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CONTINUOUS DIGESTING OF CELLULOSIC FIBROUS MATERIAL AT DECREASING PRESSURE WITH MECHANICAL DEFIBERING THEREBETWEEN

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2 Sheets-Sheet 1

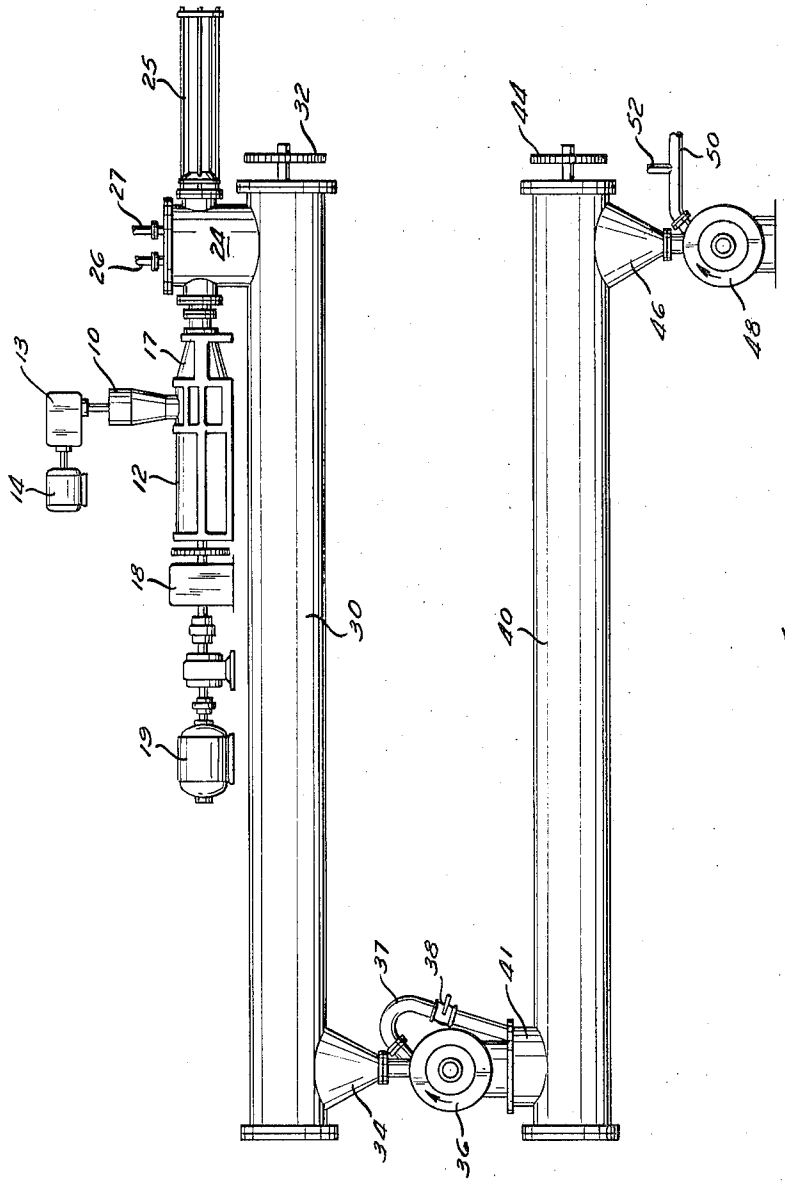


Fig. 1

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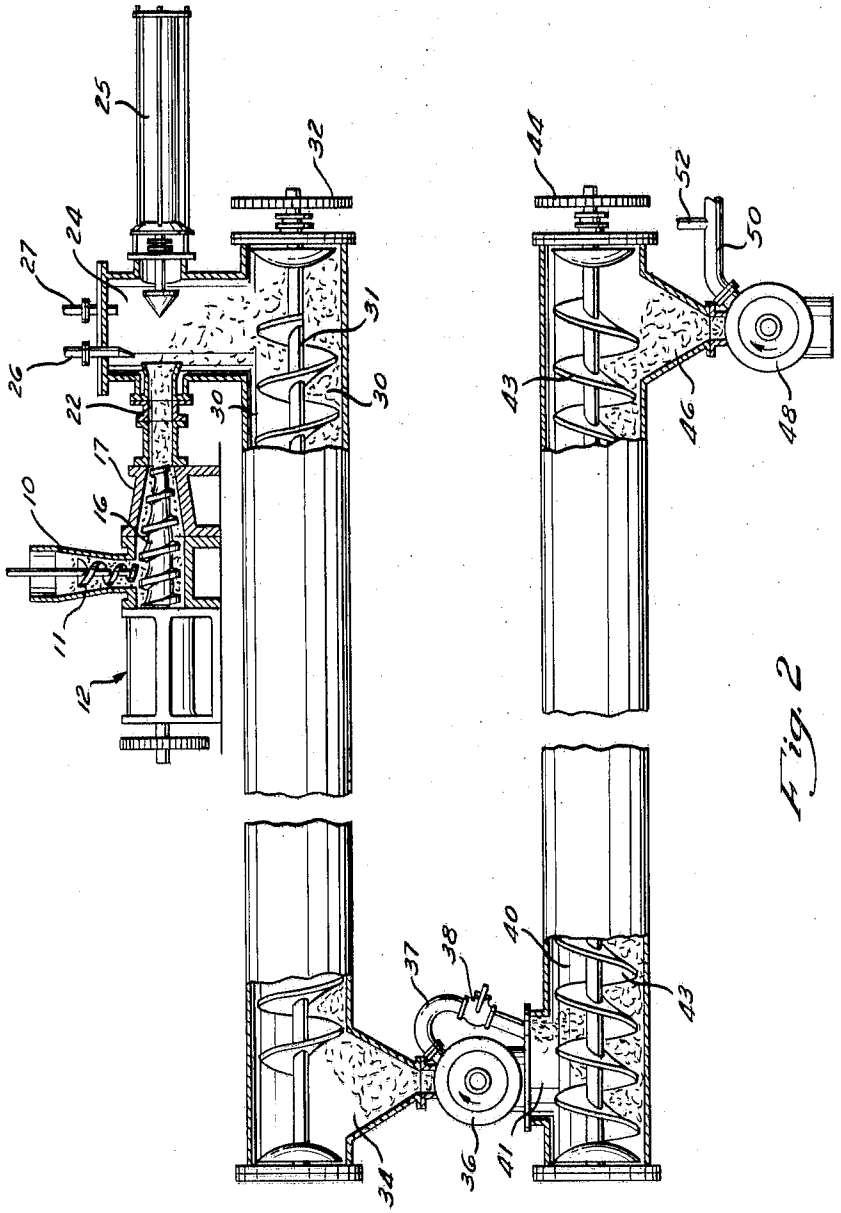


Fig. 2

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CONTINUOUS DIGESTING OF CELLULOSIC FIBROUS MATERIAL AT DECREASING PRESSURE WITH MECHANICAL DEFIBERING THEREBETWEEN

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This invention relates generally to the production of pulp from cellulosic material and more particularly to processes for obtaining paper pulp from bagasse.

Sugar cane bagasse is the residue of the cane remaining after the sugar containing juices have been extracted. This extraction is accomplished by feeding the bagasse into crushing rollers and then through extraction rollers so that the bagasse as it leaves the final expressing mill comprises broken particles of relatively low residuary moisture containing a mixture of pith cells and fiber and only a relatively few percent of the original sugar. It has been recognized that bagasse has an excellent potential as a source for cellulosic fibers for preparing pulp for making various grades of paper and paperboard.

However, there has been little commercial use of bagasse for this purpose because of problems encountered in refining bagasse into a suitable pulp by any of the usual paper making processes. Bagasse contains a large amount of pith and lignin which must be separated from the desirable fibers in order to produce a finished product of the required strength, flexibility and color. It has been found that when the bagasse is treated with pulp processing chemicals for extracting the undesirable portions from the fiber in the usual concentrations and at the usual temperatures and pressures employed for wood pulp, the bagasse fibers become damaged by loss of some of their mechanical strength and tend to darken from the exposure to high temperature. On the other hand, efforts to process bagasse using a lower concentration of chemicals and lower temperatures have required a process time so long as to be economically unfeasible and results in a product of varying quality.

It is therefore a principal object of this invention to provide a novel process for the continuous production of high grade pulp from bagasse in which the bagasse is given an initial softening and chemical impregnation step in a saturated steam zone at elevated temperatures and pressures, followed by a mechanical defibration at the same temperature and pressure followed in turn by continued exposure at elevated temperatures and pressures to complete the refining and cooking of the pulp.

It is another object of this invention to provide a novel process for the continuous production of high grade pulp from bagasse as set forth in the preceding object in which following the final cooking, the pulp is passed through an additional mechanical defibrating step in which the temperature and pressure are lowered in the defibrator.

It is another object of this invention to provide a novel process for the continuous production of high grade pulp from bagasse which may be carried out using saturated steam in a pressure chamber at lower temperatures and pressures than has heretofore been possible.

It is another object of this invention to provide a novel process for the continuous production of high grade pulp from bagasse which allows the production of a high grade of pulp with a reduced amount of chemicals for separating the lignin and other non-cellulosic materials from the fiber.

It is another object of this invention to provide a novel process for the continuous production of high grade pulp from bagasse which is adaptable to a wide variety of chemical processes in combination with the mechanical processing action.

Still another object of this invention is to provide a novel process for the continuous production of high grade pulp from bagasse which gives an improved and high quality pulp at a minimum cost and requiring a minimum amount of chemicals and processing time.

Further objects and advantages of this invention will readily become apparent to those skilled in the art upon a more complete understanding of the invention as described in the following detailed description of the preferred embodiment of the invention and the apparatus for carrying out the process as shown in the drawings in which:

FIGURE 1 is a side elevational view of the apparatus employed with the process of this invention; and

FIGURE 2 is an enlarged elevational view similar to FIGURE 1 with parts broken away to show the internal construction of the apparatus.

In the apparatus of FIGURES 1 and 2, the bagasse fiber is delivered to an inlet **10** and from there fed by means of a screw **11** into a pressure feed **12**. The screw **11** may be driven in any convenient manner such as by the gear box **13** and motor **14**. The pressure feed **12** has a feed screw **16** which extends into a tapered conical section **17** and is driven by a gear box **18** and motor **19**. The tapered conical section **17** is joined by a plug section **22** to one side of a receiving chamber **24**. The receiving chamber **24** is also provided with a blow back control indicated generally at **25** together with a steam inlet pipe **26** and a chemical inlet pipe **27** through which the necessary chemicals are added to the pulp during processing. The pressure feed **12** and the plug section **22** serve to close off the opening of chamber **24** by means of a plug formed by the fiber being fed so as to maintain the necessary pressures and temperatures within the reaction zone, while allowing additional bagasse to be fed at a continuous and controlled rate.

From the receiving chamber **24**, the bagasse passes into one end of an elongated cylindrical impregnating chamber **30** within which is a screw conveyor **31** which may be rotated through a drive gear indicated at **32**. The screw conveyor **31** serves to slowly and uniformly convey the material from the receiving chamber **24** to the outlet **34** while providing sufficient agitation to allow a thorough exposure of the bagasse to the steam and chemicals within the impregnating chamber. By controlling the rate of rotation of the screw conveyor **31**, the length of time in which the fiber remains in the impregnating chamber **30** may be controlled as desired. The outlet **34** from the impregnating chamber **30** is connected to a disc refiner or defibrator **36** which may be any of the usual types well known in the art employing rotating discs which abrade and rub the fiber bundles to break them apart and separate them into smaller pieces so that they may be acted upon more efficiently during subsequent treatment.

The disc defibrator **36** has an outlet pipe **37** which is connected through a valve **38** to the inlet **41** of the digesting chamber **40**. The digesting chamber **40** is similar in construction to the impregnating chamber **30** and is provided with a screw conveyor **43** also driven by suitable means by drive gear **44**. The rotation of the screw conveyor **43** in the digesting chamber **40** may be controlled independently of the rate of speed of the screw conveyor **31** in the impregnating chamber **30**, so that the period of time in which the fiber remains in each of these chambers is independently variable.

At the end opposite inlet **41**, the digesting chamber **40** has an outlet **46** to discharge the treated fiber pulp into a second disc refiner **48** to give further treatment to the fiber and finish the pulping action. From the second disc

refiner **48**, the finished pulp is discharged through an outlet **50** which is provided with a pipe **52** for injecting water into the pulp to prevent vaporization of the steam contained therein. This construction requires no blow chamber for receiving the discharged pulp from the digesting chamber **40**, since a pressure drop takes place in the disc refiner **48** and the water added through pipe **52** serves to cool the pulp and prevent any flashing as the pulp is discharged at atmospheric pressure.

The bagasse used in this process may be either the whole bagasse as it is discharged from the sugar expressing mills, or it may be cleaned and refined to reduce the pith content. It is recognized that a high pith content in the finished product results in a lower grade pulp, while removable of substantially all of the pith will allow the production of newsprint grade pulp. While the use of depithed bagasse will result in a higher grade end product and will require a shorter processing time and a reduced amount of chemicals, for a lower grade pulp it may be more desirable to use the whole bagasse to avoid the additional depithing step prior to the pulping process.

When the bagasse enters the receiving chamber **24**, it is in the form of pieces which consist of large bundles of fiber locked together by pith, lignin and other substances which must be removed from the finished pulp because of their detrimental effect on the properties of the products produced therefrom. Saturated steam is introduced into the receiving chamber **24** and impregnating chamber **30** through the steam pipe **26** to maintain a pressure of about 150 p.s.i.g. and the corresponding temperature of 366° F. This has been found to be the optimum temperature for maintaining sufficient speed of pulping action while preventing excessive degradation of the cellulose. As the bagasse moves through the impregnating chamber **30**, the bagasse particles are thoroughly impregnated by the chemicals added through the pipe **27** and a complete mixing takes place. By the time the bagasse reaches the outlet **34**, the softening of the fiber bundles has reached the point where mechanical action can be used to separate the fibers without causing excessive breakage and degradation that would occur if the mechanical defibering action were done prior to the softening and impregnation.

The bagasse particles then enter the disc defibrator **36** where the bundles are mechanically broken apart and the fibers separated to increase the area upon which the chemicals may act during the final stages of pulping in the digesting chamber **40**. The mechanical action of the disc defibrator **36** is improved by the fact that this action takes place at the full temperature and pressure of the saturated steam within the impregnating chamber **30**. As the bagasse leaves the defibrator **36** through the outlet pipe **37** to enter the digesting chamber **40**, flow of the bagasse is maintained by having a pressure drop of approximately 15 p.s.i. so that within the digesting chamber **40**, the saturated steam is at a pressure of 135 p.s.i.g. and the corresponding temperature of about 358° F.

As the defibered bagasse pass through the cooking and digesting chamber **40**, the screw conveyor **43** maintains a mixing action as the bagasse is conveyed toward the outlet **46** to complete the pulping process which now proceeds at a rapid rate since after the defibration the fibers have a much greater area exposed for chemical action. When the fibers reach the outlet **46**, they pass into the disc refiner **48** to allow further refining and homogenization of the fiber size by the abrading action of the discs. A pressure drop takes place within the disc refiner **48** so that when the fibers are discharged into the outlet **50** as finished pulp, the pressure and temperature is much lower than that within the digesting chamber **40** and there is no need to provide a blow tank to receive the fiber. To further avoid possible flash as the pulp is discharged, water is added through the water pipe **52** to reduce the temperature of the pulp so that it may be discharged into the atmosphere for further processing action.

Depending upon the quality of the bagasse used in the process, and the chemicals employed in the pulping action, the quality of the finished pulp may be varied from what is known in the art as semi-chemical pulp to standard quality sulphite, soda, soda-sulphite and sulphate pulps. The amount of chemical consumption in the pulping process is reduced from that normally required by about 40%, and for example where the chemical equivalent would be 500 pounds per ton of finished pulp with the usual prior art process, pulp of similar quality may be produced in this process using a chemical requirement of only 300 pounds. This process requires a total treatment time of approximately 30 minutes in both the impregnating and digesting chambers, and while this time is relatively long, the length of the chambers may be such as to maintain a high rate of output in spite of the treatment time.

In producing a purified pulp from bagasse similar to standard grades of unbleached sulphite and soda pulps, a yield from whole bagasse of 50% is obtained and the yield from clean bagasse fiber will reach 65%. This pulp may be blended with an equal amount of groundwood pulp to produce a highly satisfactory sheet of paper of newsprint grade. Using the semi-chemical pulp process, a yield from whole bagasse will be approximately 60% and from clean bagasse approximately 80% and the resulting pulp will produce a satisfactory sheet of paper suitable for use in the manufacture of corrugated board and containers.

It is pointed out that this process is not limited to the use of sugar cane bagasse as the fiber source, but has been discussed with respect to bagasse because of the difficulties of the prior art in producing suitable grades of pulp from bagasse. It is understood that this process is adaptable to the production of pulp and fiber from other materials such as wood, wood waste, linters and the like. Further modifications and rearrangements of this invention will readily become apparent to those skilled in the art and may be resorted to without departing from the scope of the invention as set forth in the following claims.

What is claimed is:

1. The process of producing pulp from cellulosic fibrous material comprising forcing the fibrous material into a first chamber, introducing into said first chamber pulping chemicals and steam to maintain therein a first pressure substantially higher than atmospheric pressure and the corresponding temperature of saturated steam, agitating the material in said first chamber to heat the material substantially to said saturated steam temperature, discharging the material directly from said first chamber into a second chamber, mechanically defibering the material in said second chamber at substantially the pressure and temperature in said first chamber, discharging the material directly from said second chamber into a third chamber, maintaining in said third chamber a second pressure substantially higher than atmospheric pressure but lower than said first pressure, subjecting the material to the pressure drop from said first pressure to said second pressure while moving it into said third chamber, agitating the material in said third chamber at said second pressure and at the corresponding saturated steam temperature, discharging the material from said third chamber directly into a fourth chamber, mechanically defibering the material in said fourth chamber and delivering it into an outlet conduit while subjecting the material in said fourth chamber to a pressure drop from said second pressure.

2. The process claimed in claim **1** with the added step of cooling the material in said outlet conduit sufficiently to prevent flashing when the material is discharged to atmospheric pressure.

3. The process of claim **1** in which said fibrous material is depithed bagasse.

4. The process of claim 1 in which said first pressure is about 150 p.s.i.g.

5. The process of claim 4 in which said second pressure is about 135 p.s.i.g.

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