

BULLETIN NO. 133.

DECEMBER, 1905.

ALABAMA

Agricultural Experiment Station

OF THE

Alabama Polytechnic Institute,

AUBURN.

The Manufacture of Cane Syrup.

By

B. B. ROSS

Chemist.

Opelika, Ala.:
The Post Publishing Company.
1905.

COMMITTEE OF TRUSTEES ON EXPERIMENT STATION.

- J. M. CARMICHAEL..... Montgomery.
T. D. SAMFORD.....Opelika.
W. C. DAVIS.....Jasper.

STATION COUNCIL.

- C. C. THACH..... President
J. F. DUGGAR..... Director and Agriculturist.
B. B. ROSS Chemist and State Chemist.
C. A. CARY Veterinarian.
E. M. WILCOX Plant Physiologist and Pathologist.
R. S. MACKINTOSH..... Horticulturist and State Horticulturist.
J. T. ANDERSON Chemist, Soil and Crop Investigators.

ASSISTANTS.

- C. L. HARE..... First Assistant Chemist
A. McB. RANSOM Second Assistant Chemist
T. BRAGG Third Assistant Chemist
D. T. GRAY Assistant in Animal Industry
C. M. FLOYD..... Superintendent of Farm
I. S. McADORY..... Assistant in Veterinary Science
C. F. KINMAN Assistant in Horticulture

The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

THE MANUFACTURE OF CANE SYRUP.

By B. B. Ross.

The Chemical Department of the Experiment Station has, within the past few years, issued two bulletins of the regular series, and at least one press bulletin, upon the subject of syrup making, but owing to the extent to which this industry has progressed in this State and on account of the numerous inquiries which have reached this office with regard to methods of clarification and of manufacture of syrups, it is deemed advisable to issue the present bulletin, which is designed to furnish fuller and more detailed information upon his subject than has been supplied by previous publications of this department.

The official reports of the twelfth census of the United States revealed the fact that sugar cane was grown and cane syrup manufactured in forty-four out of the sixty-six counties of the State and while these statistics indicate a wider distribution of this crop throughout the State than has been generally supposed, the area of profitable and satisfactory cultivation of sugar cane would have to be restricted to a considerably smaller number of counties, although it can be produced with greater or less success throughout the whole of Southern and Middle Alabama. In many of these counties patches of no larger area than from one-half to one acre are to be found in cultivation, while in the Southernmost tier of counties of the state some tracts of from ten to fifty acres are being devoted to cane growing for syrup production.

As regards the date of the introduction of sugar cane culture in Alabama, no definite or authentic information can be secured and there is even some difference of opinion as to how and where this important saccharine plant reached this continent. Dr. Stubbs, formerly Director of the Louisiana Sugar Experiment Station, who has investigated quite

carefully and critically the history of the sugar cane, is inclined to the opinion that Cochin China or Bengal was its original habitat, the cane plant being introduced successively into Arabia, Nubia, Ethiopia and Egypt, while, after the crusades, it found its way to Syria, Cyprus and Sicily. Some four centuries ago it was introduced into Madeira and the Canary Islands, and, until the beginning of the Nineteenth century, practically the whole of the sugar consumption of Europe was obtained from these islands.

Soon after the discovery of San Domingo, sugar cane culture was inaugurated in that island, and later, sugar cane was carried from there to South and Central America, to Mexico, to other islands of the West Indies, and finally in 1751 to Louisiana. Although attempts were made at that early period to grow cane and produce sugar in the vicinity of New Orleans, it appears that the first efforts were entirely unsuccessful, and it was not until about 1794 that Etienne de Bore, operating at a plantation and sugar house almost on the site of Audubon Park in that city, succeeded in demonstrating the practicability of the production of cane sugar upon a commercial scale. This was virtually the beginning of the cane sugar industry in Louisiana, and the successful termination of the experiments of de Bore marked an important epoch in the development of the industrial and agricultural activity of that rich commonwealth.

Soon after the introduction of the sugar cane plant into Louisiana, it is claimed that cane culture was commenced upon a small scale on the East Florida coast and later along the Georgia coast south of Savannah, sugar-making upon a not inconsiderable scale for that period being carried on in the latter state during the early part of the last century. As to whether sugar cane was brought from Louisiana to this state or carried west to Alabama from the Georgia coast, is a question whose solution I have been unable to accomplish, and it is even possible that it might have been introduced direct from some of the West Indian islands.

Suffice it to say, sugar cane culture has been carried on in Southern and Middle Alabama upon a small scale at least almost from the date of the admission of the state into the Union, and while this cane has been grown chiefly for use in the production of syrup, nevertheless, in years gone by, crude and low grade sugar was produced in small quantities upon many plantations by processes still more crude.

As is well known to those residing in Middle and Southern Alabama, nearly all of the villages and towns of those sections of the state are supplied with home made cane syrup during the fall and winter months, and there has been a steady increase in the production of domestic syrup for a number of years past, although during the remainder of the year the local product does not meet the requirements of the local consumption.

The cane syrup production of this State in the last census year, according to the figures given in the twelfth census reports, was much larger than many of our own people would imagine, aggregating a total of 2,672,438 gallons of syrup upon 32,871 acres, although no allowance was made for the acreage of cane reserved for planting. The value assigned this product was \$1,003,922, and though no information is given with regard to the marketing of this syrup there is no little doubt but that domestic consumption absorbed practically the whole output at that time.

The writer has called attention in a number of papers to the fact that at certain seasons of the year even in our local markets, it is well nigh impossible to secure pure cane syrups and the demand is largely supplied by syrup from outside markets.

These imported syrups are often adulterated with corn glucose, or else are the product of reboiling syrups and molasses which have undergone partial fermentation, while in still other cases it has been found that the syrups consist in part of low grade or dark colored molasses or syrups which have been bleached or brightened by treatment with

such chemical agents as bi-sulphite of soda and pulverized zinc.

It is gratifying to note, however, that within the past two or three years there has been a marked increase in the production and consumption of the domestic article in this State, and already some little attention is being given to securing outside markets for a portion of the yearly output of cane syrup. There has also been a noteworthy increase in the number of syrup producers, and some of these newest accessions to the ranks of producers are among the most progressive in the employment of rational and improved methods of cultivation and fertilization, as well as in the utilization of advanced and intelligent methods of manufacture.

In some of the border counties of South Alabama where a few years since cane patches of only from one to five acres were to be found, there can now be seen tracts of from twenty-five to fifty acres in cane, some of which vies in luxuriance and rankness of growth with the cane grown on the rich alluvial lands of Louisiana, while the sugar content is as a rule well in excess of that of the average Louisiana product.

In a previous bulletin the writer stated that as a result of observations and investigations made by him during a residence of several years in the sugar regions of Louisiana the conclusion was reached that the lighter and more easily drained uplands in the lower Mississippi valley yielded from season to season a cane much richer in sugar and total solid matters than the rich alluvial lands of the valley, although a much heavier tonnage was produced on the latter.

The results of experiments and investigations extending throughout a still longer period in this state have shown that the cane grown on the light loamy and sandy lands in the Southern part of this state exhibits a like superiority over the product of the heavy bottom lands of Louisiana, while a good tonnage can be readily secured where a judic-

ious system of fertilization is resorted to.

Much of the South Alabama cane will show a cane sugar content of 15 per cent. and upwards, while samples containing more than 18 per cent. sucrose have been analyzed in the laboratory at Auburn. The co-efficient of purity of the juices is also almost uniformly high, and with a high content of total solids the yield of syrup per ton of cane is correspondingly large.

The following analysis of three samples of cane selected at random while on a visit to Baldwin county may serve to illustrate the excellence of much of the cane grown in that section of the State.

	Sample No. 1	Sample No. 2	Sample No. 3
Total solids	19.3	19.2	19.0
Sucrose	17.0	15.1	16.9
Reducing sugars	1.31	1.92	1.15
Solids not sugars99	2.18	.95
Co-efficient of purity	88.1	78.7	88.9

When the fact is noted that much of the Louisiana cane does not show a total solid content in the juice of more than 14 per cent. and a cane sugar content frequently not exceeding 12 per cent., the good quality of such canes as the above is rendered more apparent, and as the syrup producing capacity of a cane is practically in direct proportion to the amount of total solids in the juice, the superiority of these canes for syrup making is at once evident.

Notwithstanding the fact that cane of such high sugar content can be produced upon many of the soils of Middle and Southern Alabama, it must be admitted that prior to the last three or four years the syrup industry had made but little progress from year to year and the production of this commodity commercially had not attained very large proportions.

Among the causes and conditions that have so far contributed to the slow progress and growth of the syrup in-

dustry may be mentioned; the employment of crude and unprogressive methods in the manufacture of the syrup from the cane; the production of syrup of poor keeping quality and lacking in uniformity of composition, character and flavor, and, finally, the failure to build up a market for the product, by reason of the uncertainty of its quality and of its variable composition.

In most cases throughout the cane growing region of Alabama, small bottoms are selected for the growing of cane, and, too often, comparatively little attention is paid to fertilization. The crop is grown for several successive years upon the same plot and when the land commences to fall off in productiveness the cane patch is transferred to another bottom which, in turn, becomes the seat of cane growing operations for a number of years, to be later abandoned like its predecessor, when the limit of its producing capacity has been reached.

Fortunately, some of the more intelligent and progressive cane growers in the southern portion of Alabama have demonstrated that the flat, slightly elevated, sandy uplands, with a clay sub-soil can, with proper cultivation and fertilization, be made to produce crops of large tonnage, accompanied by a high sugar content. In that section the best results have been secured by the growing of preparatory green crops, such as cow peas, or velvet beans, which supply the soil with a good proportion of humus forming material and nitrogen, together with no inconsiderable amounts of phosphoric acid and potash brought up from the lower soil. These fertilizing materials furnish nutrition to the cane crop which is to follow, while the humus which has been added to the soil makes the latter more retentive of moisture and better enables it to withstand the droughts which may come sooner or later during the cane growing season. This preliminary treatment of the soil to be devoted to cane culture is followed up by heavy applications of a mixed fertilizer furnishing a moderate supply of phos-

phoric acid and relatively large proportions of nitrogen and potash.

A number of years ago the writer conducted a series of investigations with regard to the composition of the cane plant at different stages of growth, and also made complete analyses of the fully matured plant, including both tops, or blades, and stalks. As a result of these experiments it was ascertained that a crop of twenty tons per acre required for its production 68 pounds of nitrogen, 44 pounds of potash and 30 pounds of phosphoric acid. As the juice from the cane contains only a very small amount of these constituents, it would seem that nearly the whole amount of these materials could be restored to the soil by turning under the bagasse from the cane mill, as well as the leaves stripped from the cane, but in practice the disintegration, and the incorporation of the tough and fibrous bagasse in the soil is found to be an extremely difficult problem and in Louisiana this material is used as fuel under the sugar house boilers, while the cane leaves are burned in the field with a view to checking or preventing the ravages of the cane borer.

A glance at the proportions in which these elements occur in the cane will show at once that the cane plant has a strong predilection for nitrogen, and will enable one better to understand the good results secured from the growing of cane upon lands containing abundant natural supplies of this valuable element, or upon which liberal applications of nitrogenous manures have been made.

If the employment of progressive and rational methods is necessary in the cultivation and fertilization of the crop, the use of intelligence and skill in the manufacture of the syrup is doubly essential. Indeed, it is quite surprising that the industry in some portions of this and of the adjacent States has been conducted with any profit, whatever, in view of the crude and uneconomic methods which have obtained to a greater or less extent in the manufacture of

this commodity.

In the first place the extraction of the juice from the cane is often effected most imperfectly, and even where a mill is normally capable of extracting 65 of the 90 per cent. of the juice contained in the cane, its maximum efficiency is seldom realized for the reason that the rolls are not screwed up tightly for fear that the feeding of the mill will be rendered more difficult. On this account, many mills only give an extraction of from 55 to 60 per cent., leaving from 30 to 35 per cent. in the half crushed cane, and, even where the maximum extractive capacity of the average three roller horse mill is attained, there is still a very heavy loss sustained by reason of the unexpressed juice left in the bagasse.

As an illustration of the advantage of the employment of a modern mill of high extractive power, it might be stated that Mr. E. Smith, of Fairhope, Ala., one of the most successful syrup producers in the State, was able to secure as high an extraction as nearly 75 per cent. of juice by the use of a five roller mill purchased by him from George L. Squiers & CO., Buffalo, New York. This mill consisted of two crusher rollers together with a three roller mill of the usual type, and by its employment the yield of juice from the cane was increased more than one fourth. A mill of similar construction is in operation at the plant of the Southern States Lumber Co., at Magnolia Hill plantation, in Baldwin county.

The question of the satisfactory extraction of the juice having been solved, the next problem which presents itself is the proper clarification and evaporation of the juice, and it is in this part of the process that our present or commonly followed methods of procedure have proved most unsatisfactory and unscientific.

The removal of mechanical impurities is often effected by passing the juice through an old burlap bag, while the clarification and evaporation are conducted in a single wooden-frame evaporater, the bottom of which is covered with sheet

copper or galvanized iron, while transverse partitions, supplied with gates or openings, are designed to regulate the flow of juice or of partially cooked syrup from one end of the evaporator to the other.

As a rule, no clarifying agents are employed, and the juice running in at one end of the evaporator is hastily brought to a boil, hurriedly skimmed, and, before full opportunity has been had for the formation or removal of the blanket of impurities, the liquid is pushed rapidly along from compartment to compartment, the impurities in solution and those still left in suspension being rapidly cooked down with the syrup, giving a product dark in color, lacking in delicacy of flavor, and more readily susceptible to fermentation by reason of the presence of an undue proportion of albuminoids and other organic impurities.

As the finished product is commonly allowed to flow out in a slow, continuous stream, with no means of determining its density except by the application of the "rule of thumb," the syrup is greatly lacking in uniformity of density and quality. If, on the one hand, the syrup boiler fails to cook the syrup to a proper density, fermentation is all the more likely to ensue, while if the desirable density is exceeded the product is sure to crystallize, or "sugar," sooner or later.

In addition to all of these defects and disadvantages of the ordinary evaporator, the regulation of the heat is quite a difficult matter. A slow fire will not permit the evaporation to keep pace with the mill, while a too rapid fire may scorch the syrup or cause loss by boiling over, the usual remedy being to rake out some of the fire, or else lift the evaporator off of the furnace, while operations are always resumed after some delay with the possibility or probability of the recurrence of the same trouble after a short interval.

In order to secure the best results in clarification and evaporation, the heat should be easily and quickly controlled, so that evaporation can be accelerated or retarded at

will, or, if necessary, suspended instantaneously. The employment of steam for heating purposes is the only sure means of attaining these ends, and while it may not be practicable to utilize the steam evaporator where only a crop of 200 or 300 gallons of syrup is produced, or where the only use of the boiler employed is in the working up of a small crop of cane, still, steam evaporation can be employed advantageously upon a comparatively small crop upon farms where a boiler and engine can be used to good purpose in other departments of the farm economy. With somewhat larger crops the employment of steam evaporation will be highly desirable without regard to any other possible use of the boiler and engine, as the superiority and uniformity in the quality of the product secured fully justifies the increased initial cost of the steam plant.

As regards the clarification of the juice, a number of different methods of procedure have been adopted in various portions of the cane producing belt of the Southern States and there is naturally some difference of opinion as to the relative merits of the several processes employed.

Where a syrup of higher grade and purity, as well as of a brighter color, is desired, sulphuring and liming of the juice is resorted to, and a much more thorough removal of impurities is effected by this process. With a juice slightly acid in its normal condition the acid reaction is largely increased as a result of the sulphuring process, and a portion of this acidity is overcome by the use of a high grade lime, slaked to a thin paste. Especial care must be taken to avoid the employment of an excess of lime, and the juice should be left distinctly acid to litmus test paper, as inversion, the "bete noir" of the sugar maker, should have no terror to the syrup producer, who should delight in the presence of a large proportion of non-crystalizable sugar in his syrup.

If an excess of lime has been inadvertently added, this excess can be easily removed by the use of a small amount of high grade "acid phosphate" of lime, such as is sold un-

der the trade name of "Clariphos." This latter agent is also employed as a clarifying agent instead of sulphur fumes, and bi-sulphite of lime is also employed to no little extent as a substitute for the sulphur and lime process of clarification.

With the simplest form of sulphuring apparatus ordinarily used in small syrup plants, the juice fresh from the mill is allowed to run slowly through a sulphuring box containing a number of inclined shelves, and, as the juice trickles slowly down from shelf to shelf, it meets with an ascending current of sulphur fumes, which are produced by burning brimstone or roll sulphur in a roughly constructed brick furnace. In this way the juice is at once rendered lighter in color and when heated in the evaporator, after careful liming, the separation of albuminous matters and other impurities is affected more readily and rapidly.

To show the adaptability of even crudely constructed steam evaporators to syrup making on a small scale, experiments have been conducted at the Alabama experiment station at intervals for a number of years with the employment of two small evaporators especially devised for experimental purposes, the smaller of the two being improvised from an ordinary open-fire evaporator already on hand.

The sides of the evaporators were of wood, as usual, and the bottoms were constructed of sheet copper, but no partitions were employed as in the ordinary evaporators. A series of pipes, connected at the end by return bends were placed in the bottom of each evaporator, almost the whole surface of the bottom being thus covered, with the exception of a space about four or five inches in width, which was reserved for the collection of the scums from the boiling juice. This unoccupied space should be on the side of the evaporator opposite to the point at which the steam is admitted, and this side should be slightly lower than the other in order to facilitate the removal of the scums. The piping employed was galvanized iron, from three-fourths to one inch inside

diameter, and valves were provided for the proper regulation of the steam used in the evaporation, while another set of valves enabled the operator to prevent the too rapid escape of waste steam from the coil.

The juice, after sulphuring, is run into the small evaporator or clarifier, milk of lime is added, and the contents of the evaporator brought gradually to a temperature slightly under the boiling point. The scums and impurities come to the surface quite rapidly, the greater portion of them collecting over the space not occupied by the pipes, where they can be easily removed.

The clarifier is somewhat more elevated than the evaporator, and when the juice has been well skimmed it is at once run into the large evaporator, and the steam is immediately turned on. Fresh quantities of the juice are now run into the clarifier, boiled, skimmed and then run into the evaporator, the evaporation of the juice being conducted all the while. Any scums which form in the evaporator can be removed in the usual way, and when the syrup has reached the proper density the steam is shut off and the evaporator is emptied through the usual outlet.

By the substitution of copper coils for the galvanized iron pipe, a very much greater evaporative effect can be secured from the same heating surface and from the same steam pressure—an advantage which will in most cases, outweigh the increased first cost of the evaporating apparatus.

Many of our cane planters and small syrup producers still persist in drawing off the syrup at random, and without reference to its density, notwithstanding the fact that the Beaume hydrometer or saccharometer can be employed to good advantage in determining the point at which the syrup becomes sufficiently dense to be drawn off, and when the spindle immersed in the hot liquid reads 33 to 34 degrees the liquid can then be run out of the evaporator. Farmers in Alabama who have used the Beaume spindle report good

results from its employment, and state that by means of its use no difficulty is experienced in boiling the syrup to a uniform density.

While the flavor of a syrup is a prime consideration in the production of marketable article, the relative clearness and color of the product is an important factor in determining the price it will bring upon the market, and this fact should not be lost sight of in the clarification and defecation of the juice and syrup, though it also must be borne in mind that the employment of undue proportions of clarifying agents is liable to affect the flavor or taste to an objectionable extent.

Whether the syrup is to be marketed in barrels, cans or bottles, the receptacles in which the product is put up should be well cleaned and thoroughly scalded out or steamed and every precaution taken to exclude ferments from contact with the contents of the vessels.

As is well known, a large part of the cane syrup found on the markets after the first warm weather of the spring sets in is that which has been put up in sealed cans or bottles, and almost invariably in the former. Moreover, a syrup put up hot in a clean vessel, and securely sealed while still hot, may be preserved almost indefinitely without danger of fermentation or of crystallization of sugar.

Samples of syrup in sealed jars or bottles have been preserved at the laboratory of the Alabama Polytechnic Institute for from four to five years without any indication whatever of fermentation or separation of sugar being observed, and analyses of the syrups before and after the completion of the period of the tests, showed no appreciable variations in the composition of the article.

With the exercise of proper care in the clarification and preservation of the genuine cane syrup, the imported, or at least the adulterated article, should soon be excluded from the market, and the consumer can then be assured of the purity and good quality of the goods which he purchases.

Moreover, when it is once known that syrup of good quality and high purity and possessing the fresh taste of the original article, can be obtained in any month in the year, it will be quite easy to build up a market for such goods and the home demand will necessitate an increase in the supply of the home manufactured product, while outside markets will readily take care of the surplus production of an article whose reputation for purity and excellence of quality has become well established.

EXPERIMENTS IN SYRUP MAKING.

In addition to experiments described in previous bulletins (Nos. 66 and 103,) a large amount of experimental work in methods of syrup making has been done both at the Station and at various syrup plants in the Southern part of the State, facilities for this work having been afforded at Mr. E. Smith's place, near Fairhope, and at the syrup plant of the Southern Industrial Association near Gateswood, Ala., while visits were paid to a number of other plants during the syrup making season.

EXTRACTION OF JUICE.

A number of extraction tests were made at various steam and horse mills, and it was found that in most cases the proportion of juice extracted by the two roller and three roller mills ranged from 55 to 60 per cent. The highest extraction noted was that secured upon the five roller mill of Mr. E. Smith, to which previous reference was made, and upon some trial runs approximately 75 per cent. extraction of juice was obtained. When the fact is noted that the employment of one of the poorer grades of mills would involve a loss equivalent to five tons of cane per acre upon a crop of twenty tons per acre, the importance of securing a good yield of juice should be readily recognized.

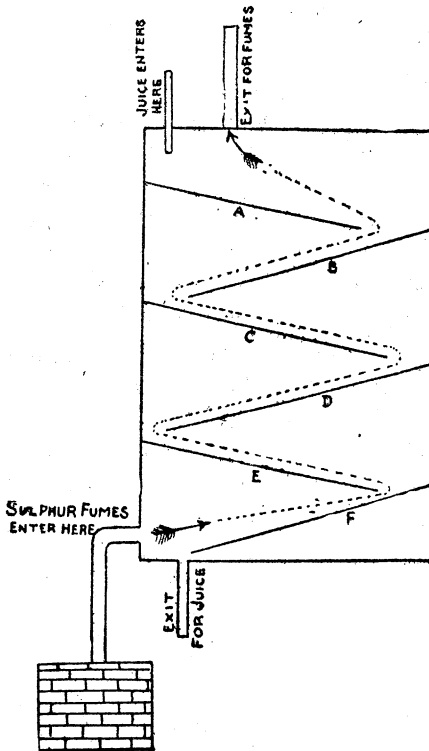
DEFECATION OR CLARIFICATION OF JUICE.

Allusion has been previously made to the common employ-

ment of burlap strainers for filtering the juice as it comes from the mill, but a strainer of fine sheet metal gauze can be used to much better advantage and can be easily kept clean. This gauze is, of course, chiefly of value in removing particles of trash, small fragments of bagasse, etc.

At some syrup plants in the southern part of the State it was noted that the juice from the mill was conducted through filters of Spanish moss, but so far as the observation of the writer has extended, the utility of this material is solely dependent upon the removal by it of mechanically suspended impurities which are found in the juice.

In bulletin No. 66, a form of sulphuring apparatus which has been much employed in Louisiana was described in detail and illustrated by a cut, this apparatus being constructed substantially as described on a preceding page in this bulletin. For the information of the readers of the present bulletin this cut is reproduced herewith.



This sulphuring box has been used to good advantage at the Experiment Station and upon some nearby farms, but as some syrup producers have experienced trouble in constructing this particular form of apparatus, it was deemed desirable to devise a somewhat simpler appliance for use in sulphuring juices, and it was soon found that a satisfactory apparatus could be improvised from a large syrup barrel of 50 or 60 gallons capacity.

Several of the upper hoops of the barrel were removed and the head was carefully taken out, in order that a couple of false bottoms might be inserted in the barrel at about one-third and two-thirds of its height, these false bottoms

being held in position by small cleats nailed to the sides of the barrel. A half inch pipe was inserted in the bottom of the barrel to provide for the outflow of juice, while a two inch pipe passing through the side of the barrel about three inches above the bottom was used to convey the sulphur fumes from the small sulphur furnace. A pipe of like dimensions fastened through the top of the barrel was employed as an exit for the fumes, while numerous perforations in the top provided for the inflow of the juice.

Straw was loosely packed between the bottom, the false bottoms and the top of the barrel, before replacing the top, this material being used to cause the juice to break up into a number of fine streams in order that it might expose a larger surface and absorb the sulphur fumes more readily. It was found that instead of perforated false bottoms a framework of small strips could be used to good advantage as a support for the straw.

The sulphur furnace to be employed in connection with the above described sulphuring apparatus can be constructed of a few brick or else a small box of sheet iron can be used. A cone of thick sheet asbestos, with the apex of the cone inserted in the end of the pipe designed to convey the fumes can also be used as a furnace in case a large volume of fumes is not required. Brimstone or roll sulphur is the form of sulphur employed and is burned in a small iron dish or in the inverted top of a tin can, comparatively free access of air being permitted.

It is desirable that the barrel be well filled with fumes before the juice is allowed to run through it and it will be noted that the escaping juice is much brighter in color, while it has been found that in many cases a sufficient absorption of sulphurous acid is affected to admit of the sulphured juice being mixed with an equal volume of the raw juice.

This department has also found that it is possible to employ liquified sulphurous acid in the sulphuring of juice, this product being obtained by condensing sulphur fumes under

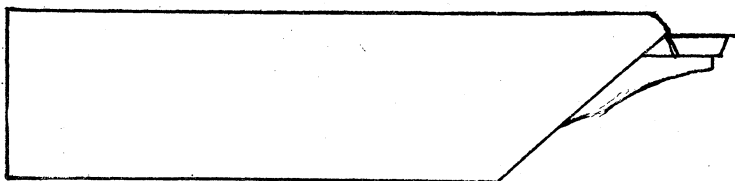
pressure in steel cylinders. A valve is attached to the cylinder and upon opening it slightly a flow of gas takes place, it being possible to conduct this gas through a tube to the bottom of a tall juice vat and as the gas bubbles up through the liquid it will sulphur it quite thoroughly. When purchased in small quantities the liquid sulphurous acid is somewhat expensive for use as a clarifying agent, but if a considerable demand for it were created in a given section, it could no doubt be secured at much lower figures.

If a settling tank is at hand the sulphured juice can be transferred directly thereto and within an hour or two it will be found that a considerable proportion of the impurities of the juice have separated from the main body of the liquid, rendering its subsequent clarification more easy.

The juice is next transferred to the clarifier or small evaporator previously described, and heated up slowly to the boiling point, milk of lime (in the form of a whitewash, free from lumps,) being added until the juice is left only slightly acid as indicated by litmus test paper. The juice is then brought to a brisk boil, so that the blanket or coating of scums rises and shows a number of cracks and seams on its surface, after which the heat is partly cut off and the scums are removed.

A deep form of clarifier is more effective than a shallow one and as before suggested it is desirable that a space unoccupied by the coil of steam pipe be left either at the side or end of the clarifiers and evaporators. It will also be found advantageous to have one end of the clarifier inclined at an angle of about 40 or 45 degrees to the horizontal, the scum trough being attached to the inclined end of the evaporator.

The following cut shows the side elevation of such a clarifier and also the position of the scum trough.



SIDE ELEVATION OF CLARIFIER.

In a clarifier of this character the scums can be pushed along easily by a broad wooden skimmer from one end of the vat to the other, being easily brushed over the inclined end of the clarifier into the scum trough.

Although the use of lime as a clarifying agent is recommended in connection with the employment of sulphur, it is quite possible to secure good results from the use of sulphur, even where lime is omitted, though the sulphur fumes in the absence of lime would give the juice quite a perceptibly acid re-action. Instead of the employment of sulphur fumes for brightening or bleaching the juice, bi-sulphite of lime may be used in the proportion of one quart to 50 gallons of juice, although it does not usually yield quite so bright a syrup as does the juice treated with sulphur fumes. This chemical can be purchased from I. L. Lyons & Co., New Orleans, La., and is prepared by the action of sulphurous acid or sulphur fumes upon milk of lime.

In conjunction with sulphur, or in the entire absence of sulphur, acid phosphate of lime may be used as a clarifying agent and in many cases with most excellent results.

The preparation of acid phosphate used by this department was sold under the trade name of "Clariphos," and was purchased from J. Watts Kearny & Sons., New Orleans. This is simply a strong solution of acid phosphate of lime, which is free from any objectionable impurities and has been prepared especially for use as a clarifying agent in sugar factories.

Prior to the application of this agent the juice must be treated with lime until the original acidity of the juice has

been neutralized and the manufacturers of this preparation even recommended that lime be added in slight excess, or until red litmus test paper changes to a slight blue. At this point the clariphos is added in the proportion of one-half gallon to 1000 gallons of juice it being diluted somewhat with water before adding it. Experiments made by the writer indicate that for syrup making it may be used advantageously in as large a proportion as one gallon of clariphos to 1000 gallons of juice.

After addition of this agent, the juice is boiled gently for a moment or two, the heat is turned off and the juice allowed to settle in the clarifier, or else it is run off in a settling tank. The lime which was added previous to the clariphos combines with the free acid of the latter, forming a bulky precipitate which settles rapidly, carrying down with it a large amount of organic impurities and suspended matter and leaving a clear, bright juice, which can easily be drawn off from the sediment. In this connection, it must be noted that the juice should be thoroughly skimmed or brushed after the addition of the lime and before the addition of the "Clariphos," and especial care should be taken to see that the milk of lime is free from lumps or granular particles.

Where agents other than clariphos are employed in clarification and in case considerable suspended matter is still present in the clarified juice, bag filters may be used to some advantage in the removal of much of this suspended matter.

The form of bag filter best adapted to this purpose is a long slender bag of closely woven texture which is supported by an outer bag of coarse netting, the two being suspended from the top of a tall wooden box or chamber which can be closed tightly, so that the interior of the compartment may be well heated by a jet of steam. The juice is allowed to enter the filter through an opening in the top of the chamber, and is drawn off from the bottom into a settling tank or into an evaporator.

By admitting steam to the filtering chamber, the filter and the juice being filtered are both kept hot and the filtration, in consequence, can be effected more rapidly.

This department is under obligations to Mr. West Livan-dais, New Orleans, La., for filter bags kindly donated for use in experiments conducted during the past season.

In case the syrup plant is supplied with a sufficient number of deep clarifiers, the juice may be advantageously evaporated down to semi-syrup in them before being transferred to the final evaporator or an intermediate evaporator may be employed between the clarifiers and the finishing pans. Where this plan is adopted, the semi-syrup is generally allowed to attain a density of from 20 to 25 degrees Beaume, hot, before being transferred to the last evaporator of the series.

Experiments were made during the past season in connection with the employment of sand filters for the removal of suspended matters from the semi-syrup, and where sand of pure quality was employed, some fairly good results were secured.

It was found necessary to wash even the best sand for some little time in order to remove clay and finely divided matter, whose presence rendered the wash water turbid, and when the sand finally permitted the water to pass through clear, it was found that the syrup would also pass through the sand filter comparatively clear and practically free from suspended matter. The sand filter was arranged by employing a tray or shallow box, the bottom of which was constructed of coarse wire gauze, covered by a coarse cloth, upon which a layer of sand of one and a half to two inches thick was placed.

Unless very pure sand, requiring very little washing be used, the employment of sand filters may be found troublesome, however, and the sand will, of course, have to be renewed frequently. Filters of this kind, nevertheless, would serve quite a good purpose in case some special lot of semi-

syrup contained an excessive amount of suspended matter, which previous treatment in the defecators had failed to remove.

The concentration of the syrup in the final evaporators is continued until the Beaume hydrometer registers about 34 degrees in the hot syrup, and where there is only a thin layer of syrup left in the evaporator, it may be advisable to shut off steam when the instrument registers 33 and one half degrees, as the hot syrup in contact with the hot pipes which may still contain a little steam, will probably evaporate a little further before it can be drawn off.

For the removal of finely divided suspended particles from the hot syrup, the employment of cotton batting which was suggested and tried last season by Mr. A. F. Cory, at the syrup plant of the Southern Industrial Association, Gatewood, Ala., appears to be quite advantageous and good results were secured both by Mr. Cory and also by the writer in some experiments conducted at Auburn. The kind of cotton batting employed in the syrup filters was the same as that used by the turpentine distillers, one surface of the goods being glazed, while the other surface was rough. The batting was placed upon coarse wire gauze in a shallow box or tray and the syrup was allowed to flow on the filter in such a way as to obviate the possibility of washing a hole through the cotton filter, the liquid being diffused over the whole surface of the material.

Previous allusion has been made to the importance of thoroughly scalding out and steaming the containers in which the syrup is to be put up, and too much care and caution cannot be given to the matter of excluding ferments or bacteria from the packages if an article capable of long preservation is desired.

As regards the arrangement of the settling tanks, vats, clarifiers, evaporators, etc., in the syrup factory, the writer would say that the plan adopted by the Southern States Lumber Co. at their plant at Magnolia Hill plantation in

Baldwin county is a most excellent and convenient one. The juice from the mill is pumped to settling or storage tanks placed on the highest floor in the building, the juice from these tanks being allowed to flow by gravity to the clarifiers or defecators, of which there was one for each storage tank on the next lower floor. The juice or semi-syrup from the defecators was also conducted by gravity to settling tanks on the next lower level, and from there to the large evaporator or finishing pan on a still lower level.

The packing of the syrup was carried out on the ground floor of the plant, the natural slope of the ground having favored the arrangement of the interior of the establishment in the manner described—an arrangement which greatly facilitated the operations of the factory.

SMALL CENTRAL SYRUP PLANTS.

Several years since the writer advocated the idea of the operation of small central syrup-making plants in connection with steam gins which are found occurring in such close proximity to each other throughout much of the cane growing territory in this State and practical demonstrations of the feasibility of the plan were made during the past two seasons. Since many of these neighborhood gins suspend operations before any destructive freezes occur, the motive and steam power of these establishments can be utilized to good advantage in making syrup.

During the present season an experiment along this line was made at the place of Mr. J. C. Moore, near Auburn, only a few hours being required to install the clarifiers and evaporators and to make the necessary connections with the boiler, while all the apparatus worked satisfactorily from the beginning of the experiments and quite a good article of syrup was produced.

As before stated, wherever a boiler of sufficient capacity is in use for ginning, milling or other purposes, it is quite a simple matter to instal a syrup making outfit, and where

new steam gins are established in cane growing regions, sufficient steam power can be provided to meet the combined requirements of a syrup plant and steam gininery.

By the adoption of such a plan, small central syrup factories could easily be put in operation throughout a large portion of Southern and Middle Alabama, and the introduction of improved methods of manufacture would quickly follow upon the inauguration of such a system.