My invention comprises a complete process by which the bagasse of sugar cane may be treated to produce therefrom an excellent grade of cellulose. My invention is an improvement over that disclosed and claimed in my Patent No. 1,680,147, dated May 24, 1927, an application for a reissue of which is now pending. The present application is a continuation in part of United States application Serial No. 192,785, filed May 19, 1927.

Attempts to manufacture cellulose from the bagasse of sugar cane have heretofore entailed considerable expense and have likewise resulted in a product that was not readily bleachable except with such strong bleaching solutions as attacked the fibre, reduced the yield, and resulted in a product of insufficient strength and hence was not suitable for the manufacture of high grade paper.

My process includes also the production of various by-products whereby great economy is effected not only in utilization of substantially all the ingredients of the bagasse, but also in complete utilization of the various chemicals employed, resulting in a minimum of waste.

In practicing my process I first reduce the moisture content of the bagasse as it comes from the mill and thereafter separate the longer fibres suitable for cellulose manufacture from the epidermis, parenchyma, and shorter fibres. The drying of the bagasse and the subsequent separation of the fibres is preferably carried out by the process described and claimed in my co-pending application Serial No. 366,825 filed May 29, 1929. This process comprises air drying of the bagasse over a period of one or two weeks in a building provided with perforated floors and side walls open to the atmosphere, the bagasse being loosely spread about one or two feet deep on the perforated floors and a gentle current of air forced through and over the bagasse. The bagasse is then treated preferably in a hammer-mill which breaks up the hard epidermis into a powdery form and partially opens up the fibrous part to the parenchyma and smaller fibres from the longer fibres. By means of screens and air flotation the longer fibre is then separated from the other parts of the bagasse and further separation of the smaller fibres and the parenchyma from each other and from the epidermis and foreign matter is effected.

The materials are then ready for chemical treatment by my improved process. In order to make clear the present process I will describe a treatment of a specific quantity of bagasse fibres together with specific quantities of the various chemicals to be employed. I wish it understood, however, that the various quantities given are representative only and are not to be taken as limiting my invention except as so limited in my claims. To a quantity of about 300 kilograms of dry bagasse fibre, separated from other ingredients by the preliminary process above described, I add about 1200 to 1500 liters of a clear saturated solution of lime. I heat the fibres and lime solution together for about one-half hour preferably first by steam allowed to enter directly into the solution, and then by passage of steam through heating coils, while maintaining the temperature below the boiling point, preferably at a temperature of about 90° C. This treatment of the fibres is of particular value as a step in the elimination of the natural coloring matters and of the sugar content, which latter amounts to about one and one-half to three per cent. or even more of the weight of the dry bagasse fibres. It is absolutely essential in order to obtain a good grade of paper stock for the sugar to be completely eliminated as otherwise it is impossible to bleach to a pure white product. After the lime treatment, and while the fibres are still immersed in the lime solution I add a cold solution containing sodium sulphite. With the quantities above mentioned I add 300 to 500 liters of the sodium sulphite solution, the amount of the sulphite in solution being about one-half to two per cent. of the fibre weight. Preferably the entire quantity of sodium sulphite amounting to about one and one-half to six kilograms, is dissolved in about 100 liters of water, and 200 to 400 liters of water are added cold to the solution in the cooker to reduce the temperature thereof to...
about 60 to 75° C. prior to the addition thereof of the cold sulphite solution. This prevents the loss of sulphite which might otherwise occur if the temperature were maintained constantly at the higher temperature of 90° C. While I have found a solution of sodium sulphite (Na₂SO₃) satisfactory for this step in my process, any solution which has an equivalent sulphite ion concentration and equivalent alkalinity is a suitable solution. After the addition of the sulphite solution, the mixture is now heated up to the initial temperature by means of steam for about one-half to one hour which time I have found sufficient for my purposes. I have found that this treatment of the fibres, first with clear saturated lime solution and then with the sulphite and lime solution, insures substantially complete elimination of the sugar content and also of the natural coloring matters. I believe this to be due to the partial opening up of the fibre by the alkaline solution to permit the sugars to go into solution and perhaps also to the enhanced solubility of the sugars in the presence of lime. The sulphite solution, I believe to be of particular value in connection with the elimination of the natural coloring matters. After this treatment I draw off so much of the solution as may be readily removed from the fibres, which amounts to about 1,000 liters or two-thirds of the total employed. The fibres are then washed with hot water and/or steam and I may add if convenient the wash water to the solution already drawn off. This solution, which I will call “solution A” is used in connection with by-product manufacture, as will be pointed out hereinafter.

The next step of my process comprises the addition to the washed fibre of a weak caustic solution, comprising about 1,000 liters of caustic potash, caustic soda and sodium or other suitable sulphite in the proportions of about .3 to .6% caustic potash, 3½% to 5% caustic soda and 1½ to 1½% of the sulphite. The mixture is now heated by the addition of live steam in quantity sufficient to add about 200 liters of water to the solution and the temperature maintained around 130° C. for from four to eight hours. The treatment is effected in a closed cooker, the pressure within which is accordingly raised to about 1½ to 2½ atmospheres.

The particular proportions of the various chemicals depend upon the age of the bagasse and also upon the soil in which the sugar cane is grown. In place of the caustic soda additional caustic potash could be used, but this is not preferred on account of the greater expense involved. During this treatment the silica is removed by the caustic po ash, the vegetable glue is dissolved, the last traces of the coloring matter are destroyed, the resinous matter and vegetable wax are saponified or emulsified by the combination of chemicals used, and any epidermis or parenchyma remaining with the fibres has been so acted upon as to render them harmless during the further treatment and manufacture of the cellulose. At the end of the cooking process samples of the solution and of the fibre are taken in order to ascertain whether the proper stage of purity of the cellulose has been reached, and if it has the pressure is reduced to about one atmosphere and the solution, which I will call “solution B”, drawn off and saved for by-product manufacture. The fibre is then washed with hot water or steam until the water runs practically clear. The fibre is then removed from the cooker and placed in hollanders or beaters where it is beaten in a lukewarm solution of about 28° C. to 33° C. of soap preferably of the type of Marseilles soap; about one to three kilograms of the dry soap being in solution in about 1,000 liters of water. The material in solution is then heated in the beaters to about 50-70° C. The soap solution washes out the last traces of the resins, waxes and gums. This solution is then removed and may, if desired, be saved for by-product manufacture. The fibre remaining is then thoroughly washed with lukewarm water having a temperature of 30° C. to 35° C. in the same beaters and bleached in any well known manner.

I have found it of particular importance that the lime solution and the solution of sulphite added in the initial part of my above described process be added separately with sufficient time elapsing before the sulphite solution is added, to insure the full respective effects of these reagents. By the separate addition of these solutions I am able to eliminate substantially all of the sugar and coloring matter and hence obtain cellulose that can be readily bleached without loss of strength of the resulting material.

In the latter part of my process it is of particular importance to add the soap solution after the removal of the caustic solution and the subsequent washing of the fibres. If the soap solution is added while the caustic solution is still in the cooker a kind of wax soap is formed which adheres in lumps to the cellulose and is most difficult to remove therefore, requiring an immense quantity of hot water, and even after all this washing the fibres remain slippery to the touch, and are therefore not readily workable with the usual paper making machinery.

The recovery of by-products is of importance in my novel process as it substantially lowers the cost thereof. By-products obtainable from my process include high grade cellulose from the short fibres of the bagasse, when these are not added to the longer fibres in the above process, sweetening syrups, fertilizers, filling material for the plastic arts or...
for explosives, waxes, resins, glues, etc. A description of the various processes by means of which these by-products may be obtained will now be given.

In my above mentioned coupling application, the separation of the short fibres from the parenchyma and epidermis is described. This separation, briefly, is effected by air flotation methods to first remove the powdered epidermis and dust, followed by screening, using slit screens through which the shorter fibres pass, leaving the parenchyma behind. I have found that a very excellent grade of cellulose, very high in alpha content, may be obtained from these separated short fibres.

According to marketing conditions these may be added directly to the long fibres and treated therewith by my above described process or treated separately for by-product manufacture. These shorter fibres when separated in the above manner are freer from adhering parenchyma, etc. than are the longer fibres, and I have found that they are particularly suitable for the production of a special high grade of alpha cellulose from which artificial silk of a quality superior to that hitherto produced may be manufactured. When treated for the production of such high grade cellulose, the short fibres are treated separately by a process similar to that described for the longer fibres. As by my process hereinafter described, I recover sweetening syrup from solution A and resins, waxes, glues, etc., from solution B, I prefer to use these solutions in treating the short fibres, in order to make those solutions as rich as possible in the recoverable ingredients. In treating the short fibres for the production of artificial silk, I first use solution A just as it comes from the cooker after treatment of the long fibres, and then recondition it by agitation of clear lime solution and after the treatment with this solution add fresh sulphite solution. The short fibres are then treated in solution B which may also be reconditioned, or solution B may be withdrawn and fresh solution used, which latter may be in turn used for treatment of the longer fibres. After the alkali treatment the short fibres are washed, beaten in soap solution and bleached, as in the case of the longer fibres. The resulting cellulose is then ready for treatment for the production of artificial silk of unusually high quality.

Without reconditioning the solutions, and employing only such temperatures as may be obtained from exhaust steam of the plant, I may obtain a by-product from the short fibres of considerable strength and of a very good light color, suitable, without bleaching, for newspapers or the like or suitable when bleached for other uses of cellulose. It is not essential to use solution A in this case, but its use is preferred in order to enrich the solution with the sugar from the fibres.

When using the unconditioned solutions, I agitate the short fibres for from four to six hours in solution B, maintain the temperature at about 90° C. by exhaust steam of the plant and then wash them, using preferably the wash water from the longer fibres and finally treat the fibres with the soap solution, which may also be that used in the treatment of the longer fibres.

Vegetable waxes, glues, and resins are precipitated by the use of acids or in any other known manner from the alkali solution after its use in treating the fibres.

The parenchyma, separated in the first part of my process from the other components of the bagasse, may be sold without treatment as a filler for explosives, or, if desired, the sugar contents contained therein may be recovered, and the remaining material used for other purposes.

The sugars, which amount to about 3% to 5% of the total, may be removed from the parenchyma by treatment with so much of solution A with or without addition of fresh lime and sulphite solution as is necessary to bring the sugars into solution. This solution is then drawn off combined with all of solution A remaining from the treatment of the long or short fibres, which solution contains the sugars removed from the fibres and added to the molasses of the sugar plant in such proportions as to reduce the specific gravity to 8° to 12° Bé. This mixture I then pass through filter presses, condense the filtrate to about 33° Bé, bleaching at the same time to a crystal clear syrup containing the sugars. This syrup is of value as a sweetening material for edible products. It has a peculiar and pleasant aroma and flavor, which I believe to be distinctive in my particular process and to the materials from which it is produced.

The parenchyma, after the above extraction of the sugars, may be sold separately as filling material for the plastic arts, or may be added to the separated epidermis and dust and the whole used as a fertilizer, as may also be used the filtrates remaining in the presses after filtration of the sugar containing solution.

I have now described my novel process in considerable detail, and given a representative treatment of a particular quantity of the bagasse. I have described as well various methods by which each of the constituents of the bagasse may be utilized in by-product manufacture with a minimum of waste not only of the bagasse but also of the various chemicals employed. Certain of the by-products and processes for their recovery disclosed herein are not claimed in the present application, as they form the subject matter of applications hereinafter to be filed. The particular by-products produced, and consequently the treatment thereof, will depend
to a great extent upon the proximity to the plant of markets for the products and upon the facilities of the plant for storage, etc. Also the cost of manufacture of chemicals in relation to the price obtainable from the products must be taken into consideration. For example, in some instances, it may be preferable to treat the short fibres for the production of cellulose for news print manufacture, thus reducing the expense insofar as chemicals are concerned, but giving a poorer grade cellulose, whereas at other times it may prove more economical to condition solutions A and B in order to produce cellulose for artificial silk. Similarly, in some instances it may be preferable to sell the parenchyma without treatment, while again, recovery of the sugars therein may be expedient.

The cellulose obtained by my improved process is of a particularly fine quality. It has a high alpha content and is readily bleachable to a pure white color.

I claim:

1. A process for treating bagasse fibres which comprises first treating the fibres in a clear saturated solution of lime, later adding thereto a solution containing a suitable sulphite then treating the fibres in a solution containing caustic potash and a suitable sulphite and subsequently washing the fibres in a soap solution.

2. A process for treating bagasse fibres which comprises first treating the fibres in a clear saturated solution of lime, later adding thereto a solution of sodium sulphite, then treating the fibres in a solution containing caustic potash, caustic soda and sodium sulphite and subsequently washing the fibres in a soap solution.

3. A process for treating the bagasse of sugar cane which comprises first separating epidermis, parenchyma, and other foreign materials from the fibres, then treating the separated fibres in a clear lime solution and heating the same while maintaining the temperature below the boiling point, then reducing the temperature while adding an alkaline solution containing sulphite ions and again heating to a temperature below the boiling point, then removing the solution and thereafter treating the fibres with a weak alkali solution.

4. A step in the process for treating the bagasse of sugar cane which comprises heating bagasse fibres with a clear lime solution to a temperature in the neighborhood of 90° C, then reducing the temperature to about 60° C by the addition of cold water and thereafter adding a solution of sodium sulphite and raising the temperature to its initial value.

5. A process for treating the bagasse of sugar cane, comprising first separating short fibres, epidermis, dust and parenchyma from the longer fibres, then treating the separated longer fibres in a clear saturated solution of lime, followed by the addition thereto of a solution of sodium sulphite, then removing the solution, washing the fibres and then heating the same in a solution, containing caustic potash, caustic soda and sodium sulphite, then removing the solution and again washing the fibres, and finally beating the fibres in a heated solution of soap.

6. Additional steps in the process according to claim 5 comprising separating the shorter fibres from the other material separated from the longer fibres, then heating the separated short fibres with the alkali solution removed after the treatment of the longer fibres, then washing the shorter fibres and heating in a weak soap solution.

7. Steps in the process of treating the bagasse of sugar cane which comprises heating separated fibres of bagasse in a caustic solution containing caustic soda, caustic potash and sodium sulphite to a temperature of about 130° C to remove the resinous matters and silica and to dissolve the glues, then removing the solution, washing the fibre, heating the washed fibre in a weak soap solution, and finally washing and bleaching the fibres.

8. A process for treating the bagasse of sugar cane which comprises first reducing the moisture content of the bagasse, then mechanically separating the longer fibres from the remainder of the bagasse, treating the separated fibres in a clear lime solution to which a solution of sodium sulphite is added thereafter, then removing the solution from the fibres, washing the fibres and subsequently treating the fibres in a weak caustic solution.

9. A step in the process of treating the bagasse of sugar cane which comprises treating separated fibres of bagasse in a clear lime solution while maintaining the temperature below the boiling point of the solution, then adding a cold solution of a suitable sulphite and reheating the mixture to a temperature below the boiling point.

10. The process according to claim 9 wherein in the sulphite solution is sodium sulphite in amount equal to about one-half to two percent of the weight of the bagasse fibres.

In testimony whereof, I have signed my name to this specification.

ERNEST CHARLES HEMKER VALET.