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PULP HANDLING SYSTEM, METHOD AND APPARATUS

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FIG. 1 - Pulp Mill

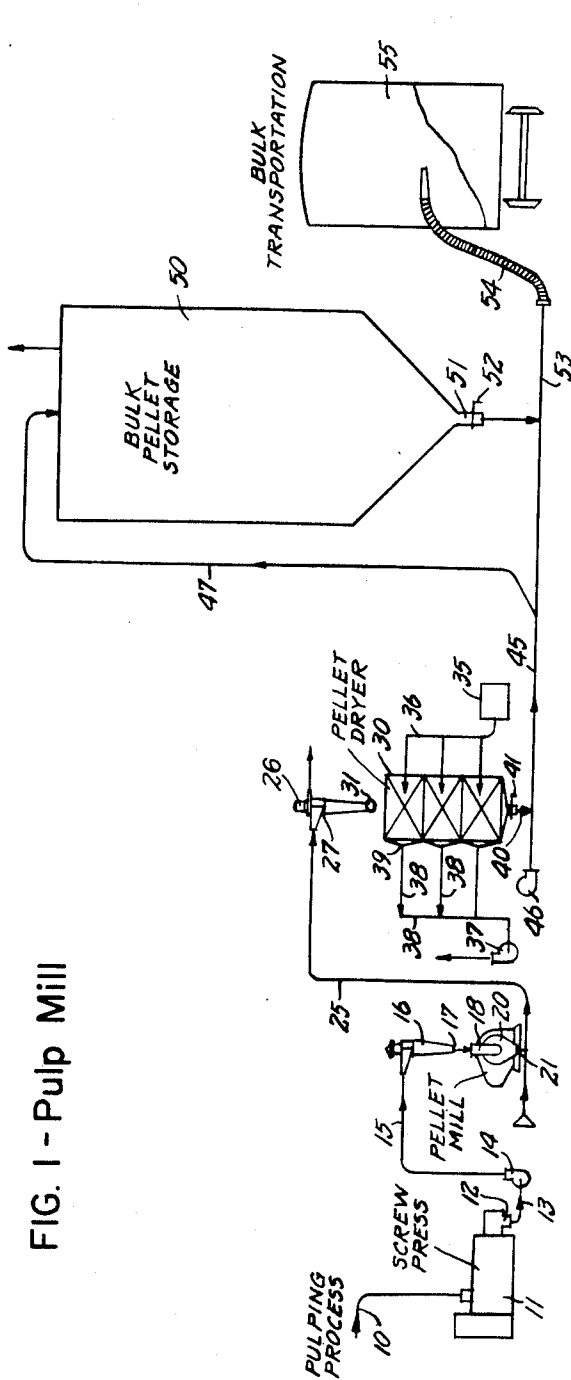
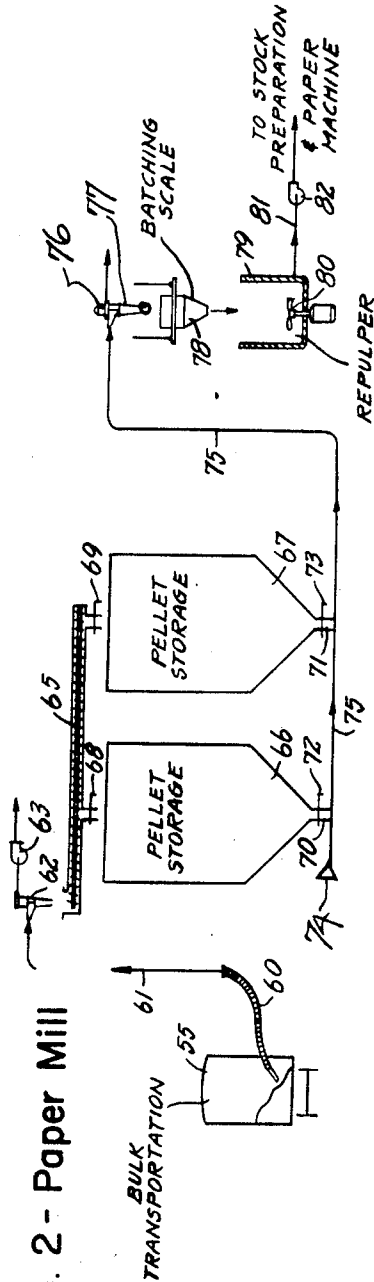


FIG. 2 - Paper Mill

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PULP HANDLING SYSTEM, METHOD AND APPARATUS

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This invention relates to methods and apparatus for handling paper pulp and the like and, particularly, to methods and apparatus for the dewatering, pelletizing, and bulk storage and transportation and handling of paper pulp and like materials utilized in the manufacture of paper and the like and which can now be handled in bulk form and as particularly disclosed herein.

In the manufacture of paper, paper board, and the like from wood and wood pulp, a water slurry of processed cellulosic pulp fibre is usually prepared by any one of a number of well recognized pulping processes in which wood or other fibrous cellulosic materials are digested, reduced, or comminuted into a slurry of cellulosic fibres, commonly known as "pulp," from which paper, paper board, wall board, insulating material, pressed hard board, and the like are formed or fabricated by methods and apparatus now well known. Particularly in the paper and paper board industry, a distinction is commonly recognized between a "pulping process," on the one hand, carried on in a "pulp mill," where the original cellulosic raw materials, whatever they may be, are converted by one process or another into a useable aggregation of more or less separated cellulosic fibres or bundles of cellulosic fibres and a "paper making process," on the other hand, carried on in a "paper mill," where the pulped fibres are formed or fabricated or otherwise manufactured into the desired finished paper or paper board or wall board or pressed board product. Sometimes, as is well known, a "pulp mill" will be found in the same geographical location as a "paper mill," but, even so, these two mill operations will be conducted each more or less independently of the other, at least from the standpoint of operational control, so that, although the operations in each may be considered more or less continuous, the efficient management of one mill is not inextricably integrated with necessary shut-downs, etc., which may be occasioned in the other. Also, a pulp mill may operate under circumstances where its pulp output is sold as such, rather than as finished paper or paper board (and shipped as baled or roll-formed pulp), and transported, frequently over long distances, to a paper mill quite remote from the pulp mill to be manufactured into the finished product. By the same token, as is well understood, a paper mill may be operated conventionally remote from and quite apart from a pulp mill, receiving all its pulp raw material as such (even from abroad as in the frequent case of importing paper pulp from foreign countries) to be used in the manufacture of paper, paper board, and other finished products. As a result, pulp is frequently produced in a form which must be lapped or baled at some great cost and, with this invention, such cost is obviated as noted below.

In general, the end result of most conventional pulp processes is a water slurry of more or less separated cellulosic fibres. Similarly, in general, the starting point of most paper making processes is a "stock" comprising a water slurry of more or less separated cellulosic fibres. In the transportation, then, of "pulp" from a "pulp mill" to a "paper mill"—whether such transportation is merely by means of a conveyor from one building to the next or several thousand miles across the ocean—the transported pulp may be in a number of conditions, among which include as a so-called "high density" stock (of about 40%

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to 50% fibre and the rest water), more or less dried and fluffy pulp (from which all but 10% moisture have been removed), baled pulp (illustrated by the foregoing dried pulp pressed into bales), lap pulp (in which the high density slurry is formed on a conventional wet lap machine into slabs of feted fibres), and/or other well-known conditions. Whether received in the "paper mill" as a high density pulp stock or in one of another of the well-known dried forms, the pulp is diluted or re-pulped or otherwise formed into a more or less dilute slurry of paper "stock" with agitation or "beating" to prepare it into a condition suitable for application to the paper machine or paper making process.

As will be understood, the transportation of pulp in slurry form, even though of "high density" involves the transportation of a substantial quantity of water, and the drying or lapping or baling or bagging of pulp for transportation between the pulp mill and the paper mill in a form other than as a water slurry involves the extra work, power expenditure and handling incident to these processes—and whether or not the transportation involved is merely to the next building or across the ocean.

According to this invention, however, substantial savings in handling and transportation of such pulp materials, as well as, in many cases, substantial enhanced results in the re-pulping and stock preparation thereof for presentation to the paper machine are affected by the pressurized dewatering of the original pulp slurry (although, of course, re-pulping of the pelleted stock according to this invention may be different than the handling of other conventional pulps) pelletizing of the pulp, drying of the pulp pellets, and the bulk handling and storage and transportation of the pulp as dried pellets between pulp mill and paper mill, with additional economies and advantages being effected in the paper mill by bulk handling, preferably pneumatically, and batching and measuring of the pelleted pulp for introduction into the stock preparation and paper making steps in the paper mill.

One object of this invention, then, is to provide a new combination of apparatus for the dewatering, pelletizing, drying, storage and bulk handling and shipment of paper pulp and the like.

Another object of this invention is to provide a method or process of the character described for receiving paper pulp and the like from various of the conventional pulp manufacturing systems and dewatering, pelletizing, drying, and bulk handling of the useful fibrous component of the pulp material.

A further object of this invention is to provide a system of the character described for automated bulk handling and transportation of pulp from various conventional pulping systems in a pulp mill to various conventional paper making systems in a paper mill including transformation of the pulp into a free flowing form for automatic bulk handling and at optimum pulp consistencies without the necessity of transporting or conveying excessive quantities of water or moisture in the pulp.

Still another object of this invention is to provide methods and apparatus of the character described for dewatering and drying paper pulp into a compacted yet free flowing condition for automatic material handling thereof substantially in the absence of large proportions of water between a pulp mill and a paper mill.

A still further object of this invention is to provide methods and apparatus of the character described for converting conventional slurry of paper pulp into an adequately dry and free flowing compacted condition for ready handling and transportation from a pulp mill to a paper mill yet with enhanced re-pulping of re-dispersible fluid characteristics adapted for easier and more efficient conversion of the dried and compacted pulp into a de-

sirably dispersed prepared stock slurry for use in a paper mill.

Still another object of this invention is to provide methods and apparatus of the character described for converting the pulp product of conventional pulping processes into a compacted and free flowing material for easier handling and transportation, preferably automatically and pneumatically, to a paper mill and for imparting to the treated pulp new characteristics for easier and enhanced re-pulping and denodularization thereof in a stock preparation system in a paper mill.

Other objects and advantages of this invention will be apparent from the following description, the accompanying drawing, and the appended claims.

In the drawing—

FIG. 1 is a diagrammatic flow sheet representation of steps and apparatus embodying and for practicing this invention in a pulp mill; and

FIG. 2 is a diagrammatic representation illustrating steps and apparatus embodying and for practicing this invention in a paper mill.

Referring to the drawing, which represents purely illustratively and in diagrammatic or schematic form sequential steps and representative apparatus embodying and for practicing this invention, a slurry of conventional paper pulp is supplied from any one of a variety of conventional pulping processes through line 10 as a water slurry having a consistency (in terms of a percentage of oven-dry pulp fibre in water) of approximately 3% to, perhaps, 12% as may be conventional. Line 10 conducts the pulp slurry to a screw press 11, which may be of any one of a number of conventional designs of well-known expressing presses adapted to receive a more or less fluid slurry and express or press therefrom liquid by forcing the slurry through a constricting foraminous or screen-type passageway by means of a screw, during which operation liquid in the slurry is expressed outwardly through the foraminous or screen-type passageway and the consistency of the pulp raised to approximately 40% to 50% after the expulsion of water in the slurry.

The dewatered pulp is discharged from screw press 11 at 12 and through line 13 from which it is received by a blower or other pumping means 14 and conveyed through line 15, which, in the case of pneumatic conveying, preferably communicates with a cyclone separator arrangement 16, as is well-known, to discharge the dewatered pulp at 17 into the inlet 18 of a pellet mill 20. Pellet mill 20 is preferably an extrusion-type pellet mill (as illustrated, generally, for example, by Patent No. 2,845,036 to C. D. Fisher in which a moist mass of material is received on a perforated die of substantial thickness and extruded or forced through the perforations in the die by pressure rollers during rotation of the pressure rollers or the die with respect to each other thus forming extruded small more or less cylindrical pellets of pulp compacted to high true density under the large compacting or extruding forces in pellet mill 20. As will be understood, in such types of pelleting apparatus, the pulp is subjected to substantial mechanical working forces during extruding and as the pulp fibers are rolled on or against the face of the pelleting die, with resulting and advantageous crushing or brushing or fibrillation and/or curling of the pulp fibers as further preparation thereof for whatever paper-making process is intended.

The thus formed pellets leave pellet mill 20 through discharge 21 thereof and are transferred or conveyed (preferably, as illustrated in FIG. 1, by a pneumatic conveying system in which the pellets are entrained in conduit 25 in an airstream of air under vacuum pressure from blower 26 and are separated from the stream of air in cyclone separator 27 in known manner) to pellet drying apparatus 30. As illustrated in FIG. 1, the pellet drier 30, which may satisfactorily be of any one of a variety of known types of drying towers or other apparatus for drying free flowing pelleted material, is, prefer-

ably, a rotary-type dryer arrangement or, less preferably, the tower-type. In any case, satisfactory results are achieved by drying 30%–55% consistency pellets to a reduced moisture content of about 90% consistency at a rate of 5,700 O.D. pounds per hour using an 84" I.D. x 45' rotary drum with air inlet temperature of about 700° F. and an exit temperature of 210° F. The exit material temperature was about 162° F. after a retention time in the rotary dryer of about 20–35 minutes with the average log. Mean velocity of the material in the rotary dryer was about 480 ft. per min. at a loading of about 12%, when the dryer efficiency was about 65%–70% at about 16,700 c.f.m. of drying air from a direct gas-fired burner—as compared with a steam dryer at 700° F. maximum steam ingress.

Such an arrangement is illustrated in FIG. 1 as having a heater or boiler 35 with suitable conduits 36 for introducing drying air or steam into drier 30 and with a blower 37 with suitable conduits 38 for withdrawing or sucking out of drier 30 the moisture laden atmosphere, preferably through a plenum chamber indicated at 39. As illustrative of this drying step, satisfactory results have been achieved in the drying of 30% to 55% consistency pellets from pellet mill 20 to a reduced moisture content of approximately 90% consistency using steam under 150 lbs. pressure (approximately 350° F.) with a retention time of pellets in drier 30 of approximately 15 to 30 minutes. As will be understood, higher drying temperatures or other drying conditions may be satisfactory if desired and according to the capacity or throughput desired, provided, of course, that temperatures in excess of 350° F. do not result in so-called toasting or other heat damage of the particular type or kind of pulp being treated.

Alternatively, of course, as may be desired, a conventional rotary drum drier is satisfactorily utilized in place of the tower drier above mentioned, it being understood, of course, that the particular drying apparatus to which the pulp pellets are subjected should be such as, as noted, will dry the pellets at a rate commensurate with the desired total throughput velocity of pulp through the system, and yet not at such a high temperature as would result in toasting or heat degradation of the pelleted pulp. Accordingly, whether a tower-type or a rotary-drum-type drying apparatus is utilized, or other drying apparatus, still, as will be understood, the drying step indicated in the drawing and in this description is intended merely to evaporate water from the pellets, rather than to cook or degrade or toast or burn the cellulosic content thereof to a degree which would interfere with the ultimate formation of the desired paper sheet on the paper machine.

After the dried pellets are discharged from drier 30 through discharge 40 thereof, preferably controlled by a gate or other flow control apparatus 41, they are in a free flowing condition and have a moisture content which, to all intents and purposes from the standpoint of subsequent handling, storage, etc., is substantially dry. Thus, the mass of pellets are readily and conveniently susceptible to bulk storage, bagging, and/or bulk conveying either directly to the paper mill stock storage or to trucks or other transportation.

The particular embodiment illustrated in FIG. 1 indicates that the dried pellets drop from the discharge 40 into a pneumatic conveying line 45 where they are entrained in a stream of air under pressure from blower 46 and pneumatically conveyed in bulk up conduit 47 into a bulk storage bin 50. Periodically and/or as desired, the pellets from storage bin 50 are withdrawn from outlet 51 in the bottom thereof controlled by gate 52 and drop into pneumatic conveying line 53, where they are entrained in a stream of air under pressure from a blower such as 46, to be pneumatically conveyed, as through flexible conduit 54, into a truck or railroad car 55 for bulk transportation to a paper mill remote from the pulp mill. As will be understood, although FIG. 1 illustrates pneumatic conveying means from the screw press 11 to the railroad car

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55, other known conveying means, such as mechanical belt or screw conveyors, bucket conveyors, and the like, may be satisfactorily included in systems and apparatus embodying and for practicing this invention. Also, because of the pelleted condition of the pulp and the low moisture content thereof after leaving drier 30, pellet storage facilities such as bin 51 may be conveniently arranged at virtually any point in the pulp mill, and indeed, even situated outdoors without the danger of the stored pulp freezing in winter or otherwise caking, etc., and the utilization of pneumatic conveying systems according to this invention lends further flexibility to location of pulp storage facilities without particular regard to the space and positioning and accessibility limitations incident to the manual or mechanical handling of baled or lapped or other known types of dried or transportable pulps. The dried and pelleted condition of pulps according to this invention, also, provides for a more simplified construction of storage facilities, such as bin 50, than is the case where known varieties of pulp are warehouse stored or where wet slurries of pulp of 8% to 12% consistency are stored in heated or insulated liquid-containing tanks or heavy concrete slurry chests. Actually, pulp prepared according to this invention is adequately stored under circumstances where prior art pulps were not susceptible to practicable storage at all and without the dangers of freezing, etc.

The diagrammatic showing of FIG. 2 illustrates the pulp receiving portion of a paper mill arranged for embodying and practicing this invention. A railroad car 55 containing a quantity of pulp pellets in bulk is shown being unloaded pneumatically through a flexible conduit 60 leading to a line 61 with the pellets being entrained in a stream of air and sucked through to a cyclone separator 62 by an air stream under vacuum created by blower 63. From cyclone separator 62, the pellets drop onto conveying means illustrated as a conventional screw conveyor 65 which conveys the pellets to one or another of a plurality of storage bins 66 and 67 depending upon the opened or closed conditions of control gates 68 and 69. A plurality of pellet storage bins 66 and 67 is preferred particularly for paper mills which may, in the stock slurry furnished to the paper machine, utilize a mixture of a plurality of different kinds or types or grades of pulp so that one type of pulp may be pelleted and stored in, for example, bin 66 while a different type of pulp for later blending into the paper mill furnish may be separately stored in a separate bin 67.

As it is desired to withdraw the pulp pellets for use in the paper mill, they are withdrawn from one or another of outlets 70, 71 of storage bins 60, 67 under the control of gates 70, 73, and allowed to drop into a pneumatic conveying line 75 where the pellets are entrained in a stream of air under negative pressure from blower 76 drawing air through filter 74 and line 75, and conveyed, through a cyclone separator 77 to a conventional automatic batching scale 78 from which the pellets are discharged into repulping apparatus 79 in which a water slurry of the pelleted pulp is produced by mixing the pellets with water with the action of a motor driven agitator indicated at 80. From repulper 79, the slurry of pulp is pumped through line 81 by pump 82 to the conventional stock preparation steps of the paper mill for final treatment to form a paper machine furnish to be delivered to the paper machine.

As with the previous discussion of FIG. 1, it will be understood that mechanical or even manual receiving and transferring or conveying of the pulp pellets may be satisfactorily employed in the paper mill in lieu of the automatic pneumatic conveying system just described. Also, and particularly where the pulp mill is reasonably adjacent the paper mill, the pulp pellets may be directly conveyed or transferred pneumatically or otherwise, from the pulp mill to the paper mill repulper 79, although some storage, is preferably interposed between the pulp mill

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and paper mill portions of the system to accommodate for situations where some difference may exist between the day-to-day output of pelleted pulp and requirements of the stock preparation system in the paper mill. In situations where rail or other more or less long distance transportation is not desired or bulk transportation not convenient, bagging of the pulp pellets from the pulp mill pellet storage bin 50 provides a convenient and accurate measurement of the pulp quantity for the paper mill operator in the preparation of his paper machine stock or furnish. Also, it may be desired to process the pulp through a refiner or other apparatus after leaving the repulper 79 and prior to entering conventional stock preparation apparatus, and as an example, a refining step may be desired for the elimination of "fish eyes" in the repulped pellets, if necessary.

As illustrative of some of the advantages of systems embodying and for practicing this invention, it may be noted that satisfactory results are achieved according to this invention in obtaining pulp pellets dried down to approximately 5% to 10% moisture which pellets are in cylindrical form approximately $\frac{3}{32}$ " in diameter and varying from 1 to 3 or 4 diameters in length. A mass of such pellets as stored, bagged, or conveyed in bulk may have a density of at least 14 lbs. or upwards (as oven dried fiber density). When such densities are compared with, for example, conventional wet lap pulp having approximately no more than 10 lbs. to 15 lbs. of pulp per cubic foot and perhaps 20 lbs. of water per cubic foot, the savings in transportation, storage, and conveying according to this invention become more apparent. Thus, with such wet lap pulp a total weight of about 32 lbs. per cu. ft., may be obtained, 20 lbs. of which is water. With dried pelleted pulp according to this invention, by contrast, a total weight of 14 lbs. to 24 lbs. per cu. ft. O.D. may be expected with only 10% or less as moisture so that about twice as much pulp is conveyed or shipped for only about 50% total weight as compared to conventional lap stock at 40% consistency. Similarly, as compared with conventional dried or felted or baled systems of pulp transportation, the pulp pellets according to this invention are susceptible to mechanical or pneumatic automated handling systems conveniently and economically situated within the mill more or less without regard to available floor area or accessibility.

In addition to the inherent ease and economies of the handling and transportation of pulp prepared in accordance with this invention, it has been noted that pulps so processed may have certain enhanced characteristics in the manufacture of paper therefrom as compared with paper pulp produced and handled in conventional systems and processes. For example, certain conventional pulp handling systems, particularly those involving a pressing operation in connection with the dewatering or drying of shipping of the pulp, may induce in the pulp so processed a difficulty (conventionally referred to as "nodularizing") whereby, when it is attempted to re-pulp or re-constitute the dried pulp into a water slurry for paper making, an excessive amount of agglomeration of pulp appear in the slurry which either show up as agglomerations in the paper made therefrom or require an extra amount of agitation or mixing or beating during stock preparation in the paper mill, which excess amount of beating may be disadvantageous for other reasons.

In one instance, for example, screw pressed, fluffed and baled undried pulp, showed a freeness of 715 cc. (as indicated by the so-called Canadian Standard freeness test which is both conventional and recognized in the pulping industry). After five minutes of beating time in an effort to reconstitute the pulp into a low consistency water slurry, an excessively large quantity of nodules were apparent. Even after twenty minutes of mixing time and a freeness of 705 cc., there was little apparent change in the characteristics of the pulp. By contrast, however, a pelleted pulp according to this invention, after only five

minutes of mixing time and a freeness of 650 cc., produced a slurry from which a substantially nodule-free paper product was made.

Such enhanced fiber separation or de-nodularization, particularly in the stages of re-pulping or re-constituting a slurry from the dried pulp, may also be advantageous in pulping operations where the pulp, after being re-constituted into a slurry, is bleached or otherwise treated prior to forming on the paper machine and, particularly, in the instances where it is desired to re-constitute the pulp slurry from the dried pulp with a minimum of beating or mechanical work thereon.

As further illustrative of the satisfactory pulp operations according to this invention, a comparison was made between a quantity of wood pulp for paper prepared from the well known neutral sulfite semi-chemical process. A slurry of such pulp, re-constituted from that dried into what is known conventionally as pressed pulp, showed a freeness (Canadian Standard) of 610 cc. at 35% oven dried consistency, a standard Mullen test of 53, beating time 32, standard tear test 102, and standard fold test rating of 88 at 350 C.S.F. The oven dry density of this original pulp, as baled, was approximately 10 pounds per cubic foot. By contrast, this same semi-chemical pulp processed into pellets according to the invention and dried to a consistency of 90% oven dry (as compared to 35%) showed a freeness of 580, beating time 27, Mullen 51, tear test 114, fold test 304, and an oven dry density of 15 pounds per cubic foot of loosely packed pellets.

While the methods and forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods and forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In a method for handling paper pulp produced as a water slurry of pulp fibers in a pulping process for transportation and storage between a pulp mill and a paper mill, the steps which comprise dewatering said pulp slurry under pressure, introducing said dewatered pulp to a pellet mill for mechanically working and pelleting said pulp fibers, said dewatering increasing the consistency of said slurry to a degree permitting pelleting, subjecting said pulp fibers in said pellet mill to mechanical working by a rolling pressure against a hard surface, extruding said worked pulp under high pressure through a restricted compacting extrusion passage in said pellet mill thus forming compacted and self-sustaining pellets of said dewatered and worked pulp fibers, and drying said pellets to a substantially free flowing consistency for bulk storage and transportation and handling thereof.

2. The method as recited in claim 1 in which said pelleting of said pulp fibers forms a fiber consistency of at least about 30-55% in said pellets.

3. A method as recited in claim 1 in which said dewatering step raises the consistency of said fiber slurry entering said pellet mill to about 40-50%.

4. A method as recited in claim 1 in which said pulp pellets are dried in said drying step to a consistency of about 90% fiber.

5. Prepared wood pulp comprising a mass of self-sustaining compressed and compacted extruded pellets which are essentially free flowing and contain substantially no water in an amount which can be mechanically expressed therefrom, said mass of pellets having a bulk density of at least 15 lbs. per cubic foot when packed under the force of gravity alone, and said pellets having been produced in accordance with the method as recited in claim 1.

6. In a method for handling paper pulp produced as a water slurry of pulp fibers in a pulping process for transportation and storage between a pulp mill and a paper mill, the steps which comprise dewatering said pulp slurry under pressure and substantially in the absence of additionally fiberizing said pulp fibers, introducing said dewatered pulp to a pellet mill, said dewatering increasing the consistency of said slurry to a degree permitting pelleting, subjecting said pulp fibers to mechanical working in said pellet mill by a rolling pressure against a hard surface for additional fibrillation of said fibers and squeezing water therefrom, extruding said worked pulp under high pressure through a restricted compacting extrusion passage in said pellet mill thus forming compacted and self-sustaining pellets of said dewatered and worked pulp fibers and drying said pellets to a substantially free flowing consistency for bulk storage and transportation and handling thereof.

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