubes. Sometimes a second return is made over the top—a very objectionable practice. This description of boiler requires water free from sediment or anything that will form scales, for the tubes, owing to the deposit forming on the outside and being in a nest inside the boiler, there has been no way yet found to scrape them mechanically. Either natural clear water, filters or boiler compounds have to be depended on to keep fire tube boilers clean, hence they are not popular where bad water exists, for expensive filters have to be purchased, to first clarify the water, and I have yet to hear of any compound that is a satisfactory solvent on all characters of scale. My belief is that you must either clarify the water before it enters the boiler, or purchase a boiler that can be mechanically cleaned and scraped, both inside and outside of the tubes. The tubes of an ordinary fire tube boiler allow the soot to collect very fast, so that in a short time the tubes fill up about one-third, and the boiler loses one-third its effective heating surface.

Fire-tubes are quenchers of flame. They extinguish it. The flame from the fuel enters the tubes subdivided, and striking the cooler surfaces, the separated particles of flame never reach more than a few feet into the tube, the tongues of flame are condensed at once by the lower temperature and soot forms and deposits inside the tubes.

There are some cases, however, where fire tube boilers seem to be necessary to be used in one form or another, such as locomotives and marine boilers, and they play an important part the world over in the generation of steam. As to their safety, not much can be said. They require the greatest possible care, and within my own knowledge, one of the most disastrous explosions I ever saw, where a fearful destruction of life and property occurred, was produced by a fire tube boiler at the Natchez Cotton Mills a few years since. And the records of the Boiler Insurance Companies show that the fire tube, the double flue and the cylinder boilers are all very much alike in one respect—they persist in "blowing up."

The Hartford Steam Boiler Inspection and Insurance Co., report that up to January 1st, 1885, they made in all 560,979 inspections, and had discovered 303,718 defects, of which 64,216 were considered dangerous.

If the above be a fair average of the boilers in ordinary use, (and who shall say they are not), we have the startling fact that about one boiler in nine in common use is in "a dangerous condition." That more do not explode is probably due less to intelligent watchfulness than to the fortunate want of all the conditions existing at one time.

In the boilers examined by the before mentioned Insurance Co. up to 1880, 11,757 fractures in plates were found in, at or near the seams of rivets, 5,079 of which, or about one-half, had arrived at a dangerous state before discovery.

This state of things in ordinary boilers may be attributed largely to the causes before spoken of, which undoubtedly make such boilers dangerous and liable to explode under certain conditions, and the records of the Boiler Insurance Company before named, show that the fearful proportion of every ninth boiler out of 560,979 was dangerously unsafe, (it will bear repetition.)

According to the report of this same company, there were during the year 1880 in this country, 170 explosions of fire tube, flue and cylinder boilers, by which 259 persons were killed and 555 persons injured. During the year 1881 there were 159 explosions, 251 persons killed and 331 persons injured. During 1883 there were 184 explosions, 263 people killed and 412 injured.

So that in three years there were 513 explosions, 773 persons killed and 1,298 persons injured, of whom, doubtless, a number afterwards died. Added to this loss of human life is the vast amount of property destroyed and the losses from stoppage of business caused by these explosions. Is not this a sad commentary on the question of danger from steam boilers in common use?

On the other hand, there are now over 400,000 horse power of the Babcock & Wilcox safety water tube boilers in use in various parts of the world, a large number of which have been in use constantly from ten to eighteen years and there has never been one explosion of these boilers or one person killed by them.

It seems to me these are very grave facts, worthy of consideration by all steam users.

The class of boilers known as water tube boilers must now be noticed and I shall select

THE BABCOCK & WILCOX SAFETY WATER TUBE BOILER

as the highest type of this character of boilers. It is the reverse of a fire-tube boiler, where the fire passes in a subdivided state through the tubes, for in the boiler now to be described the water is inside the tubes and the fire outside.

In the water tube boiler of Babcock & Wilcox, the boiler consists of an upper drum for water and steam, like a plain cylinder boiler with double riveted longitudinal seams. Under this drum are a series of staggered tubes inclined downwards from front to rear.

These tubes are connected at their upper ends to upright headers which are connected at their upper ends to the front end of drum. The lower end of the tubes are connected also to upright headers which at their upper ends are connected to the rear end of drum by circulating tubes.

The lower ends of these rear headers are connected to a mud drum. There are divisions, one or two as the case may require, called flame plates, that divide the length of the tubes and cause the heat from the furnace, which is under the front of the tubes, to pass in a zig-zag direction several times upwards and downwards among the tubes and thence out to stack at rear end of boiler. The water and steam drum overhead has one-half its shell exposed to heat, and is set like a cylinder boiler, the whole of the water tubes being heating surface.

The water line is about one-half or at the diameter line horizontally of the upper drum. Fire being started in the furnace, steam begins to form in the tubes and rapidly rises in the inclined tubes into the drum. Necessarily water follows from the rear end of drum down the circulating tubes to the rear headers and into the inclined water tubes. A rapid circulation is at once established, which tends to quickly prevent any injurious expansion taking place from any unequal heating of the plates or tubes, but from the construction of the boiler, this is impossible as long as the water is kept up, for the tubes are allowed to expand freely forwards, the headers being hung from upper drum by wrought iron nipples, and not allowed to touch the masonry at their bottoms.

In this boiler the circulation is so rapid from its principle of construction that even if the water gets very low the damage is less than in any other description of boilers. The worst that can happen is a seam in a few tubes, generally but one, opens over the fire where the heat is greatest, and the steam and water rushing out, the fire is quickly extinguished.

All the lower rows of tubes on horizontal lines crosswise of the furnace are an equal distance from the grates, so the heat is evenly distributed, and there is no liability to burn the bottom of the cylindrical drum for it is above the tubes, and the drum cannot receive the first intensity of the heat which is taken by the water tubes, which being of small diameter can be of thin metal, at the same time possess immense strength, and if one should burn no great damage is done, or great expense incurred for repairs.

In any boiler set in brick-work each square foot of masonry is an absorber and a radiator of heat; therefore, it is desirable to have as little brick heating surface as possible in proportion to boiler heating surface, and the boiler heating surface to be as near the furnace as can be got, for one square foot of heating surface near the fire is equal to several square feet twenty or twenty-five feet away.

The danger to a shell boiler fired underneath before spoken of from unequal expansion, and from burning out the bottom from heavy firing, cannot exist in the Babcock & Wilcox boiler for reasons given. When dirty water is used, if the mud drum is blown off about every six hours for half a minute or so until the water looks white, these boilers will, I believe, work on bad water with impunity. The tubes can be scraped inside, and the soot removed from outside by a steam hose. This latter can be done at any time while the boilers are at work, and it has been found that in such cases where these boilers are in use on sugar plantations, even on raw Mississippi water that they require cleaning, by scraping, only between crops, or once a year.

The cost of repairing is insignificant, compared to shell boilers, and repairs can be made much more quickly.

There are other water tube boilers—the Root, the Heine, the Zell and various others, all claiming their special advantages, but this article would be too long were I to attempt to describe the mechanical differences between the various patent boilers, therefore I have confined myself to the description of the Babcock & Wilcox boiler as, in my opinion, possessing the greatest merit, and most largely used of its type.

The advantages of this boiler may be summed up as follows:

Safety from explosion.
Greatest economy of fuel.
Ease and cheapness of repairs.
Large heating surface near the fire.
Rapid circulation.
Large draught area.
Thorough absorption of the heat.
Freedom from expansion.
Durability.

As to the economy of fuel, the various boilers under discussion from the best authorities I can get, and from my own experience, stand about as follows:

POUNDS OF WATER EVAPORATED PER POUND OF COAL.

Plain cylinder boilers	4 to 5	pounds
Double flue boilers	6 to 7	"
Fire tube boilers	8 to 9	"
Babcock & Wilcox boilers	10 to 11	"

The usual heating surface allowed by best builders for one horse-power is:

Plain cylinder boilers	10 square feet		
Double flue boilers	12	"	"
Fire tube boilers	15	"	"
Babcock & Wilcox boiler	11½	"	"

The relative grate bar surface to heating surface as generally allowed is:

Plain cylinder boilers	1 to 8 or 9
Double flue boilers	1 to 20
Fire tube boilers	1 to 20 or 25
Babcock & Wilcox boilers	1 to 40

The temperature of the waste gases at the point of leaving them on its passage to the smoke stack with these different boilers is about as follows:

Plain cylinder boilers	1,100 to 1,200	degrees
Double flue boilers	900 to 1,000	"
Fire tube boilers	550 to 650	"
Babcock & Wilcox boilers	400 to 500	"

The lower the temperature of the waste gases the better the absorption of the heat by the water in the boiler, and shows the best work done by the coal.

The large amount of heating surface to the square foot of grate, 40 to 1, in the Babcock & Wilcox boiler, should be noted with a temperature of waste gases of 400 to 500 degrees (I have seen it as low as 350), while the plain cylinder boiler has eight square feet heating surface to the square foot of grate with a temperature of waste gases of 1,100 to 1,200 degrees.

The double flue boiler has 20 square feet of heating surface to one square foot grate surface, and a temperature of waste gases of 900 to 1,000 degrees.

The power of a steam boiler, the work done by it, and what your steam costs you, can only be obtained by finding out how many pounds of water it evaporates with one pound of coal, and I think that you will allow that that boiler is the most economical that evaporates the greater amount of water with the least quantity of coal.

Every steam user should know what his boiler is doing, and accordingly have an evaporation and fuel test made occasionally by which only he can tell if his boilers are doing their duty.

Tests are made by attaching a water metre to the feed water pipe which records the cubic feet of water entering the boiler in a given time. The temperature of the water is taken every hour, and an average temperature obtained for the whole time of test, so that the whole amount in pounds of water from and at 212 degrees can be ascertained that has been evaporated in the boiler, The average steam pressure is taken, and the average temperature of the waste gases at stack. These data with the weight of the coal used in from twelve to twenty-four hours' duration of test, enable you to tell how much water from 212 degrees has been evaporated by one pound of coal and the horse-power developed.

If the boiler is not doing its duty then something is wrong, and should be corrected.

There is a great deal more that could be said on the subject of steam boilers. It is a subject the best mechanical brains of the civilized world have made a study of, and yet it is a singular fact that specially in respect to the matter of the furnace, the coals are still thrown in and burnt in the primative way they were in the days of James Watt, the economical use of them largely depending on the attention and judgment of unskilled, and possibly, drunken firemen. And it is a fact that, theoretically speaking, by the present manner of burning coal with ordinary boilers, about 50 per cent. of the fuel value of the coal only is obtained.

Efforts are now being made in the North to improve the present wasteful furnace, and the feeding of the coal, by which the furnace doors will never be open and the feed of the coal be small and continuous, evenly distributed on the grates. An instrument has also been invented in New Orleans, built and in use some months in this city in several places, by which the boiler regulates its own feed water supply, and causes the exact quantity of water per minute to be supplied that the boiler evaporates per minute; thus an even water line is preserved at any point the instrument is set at.

This instrument is a practical success, and will prevent a prolific source of accidents to steam boilers, namely, low water, and it will place a guard over the water line outside of a careless fireman or water tender.

I must now close this, my humble effort as a member of this Association, to throw some light in a popular way without theoretical technicalities on this very important subject, and although the labor has been somewhat onerous, I shall be repaid if my articles sets one man to thinking, and may possibly save him money, and perhaps human life.

I trust that from want of time, owing to business engagements, you will excuse the somewhat crude and general manner in which I have been compelled to treat this most interesting subject.

Frederic Cook,
Member American Society Mechanical Engineers,
57 Carondelet street, New Orleans.

THE DELIVERY OF SUGAR CANE BY CARTS AND BY CARS.

A Paper read by Mr. John Dymond before the Louisiana Sugar Planters' Association, October 11, 1888.

The delivery of sugar cane from the field to the factory is one of the most serious problems that presents itself to the sugar planters. It is even more serious for any one season than the question of profit itself, as non-delivery means the loss of the whole.

The difficulty of delivery of cane to the sugar-house presented itself to the ante-bellum planter with such force that it became common to have two sugar-houses on one plantation—one in the front field and one in the back field, and each about the center of their respective fields. When but one sugar-house was built it was usually built at about the existing or prospective center of the whole field, it being held that it was much easier to haul the finished sugar to the river than to haul the sugar cane to the river, the total produce weighing less than one-tenth of the weight of the cane. The wood that was used as fuel usually lay in the rear of the place, and the hauling of it was also a matter of serious importance, and the sugar-houses in the rear shortened this haul.

As the sugar industry began reviving after the war the crops were generally small, and the question of delivery of cane did not assume any very serious shape. The writer, however, saw in 1869, in the new Brooklyn park, a portable railway used for transporting the earth used in filling many low places. This was a wooden railway with half-round iron traps on the wood rails and with dumping cars, and was known as Peteler's Portable Railway, he having introduced it from Germany, where it had been used in swamp work and earth work. The writer was much impressed by it, and bought the right for the use of it on his sugar plantations in Louisiana, and bought a number of cars and built about two miles of the road for use on Belair and Fairview plantations.

At that time ten tons of cane per acre was a possible crop—in fact an average crop: and five or six tons was not sneered at, and twenty tons was extraordinary.

The wooden railway being heavy and cumbersome, and the crops so small, it became evident at once that there wasn't cane enough on the land to justify the expense of so frequently moving the track. Mr. Peteler, who was extremely anxious to make his road a success in handling sugar cane, sent out an agent from New York to aid us, and we gave him *carte blanche*, but he failed. The delivery was small as compared with what the same effort would perform with carts. The next year we did not use it, and the following year it was burnt up when the fields were burnt off, and so ended our wooden railway.

In the meantime Mr. Peteler had made some sales to Cuba, based upon the sale to Louisiana, and the scarcity of labor there made them seem more of a necessity, and they were received with considerable favor. He also made some sales to Louisiana for handling earth, and one of these outfits was subsequently purchased by Mr. Bradish Johnson for use on his Pointe Celeste and Woodland plantations, and I think some cane was hauled on it, but not much. Mr. Duncan F. Kenner was there at the time to examine the working of the road, and said subsequently that he thought well of it, although fully aware of the non-success at Belair.

In the meantime portable and fixed railways for hauling cane were made a success in Cuba. Iron was substituted for Peteler's wooden rails, and, still better, light steel rails came into vogue and the portability of the roads became a fact.

Mr. Kenner, a year or two after he examined the working of Mr. Johnson's road, went to Europe, and while there secured a portable railway from John Fowler & Sons, for use on Ashland and Bowden, and there portable railways for the delivery of sugar cane were first made a success in Louisiana.

The writer, who was regarded as something of an authority on the matter, having experimented at several thousand dollars' cost, and without success, argued that portable roads could not be made a success in Louisiana because of the insufficient quantity of cane on any given area to justify the removal of the track from place to place.

Mr. Kenner determined to test for himself, and bought the Fowler road. Fortunately for him and for the success of portable railways in Louisiana, Gen. Brent undertook the conduct of the experiments, and from the first season success was assured.

The quantity of cane on an acre of land had been about doubled since the earlier experiments. The portable railway was made in sections, light enough for one man to carry, and could be carried by two men with ease; and so, with double the quantity of cane on the land and the railway of half weight the favoring conditions were quadrupled.

Mr. Kenner's success was contagious, and Mr. John A. Morris was the next buyer. Mr. Frank Ames followed, and then Governor Warmoth invested in three miles of portable; and the writer, now again convinced, took one and a-half miles of portable and one and a-half miles of fixed railway. Mr. Charles Walker, Messrs. Foos & Barnet, Gen. Adolphe Meyer, and a number of others invested in some one of the various railways offered, until now they have come into very common use.

This short retrospect shows how slowly these things move, for it has taken now nearly twenty years to develop the portable railway to where it now stands.

The tendency to large and highly efficient sugar-houses became the turning point, and it became apparent that if cane could be transported at all, it was better to carry it to one excellent sugar-house than to two indifferent ones, though the latter haul might cost less. Portable railways, therefore, first became identified with the long haul of sugar cane, until Governor Warmoth, always in the vanguard of progress in sugar planting matters, determined to entirely abandon the use of carts, and to transport all his cane in cars, and this he did for two seasons, but last season hauled some odd outlying lots in carts to save the cost of track-laying for the small quantities so hauled.

All others who have used cars have used them for only portions of their crop delivery, and then for distant cane. The writer has canvassed carefully the question of cost of delivery to the sugar-house in carts or cars, and arrived at the conclusion, several years ago, that with the conditions all favorable, the immediate cost of delivery of cane by cars was greater than by carts. The indirect cost or injury or advantage will be considered later.

The common method of loading cane cars in the field, which was first worked by Gen. Brent, and has since been accepted as the best method, has been to run a track down the middle of each square containing fourteen or fifteen rows. The canes are cut and thrown into four heap rows, two on each side of the central track, and the contrast of cost comes now in the expense of the track gang, and the loading of the canes from these four heap rows into the cars, as against carts driving directly to the cane and passing up between two heap rows until filled. The cars require a track gang, and then that the canes be carried an average of twenty-five feet further than to the carts. General experience has shown that eight tons per day per loader was good work in loading cars, and ten tons per day was rarely reached. In loading into carts eight tons per day per man is but moderate work, ten tons is good work and twelve tons is frequent when the loading is paid for by the ton.

General Brent had a gang of picked men, and for several years loaded more per man into cars than anyone else, reaching a daily average of about 100 tons with eight men. He, however, carried the two outer heap rows over to the two rows near the track with other labor, leaving the gang of eight men to load from the two rows. Mr. Libby, when in charge of Mr. Ames' plantation paid fifteen cents per ton for loading cars from four heap rows, twelve and a half cents per ton from three heap rows and ten cents per ton from two heap rows, based, if I recall his remarks correctly, on the assumed capacity of a man to load eight tons per day from four heap rows, ten tons from three heap rows and twelve tons from two heap rows, in the latter case about reaching General Brent's standard.

Assuming then, for the sake of comparison, that in doing fairly good work in each case, we can load ten tons per man per day into carts and but eight tons per man per day in cars, the loading into cars would cost twenty-five per cent more than the loading into carts. The common unit of the most successful car work has been the delivery of about 100 tons per day. This may be raised to 125 tons, but it has seemed more economical to organize a separate gang than to enlarge a single gang to effect a large delivery.

The 100-ton car going then would require a track gang of five men, a special man to receive the cane at the yard, four drivers, eight mules and a headman, or say, presuming some of the drivers are boys, the equivalent of ten men and eight mules so employed. One of these two-mule teams is required in the field for switching and making of trains. Each car will weigh about two-thirds of a ton, and hence the delivery of 100 tons will require the movement of 150 cars each way, and requires quick and accurate work.

As against the ten men and eight mules employed in the delivery of 100 tons of cane by cars, ordinary delivering by carts would require seven cart drivers and twenty-eight mules. Assuming wages at one dollar per day and mule service at fifty cents per day, we should then have this part of the car work to cost $14 as against $21 for the same work by carts. But as under common conditions the number of mules necessary to properly cultivate a crop are fully competent to haul it in, there is a disposition not to count the mule service, and in that event we should have the additional car labor cost $10 as against $7 for carts. Therefore, on the face of it we have twenty-five per cent extra cost of loading by cars and forty per cent extra cost for track gang and drivers, as against the cart drivers; and hence we may say that in direct cash money it does cost more to deliver cane in cars than by carts, under average conditions. This excesss of cost is so important that when mule labor is not of much importance, and when the season is dry, the roads good and the distances not great, there is a strong temptatation to deliver the cane by carts rather than by cars.

On the other hand, there are many advantages that car delivery possesses that do not take so definite a shape in wages, but which are of great and sometimes of vital importance.

Bad weather, soft, soggy lands and bad roads, affect car delivery, as well as delivery by carts, but not to the same extent.

The pair of mules, driven tandem, that bring the trains out of the fields do but little harm to the stubble, even in a wet season; whereas it is well known that hauling by carts is very injurious to stubble in wet seasons.

In bad seasons the roads become worse daily when carts are used, and may become impassable. While such weather interferes with delivery by cars it does not stop it, and delivery by cars is possible when by carts it would be impossible; and thousands of tons of cane have been lost during the last ten years because its delivery by carts was impossible.

The proportion of mules for the delivery for moderate distance as given herein—eight mules for cars as against twenty-eight for carts, or three and a-half to one—would hold good for long distances, and distances that would make the cart delivery expensive or inexpedient in good seasons, and impossible in bad, so it would seem the central factory idea is impossible without the portable railway adjunct.

Another advantage of railway delivery is the cheapness with which such cane can be put upon the carrier. This is a matter of direct saving in wages, and in many instances the saving amounts to all the excess in cost of loading and hauling.

Governor Warmoth has reached a high degree of efficiency in this respect. Having had an immense number of cars at his command he hauled cane in cars to grind night and day on the basis of about 250 tons, and all the cane was put on the carrier from the cars, and the night force on the carrier was the same as the day force, and consisted, all told, of some six or seven men, whereas, under common condition, twenty men are used for that amount of work at night.

Admitting, then, the excessive cost of loading into cars, the greater cost of the track gang and drivers, than the cost of cart drivers, we have, as an offset, an economy in mule power of seventy-two per cent, and an economy in handling at the cane carrier of one-third during the day and two-thirds during the night. This much from the common economic point of view. Then we have the possibility of delivery of cane from long distances, cane that would not be grown except for this assurance; and next the possibility of the ready delivery of canes from any distance in difficult seasons, when it is impossible to economically deliver by carts, and every three or four years we have such a season.

These reasons seem to be convincing all of our planters of the desirability of the delivery of sugar cane by cars, as is evidenced by the rapid growth of the new method.—*Louisiana Planter, Oct. 13.*

FECUNDATION OF PLANTS.

A recent bulletin issued from the Experiment Station of the University of Minnesota, contains the following interesting information on the natural and artificial fecundation of plants:

We are in the habit of hearing much about the means used for improving our fruits, vegetables and flowers, and I thought a few remarks on this subject, in a direct, practical way, would be interesting.

I design, first, to indicate how fertilization in plants may be accomplished naturally, and then, how it is done artificially. To make myself the better understood, I have thought it best to define, in a general way, the great divisions of our cultivated plants and some of their fruits.

Plants are divided, according to the length of time they live, into three classes:

Annuals. Those which come from the seed, and produce seed in a single season; as beans, pease, corn, wheat, oats, barley and the like.

Biennials. Those which live two seasons, come from seed one season, and die the next, after flowering, as:—turnips, beets and carrots.

Perennials. Those which live from year to year, as our forest and fruit trees, shrubs, grape-vines and horse-radish.

A flower is that part of a plant in which the organs of reproductions (stamens and pistils) are situated, and which consists, principally, of a single group of these, surrounded by a floral envelope (the calyx and corrolla). But the organs of reproduction and the floral envelope are modified leaves.

The general laws which govern life, prevail in plants, as in animals. They have organs of nutrition and organs of reproduction; but there is nothing in plants corresponding to the mouth and stomach and alimentary canal of animals; and nutrition takes place in a very different manner.

The organs of reproduction in plants are not permanent, but fall off after fecundation has taken place. Fecundation or crossing in plants can take place only when the plant is in blossom. For this reason, there is no danger of biennials, as carrots and parsnips, crossing the first year. Nor will plants like potatoes, artichoke, horse-radish, raspberries and strawberries, when propagated by offsets, divisions, runners, cuttings or layers, fail to produce like the original. One should bear in mind, however, that these may be changed to a great extent by selection, and that at times they may sport.

As an illustration of the great improvement and the changes wrought in the plants by different methods, I have chosen the strawberry, because it is well known, and because it offers a very strong illustration of change under cultivation. In 1476, there were known, in France, where this fruit was early cultivated, only three kinds of strawberries. The varieties of the present day are almost innumerable. In the parentage of our cultivated strawberries, enter, perhaps, five different species, of which the *Fragaria Virginiana*, or our common wild strawberry, bears the largest fruit. A comparison of the fruit of this, which is small, even when developed under the best circumstances, with the fruit of such a variety as the Sharpless, which under special cultivation, has frequently been produced three inches broad by two inches long, will show the great change made in the size of the fruit by cultivation. These changes were brought about by cross fertilization, and the selection of the best of each kind.

Let us for a moment glance at the construction of the strawberry blossom, where the originating of these changes must commence.

The strawberries have two kinds of blossoms:

1st. What are called perfect, or hermaphrodite blossoms; that is, one in which both the male and female organs are fully developed. Examples of which are Wilson, Iron Clad, Capt. Jack and Countess.

2d. What are called pistillate; or blossoms in which the female organs are alone, or mostly developed. Examples of which are Crescent Seedling, Manchester and Minnetonka Chief.

We find these blossoms made up of several parts; what would be termed the outside of the blossom before it is opened, and the under part of the blossom after it is opened, is the calyx, and is made up of ten separate pointed leaves, each of which is called a sepal. It remains on the berry when the fruit is ripe.

Just above the calyx, we come to a circle of five white leaf-like structures, which is the corolla; and each separate leaf is called a petal. Now, if several sepals are very carefully pulled off of a staminate variety, where they separate easily from the stem, we find, growing to the bottom of them, several little yellow appendages. These are the stamens, which are the male organs of the plant and drop off after fecundation has taken place. These are made up of a little stem with a swelling at the top. The little stem is the filament, and the swelling at the top is really a little pod called the anther and is filled with a fine yellow dust, called the pollen.

If we now remove the rest of the corolla and the calyx, we have left what appears to be a very small strawberry, with delicate hairs growing up all over it. These little, delicate hairs, with the little swelling at the base of each, constitute the pistils, or female organs of the plant. Each of these is made up of three parts; the stigma, which is a little sticky enlargement on the tip of the hair; the style, which is the hair itself, connecting the stigma with the swelling at the base, which is the ovary or future seed.

The little strawberry itself, or what is left after removing the seeds, is called the receptacle because it holds and supports the seeds or ovaries.

In order to have a strawberry produce fruit it is necessary that some of the dust or pollen from the anthers of the stamens come in contact and adhere to the stigma of the pistils. By this means, fertilization, or fecundation is produced and the seed is formed.

Without this fecundation no seed would be formed and nature apparently is not willing to develop a luscious receptacle or berry unless she in turn can use it as a resting place for seeds. For unless the strawbery can produce seeds, we have no fruit.

And just here another interesting feature comes in, and that is the fact that no matter how much pollen from an apple or pear-tree, or currant-bush, or any other dissimilar plant, may come in contact with the pistil of the strawberry, it will not fertilize it.

The strawberry requires to be fertilized by strawberry pollen, the apple by apple pollen, and so on; each variety, generally speaking, with pollen of similar varieties.

On account of the above reason, it has in practice been found necessary, for the best success in planting such pistilate varieties as the Crescent Seedling and Manchester, to have at least one row in every seven of some strongly staminate variety, as the Iron Clad or Wilson. These latter have abundance of pollen to fertilize their own fruit and that of their neighbors. Care must be taken, however, in securing a staminate variety for fertilizing a pistillate one, that both shall be in blossom at the same time, or it will not produce the result desired.

Pollen is distributed in strawberries by insects and the winds. The anther bursts open when it is ripe, and its pollen floats on the air and is very much diffused, or some bee in its wanderings and investigations for honey, lights on the staminate plant, and the pollen collects on the hairs on his legs, and then he may go to some pistillate variety, where the pollen grains on his legs come in contact with the sticky end of the pistil and is left to produce fecundation.

Where strawberries are grown with a view of producing new varieties, fecundation is done by hand. For this purpose, three tools are required; a camel's hair brush, a delicate pair of scissors and a piece of fine muslin. If it were decided to cross two such berries as the Iron Clad and Chas. Downing, the way of precedure would be something after this manner. As soon as the Iron Clad is in full bud, and before the blossom is opened, it should be covered with a little muslin bag, or wire gauze, which fits snug up to the stem, though wide enough at the top to allow the flowers to open. When the blossom has fully expanded, the muslin should be removed, and the stamens carefully cut off below the anthers. The muslin is then replaced. In a few days a camel's hair brush is brushed over the stamens of a Downing berry, which has plenty of pollen dust, and then touched lightly to the pistils of the Iron Clad, when some of the pollen dust will be found to adhere to them. The muslin is at once replaced, and when the blossom begins to fade, is removed altogether. The plants from the seed of this hand-fertilized berry will partake of many of the characteristics of both plants.

The operation would be the same when a pistilate variety like the Manchester was to be fertilized; but there would, in all probability, be no stamens sufficiently developed to need cutting off.

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SUGAR-HOUSE CHEMISTRY.

A Paper read by Dr. W. C. Stubbs, before the Louisiana Sugar Planters' Association, Nov. 8, 1888.

The Louisiana planter is from necessity a manufacturer. Since syrup and molasses are with us, commercial articles of value, we find among our planters three different kinds of manufacturers: *1.* Those who make only syrups. *2.* Those who make both sugar and molasses. *3.* Those whose aim is to make the largest possible amount of sugar with a minimum of residue.

My remarks will apply only to the latter. With them every question involved in the methodical accomplishment of this double condition is of vital importance, and the assiduity with which they are striving to reach a high degree of perfection in their work, is a great compliment to their intelligence and energy. They know that they are extracting a vegetable principle which has engaged the best scientific talent in other lands, a principle which is alterable by a number of causes and a multitude of agents, and can by different treatments be converted into an almost innumerable number of organic products. They are abandoning the "rules of thumb" routine and treasured traditions of long ago and are seeking to eliminate the causes of alteration, and to establish their industry upon science, reason and experience.

The crystalizable sugar found in vegetable cells is always accompanied by a great number of soluble substances, of a nature more or less variable—some useful, some indifferent and others positively hurtful to the substance we wish to extract.

It is the business of the chemist to determine these impurities and give rules for their removal or transformation into inocuous compounds.

The great chemists, Peligot, Icery, Payen, and others, found that Otahaiti cane grown in tropical countries reached an epoch of perfect maturity. At this epoch it contained its maximum of sugar and a minimum of impurities. Glucose, our most formidable obstacle to sugar making in Louisiana, was entirely absent.

This period of maturity lasts only a short while, when disintegration and decay begins from the action of ferments always to be found in vegetable and animal systems; implanted there by nature for their destruction when removed from the influence of vitality. In the tropics, where this period of maturity can always be reached, it is possible to prescribe rules and regulations for the use of every sugar-house which works only matured cane, by which it will be enabled to either remove or render inocuous every substance accompanying the sugar in the cane. There science can assert full dominion and require as a penalty for disobedience a forfeiture of a large amount of sugar. But our conditions are different in Louisiana. Our cane never reaches maturity. In fact it is difficult to find two plats on the same plantation of the same approximation to maturity. The composition of our canes varies with the soils upon which they are grown, with different manures used, with different seasons, with different varities of cane, with plant and ratoons, with latitude of the planter, with the time of harvest; yea, even different parts of the same stalk present differences in composition of a striking character, I need not elaborate these points; they are familiar to all, and they are mentioned simply to show the utter impossibility of establishing a sugar chemistry applicable to every sugar-house in the State. But it is possible to learn the general chemistry of our cane, and when known, any intelligent man may apply it *mutatis mutandis*, to any cane in any sugar-house. The juice obtained either by pressure or diffusion is accompanied by many of the substances found in the cells of the cane. These foreign bodies are far from being without influence upon the substance we are seeking, and if we wish to secure the largest yields we must study the action of each in detail, as well as the influence of air, water and heat, upon our juices and syrups.

Our cane contains water, sucrose, glucose, hydrocarbons, woody fibre, pectose, cerosin, fatty and aromatic matters, albuminoids, coloring matter, organic acids and the mineral part usually denominated as ash. Of these, water, woody fibre and cerosin are without action on the sugar. The rest are more or less hurtful, and should be removed or rendered harmless by transformation into inocuous compounds. Unfortunately, several of the above cannot be removed by any chemical process yet known, and they accompany the sugar all the way to the masse cuite and restrain in the molassess a goodly portion of the sugar. A short examination of each group may be instructive.

GLUCOSE

is the name given improperly to invert sugar, and is in reality a mixture of dexilose and levulose. It is abundant in unripe cane, decreasing as maturity advances, even to obliteration. It is the molasses making element of our juice, and there is no known way of removing it. Its melassigenic character opposes the crystalization of sugar, and the amount restrained is now approximately put at one and a-half times the glucose. Again, it is the action of this substance upon caustic lime and potash which blackens our syrups and colors our sugar products. It is a veritable *bete noir* to our sugar makers, and is readily formed from sucrose by many influences. We are obliged to submit gracefully to the disastrous consequences of that already in the juice, and should exercise the most judicious care in preventing its increase by any inversion of the sucrose present.

HYDROCARBONS.

To this class belong starch, dextrine, gum, etc. While the station has never been able to discover starch in sugar cane by any chemical reagent, our contemporary, "Greybeard"—a microscopist of large reputation—has, with the microscope, isolated and determined grains of this substance in the cane growing below this city. It exists, however, in very small quantities and is not to be dreaded by the sugar maker.

Dextrine or some forms of *soluble starch* are present in small quantities in all unripe canes. Like glucose they are not precipitated by any reagents used in the sugar-house. They are annoying to the sugar maker, constituting the "gum" which is found in juices from immature canes. They accompany the juices all through the sugar-house, increasing the molasses and restraining a goodly amount of sugar from crystalization. Under certain conditions these substances give rise to the lactic butyric and ropy fermentations. They are more abundant in fermented and windrowed cane, and like sucrose turn the polarized ray of light to the right.

GUM

is analagous in its action to dextrine and is found in very small quantities in cane juice—a fortunate occurrence, since there is no known way of eliminating it. Unlike dextrine it turns the ray of polarized light to the left.

PECTOSE

is not found in juices extracted by pressure without heat, provided a wire screen is interposed between the mill and the clarifier to remove broken particles of bagasse. It may be found in diffusion juices and juices extracted by pressure with heat. Heat is needed to convert pectose into soluble pectine, pectic, metapectic and parapectic acids. Little or no trouble should arise from these substances, since they are all removed by lime and tannic acid.

CEROSIN

is the name given to the wax adhering to most canes, prominently to the purple variety, by Mr. Avequin, of New Orleans. It is insoluble in water and is therefore without action on the juice.

FATTY MATTERS

are objectionable from two points of view: *1st*, when lime is added it unites with the fatty acid and releases the glycerine, which acts as glucose in increasing the molasses and restraining sugar; and *2d*, their presence often directs fermentation into the lactic, butyric, mannitic, or viscous forms, all of which are far more objectionable and destructive than the regular alcoholic kind. Just here permit a condemnation of a custom which prevails of preventing excessive foaming in the pan by the introduction of fat of some kind. It would be far better to use the fatty acids deprived of glycerine, which could be easily procured, than to inject a substance which must increase the molasses and restrain sugar.

The delicate perfume of the open-kettle sugar-house is due to an essential oil, which it would be well to conserve rather than to destroy; but most of it is eliminated by the different treatments to which the juices are subjected in the manufacture of sugar.

ALBUMINOIDS

or nitrogenous bodies are found in the cane. The white of an egg, the curd of milk and the fibrine of meat are familiar examples of these bodies. They are often called "*protein*," because they are essential to the development of all kinds of life. Cane grown on new ground, or with highly nitrogenous fertilizers, always contain increased quantities of albuminiods. Along with the albuminoids occur the "ferment," which destroys the sugar. This ferment *alone* destroys a certain quantity of sugar and dies; but in the presence of albuminoids a rapid multiplication of new and active globules takes place, which replace the effete ones, and which destroy, in a short while, a large quantity of sugar. The planter has no more redoubtable enemy than these albuminoids, which, if not removed, show themselves in every phase of concentration. To avoid their noxious influence cane should be worked as soon as possible after being cut, and the juices clarified properly as soon as they come from the mill. Their removal, however, is not a simple process. Some of them coagulate by heat—others will not. Some are transformed by long heating into glycerine, especially if free acids be present. Lime precipitates only a portion, and if used in excess will redissolve, with heat, a portion already coagulated. Therefore albuminoids are found in the juices, in the syrups, in the masse cuites—augmenting the molasses and engaging a part of the sugar. They cause the foaming in the pans and the fermenting in the molasses, when kept till summer. To relieve the juices of all of the albuminoids has been the effort of sugar chemists for years. Chemicals which will entirely remove them are either too expensive or poisonous. Tannic acid removes most of them by forming insoluble compounds with them, and also destroys the ferment. Hence, the station is still studying the effect of this acid as a clarifying agent, and so far with promise of success.

VEGITABLE ACIDS,

with the exception of tannic acid, acetic and carbonic, have the power of converting sucrose into glucose. Even acetic acid favors a ropy or viscous fermentation. Therefore only the highest and best results can be obtained by neutralization of all acids of every kind. Acids also dissolve albuminoids.

THE MINERAL MATTERS

of juices are mostly removed by a proper clarification. Only potash and soda are left in solution, and if properly combined can be made inoffensive.

THE COLORING MATTER

is generally conceded to be removed in the usual methods of clarification. Sulphurous acid entirely suspends its action.

Applying the above facts to our cane juices we can see the aim and object of clarification. Gum dextrine and glucose cannot be removed, and remain, preventing the crystalization of sugar. The pectic principles and albuminoids accomplish the same end, but can be wholly or partly removed. The free acids, with three exceptions, convert sucrose into glucose, causing a double loss, the transformed sugar and that restrained in the molasses by this sugar. Here is the great cause of loss in Louisiana. Whenever one part of sugar is converted into glucose it is equivalent to a loss of two and a-half parts. Therefore when chemistry assigns you an inversion, the loss in sugar may with propriety be reckoned two and a-half times this inversion. Therefore every effort should be made to avoid this loss. The unavoidable causes of inversion are numerous. The natural acids of the cane, certain bases, the ferment, the action of air, of water, of heat, together can alter so much sugar as to seriously decrease yields. Add to these the indiscriminate use of sulphur, with the reprehensible custom of leaving clarified juices quite acid, and their cooking in open pans, and the wonder is that so much sugar is made.

In the work of the sugar-house only the clarification belongs to chemistry. It has often been said that "any fool can make sugar from well clarified juices." This expression is but a declaration of the high importance of this work in a sugar-house, and yet we sometimes find very ignorant men performing it. The fundamental principle involved in clarification is to remove or render inoffensive all foreign matters in the juice, and is practically performed in two ways by the use of reagents: *1st,* which will produce insoluble compounds, which are removed; *2d,* which will neutralize all causes of alteration to the sucrose. These chemical means are aided by mechanical and physical processes as equally essential.

In Louisiana clarification is accomplished usually in the following manner:

Burnt sulphur (sulphur dioxide) is poured into the juice until it is saturated. The juice is then sent to tanks, where it remains until drawn to the clarifiers. The action of this sulphur is threefold. It acts as an *antiseptic ;* it *decolorizes ;* it assists in rendering *coagulable* a portion of the *albuminoids.* Ordinary cane juice will absorb about thirty-three times its own volume of this gas, and this solution, when left exposed to the air, absorbs oxygen, and is gradually converted into sulphuric acid. The sulphur arrests a fermentation visible to the eye, but at the same time introduces an unseen destroyer of sugar far more formidable. Few persons realize how much sugar is thus lost. It is very desirable to find a substitute for sulphur, since against its good offices are to be placed the constant danger of inverting sugar, the decreased yields, the difficulty of cooking its syrups without filtration, the deliquescence of sugars made by its use, and the formation of sulphates and sulphites in the juice, which interfere with the crystalization of sugar, and the deposition of scale upon the apparatus in which the juices are cooked.

It is used in sugar manufacture from the raw juice to the masse cuite in the pan, and in all forms, from the pure gas and its water solutions to every one of its salts.

Sulphured juices should be handled with great care, since this gas is an acid, which has in itself a power to convert sugar, and moreover is easily converted into sulphuric acid, a most energetic destroyer of sugar. Sulphuric juices should be worked as soon as possible, limed to neutrality and never heated before being limed. It is an excellent practice to run a little milk of lime into the juice as it comes from the mill before sulphuring, so as to unite with and render inactive any sulphuric acid that may be found in the combustion of sulphur and which may have escaped the wash water.

LIME

is the universal agent of clarification. Nothing yet found can equal it. It is of prime importance, however, that it should be pure, since its impurities introduced into the juice may seriously interfere with the afterwork of the syrup. Lime accomplishes the following:

1. The partial removal of the albuminoids and with them the ferment.

2. The neutralization of all acids and the formation of insoluble compounds with most of them.

3. The precipitation of most of the vegetable bases.

4. The precipitation of all the mineral bases except potash and soda.

5. The removal in the blanket and precipitate of a large quantity of the coloring matter and other matters mechanically suspended in the juice.

In liming the juice, care should be taken that neither too much nor too little should be used. Either is destructive of good results. The exact neutral point can be determined in two ways: *1.* By litmus and turmeric papers. *2.* By the eye, examining a sample in a small glass jar by the aid of transmitted light. A rapid deposition of a thick, heavy and persistent precipitate, leaving a clear, supernatant liquid of a light, amber color, indicates a good defecation. A little practice will enable a skilful observer to determine quite accurately the neutral point. Each clarifier should be separately tested on account of the ranging composition of our juices. Milk of lime, graduated with a Baume hydrometer is preferable to lime paste.

An excess of lime unites with sucrose and glucose to form sucrates and glucates of lime, the latter always blackening the juice. It also leaves the potash and soda in the juice in a caustic state, which if not neutralized by an appropriate acid, will, during subsequent concentration, convert the glucose into melassic acid, blackening the juice.

Phosphoric acid is best adapted for the neutralization of caustic potash and soda, and is supplied usually in the forms of "superphosphate of lime" and "superphosphate of alumina."

These compounds, as found in commerce, contain goodly quantities of sulphuric acid, which render them totally unfit for the purposes designed. Indeed, it is difficult to make these compounds free from this acid, and it can only be done by avoiding strictly an excess of sulphuric acid in their manufacture. On account of the presence of sulphuric acids in these compounds their use has not been extensive. When pure they can be highly recommended, but as found now in commerce, their use should be strongly condemned. When these substances are used, they should be added in just such quantities as to slightly redden blue litmus paper.

It is useless to speak further of tannic acid, or even to mention boneblack as clarifying agents, since they are used only to a very limited extent in this State.

In closing this article I would summarize my suggestions as follows:

Procure several quires of blue litmus and yellow turmeric paper for use at the clarifiers and evaporators. Secure the best quality of lime, with the least quantity of impurities ; see that your sulphur fumes are well washed.

Grind your cane as soon as possible after it is cut. Interpose a screen between your mill and the tanks that will remove the finest particles of bagasse. Partially lime your juice as it leaves the mill, to neutralize any sulphuric acid that may be formed in the burning sulphur. Don't leave *even sulphured juices* long without clarification. Don't heat sulphured juices till limed. Sulphured and raw juices should be limed to neutrality. Neither acid nor alkaline juices are safe for subsequent manipulation.

Add lime to the clarifier before heating; then heat till the bubbles break the blanket, which occurs at about 180 deg. F. to 200 deg. F. Withdraw heat and remove blanket; then heat to boiling and remove any further scums that may appear. Add now, if it can be obtained, pure superphosphate of lime until the juice slightly reddens blue litmus paper, gently heat again and then settle. Send the settlings and scums through the filter-press, the settlings first, to form a coating over the cloths, which will prevent the scums from choking up the press. In the absence of a filter-press drain both scums and settlings as soon as possible, since inversion is most rapid in the presence of so much feculent matter.

The subsequent operations of a sugar-house are mechanical, but I must proffer a suggestion or two, based upon actual experiments. Cook your masse cuite to a stiff consistency. It is better to get sixty per cent of first sugars than forty per cent. You will save fuel and prevent loss by inversion. The glucose in our masse cuite gives us a liquid menstruum in which sucrose can crystalize, therefore our water content can be reduced to a very low quantity. Six to seven per cent of water is the quantity which has given us the best results. A larger quantity of sugar with better grain has been obtained by letting the masse cuite cool for a few hours before centrifugaling, heated water exercising a higher solvent power on sugar than when cooled. Washing the masse cuite with a solution of pure sugar in water is also deemed economical by many chemists, the water exchanging the sucrose for the glucose and other melassigenic elements in its flight through the centrifugal.

Every sugar-house should have a chemist to detect its losses and point out corrections. The ratio of glucose to sucrose must be preserved throughout the manufacture, from the juice to the masse cuite, or else inversion is taking place. If inversion be occurring the chemist should tell us where and how much, and the honest and intelligent sugar maker should correct his methods at once. The accuracy and importance of chemical analysis was clearly shown last week in the work of the station. The young man who ran the double effect was permitted in the morning to visit the city. Soon after his leaving, the vacuum pan was started on the syrup concentrated the night before in the double effect.

In the evening the sugar and molasses after being separated by the centrifugal, were weighed and analyzed, and there was an unaccountable balance of sugar of about fifty pounds on the calculated amount in the eight tons of cane which we had diffused and concentrated the day before. Where was it? None had been wasted. Chemical analysis showed no inversion. Each cell of diffused chips had also been carefully analyzed and the amount of sugar left in them correctly calculated. We tried every way to solve the perplexing question, but failed and quietly resumed our work. Night came and with it the return of our young man from the city. At supper I mentioned incidentally the perplexing loss of the day, and he at once inquired if we had gotten a small quantity of syrup from a third tank up on the upper floor. He had filled two tanks and having a small quantity over had run it into this third tank. He had forgotten to tell us of it. After supper the syrup was found, weighed and analyzed, and the calculated sugar was found to within six pounds.

I mention this incident to show that a chemist can not only detect inversion, but may discover overflows in the pans, leaks in the vessels, carelessness of the operators and dishonesty of the employees. Such detection requires a thorough acquaintance with the work of the sugar-house, and consummate skill as a chemist and calculator; yet I believe it can and will be done. Already its coming is foreshadowed by the large demand for chemists in our sugar-houses, and it is for you, gentlemen, "men of thought, and men of action," to "clear the way."