

UNITED STATES PATENT OFFICE.

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MANUFACTURE OF PAPER-PULP FROM WOOD, &c.

SPECIFICATION forming part of Letters Patent No. 223,670, dated January 20, 1880.

Application filed September 27, 1879.

To all whom it may concern:

Be it known that I, WILLIAM E. FARRELL, of the city and county of Philadelphia, and the State of Pennsylvania, have invented certain new and useful Improvements in the Process of Manufacturing Paper-Pulp from Wood and other Vegetable Fibrous Material; and I do hereby declare the following to be a full, clear, and exact description of the same.

My invention has reference to an improvement on the process described in my Letters Patent No. 215,728, dated May 27, 1879, granted to me on an application filed April 18, 1878.

The nature of my invention will be fully shown in the following specification and claims.

I cut the wood, which may be wet or dry, into any convenient or suitable lengths or sized pieces by any of the many well-known devices used for that purpose.

Wood cut at right angles with the grain will pulp more rapidly; but wood cut at an acute angle or parallel with the grain, while taking a longer time to pulp or reduce to fiber, makes a better and longer-fibered pulp. Sawdust, by my process, will make a fair paper-pulp, better than the ground wood pulp.

My first step is to soak the wood to be pulped. The wood being cut as desired, I place it in a suitable pan or vessel, which may be steam and water tight, having the necessary outlet and inlet valves and screens for the subsequent manipulation. I cover the wood with water, and to hasten the thorough soaking of the woody fibers, I now introduce steam to heat the wood and water to any degree desired.

To greatly facilitate the soaking where time is an object, I use a steam-tight receptacle capable of sustaining any pressure required, as some woods will take up the water at a low pressure, some require a high pressure, some will take it up with sufficient rapidity in an open vessel; but generally the higher the pressure the more rapidly will the soaking be done.

The process can be carried on in cold water in the open air, but will take longer, so I prefer heat and pressure; or it can be first soaked in hot or cold water in the open air,

and then be subjected to heat and pressure, according to the kind of wood to be reduced. The wood, being thus saturated with water in the open air or under pressure, is then passed between two or more surfaces, which squeeze, press, compress, or condense the fibers of the wood in and upon the intercellulose matter, or vice versa, which drives out the moisture, and with it a portion of the intercellulose matter, which is transferred from in and around the fibers and held in suspension in the water, which water, for most woods, I prefer should be heated above 200° Fahrenheit.

When the fibers of the wood have been relieved from the pressure between the surfaces they are comparatively dry and porous, and expand, returning to nearly their original position. In thus expanding after the removal of the pressure, the fibers begin to separate from each other and the intercellulose matter, their cohesion is destroyed by the pressure, and they are not so firmly held together, owing to an increase of the spaces between the fibers, caused by the displacement of all the particles, the increased elasticity of the fibers, and the absence of some of the intercellulose matter, which was displaced by the first compression, and is now held in solution or suspension by the water in which the wood is submerged. This intercellulose matter is thus gradually forced away from its original position surrounding the fibers, and the cohesiveness of the fibers is thus destroyed.

When the fibers have been released from pressure they are again soaked, and the water rushes in to fill the pores of the wood as it expands, and assists in its expansion; and this process of soaking and crushing is repeated until the desired disintegration and cleanliness of the fibers is obtained. The water also acts as a cushion, to prevent excessive compression of the fibers.

This process of alternate pressure and expansion of the fibers has the effect of separating them into strings and separate fibers, and making them elastic, tough, pliable, and soft, and retains them in their full natural length, and is kept up until most, if not all, of the intercellulose matter is washed away from the fibers and is held in suspension in the water.

The water which becomes charged with the

intercellulose matter is allowed to run to waste through suitable screens, which retain the fibers, and fresh water is added to supply its place. In this way the impurities other than
5 fibers are washed out and the comparatively clean fibers retained.

This is the only process known to me by which the greater part of the intercellulose matter is first washed out before the fibers are
10 subjected to an alkaline solution.

If the wood is poplar or any similar white wood, and contains no pitch, gum, rosin, or any resinous matter, the refining process can be carried on until the degree of desired fineness
15 is reached, and this pulp can be subsequently made into paper by the many well-known manipulations.

When it is desired to make a very fine white paper, absolutely pure and free from all intercellulose matter, or which it is desired to make
20 from woods (such as pine) which contain gums and resins, I allow the process, as above described, to continue until I have removed all the intercellulose which it is possible to remove with hot water, when I draw off, through
25 suitable screens, all the water, replacing it with an alkaline solution. As the wood is now in such small fibers and comparatively free from intercellulose matter, the fibers are
30 in the best possible condition to receive the alkaline solution to further reduce them, which solution may be used in the open air or under pressure. I make it, preferably, of soda-ash rendered caustic by the addition of lime.

35 The process of alternate pressure and expansion of the fibers by passing them between two or more surfaces is continued, in connection with the alkaline solution, in open air or under pressure, the same as is before done with
40 water alone, and the solution may be hot or cold.

The advantage is, that this pressure and subsequent expansion process, when used
45 while the fibers are comparatively clean and greatly disintegrated, in connection with the alkaline solution, result in a very speedy reduction of the fibers to the purity required for the finest papers, and it is done with the expenditure of the least lime and smallest quantity of alkalis, as the alkalis are forced into
50 the fibers by the crushers.

The alkaline liquor can now be drawn off to be used again, or the soda can be recovered
55 in any of the ways well known to the arts by evaporation and incineration. The pure fibers are then freed from all traces of alkalis by washing in water, cold or hot. The pulp can now be emptied into the ordinary drainers to allow the water to run away, and is ready for
60 the subsequent manufacture into paper, and can, if desired, be bleached in the ordinary way when alone or combined with other fibers. If, however, it is desired to bleach the pulp before emptying it from the crushing-engine, the chlorine or other bleaching solution is
65 added while it is still in the crushing-engine, and the washed pulp is again submitted to the

process of alternate compression and expansion, as already described, in connection with the chlorine-bath, which may be done hot or
70 cold, in the open air or under pressure. As by these means the chlorine is forced into the fibers in a very effective way, the process of bleaching is greatly shortened as to time and a materially-diminished quantity of chlorine is
75 used. It is then emptied into the usual drainers, and may or may not, as is found desirable, be passed through an ordinary wet machine to remove the particles of wood not thoroughly disintegrated. This completes the
80 process of a reduction of the fibers to fine pulp.

There are many mechanical devices by which I can produce the effect of alternate pressure and expansion of the fiber, as described. For
85 instance, the wood can be passed between a stack of calender-rolls or two or more revolving rolls, whose surfaces may be smooth or corrugated and traveling at the same or different rates of speed. I can use a level plane,
90 the surface of which may move or be stationary, which may be smooth or corrugated, over which a smooth or corrugated surface may travel, or a combination of these or similar devices, or a machine similar to a putty-grinder,
95 which is a deep circular pan, in which broad heavy wheels, rolls, followers, or chasers revolve on their faces and their own axes around a perpendicular driving-shaft, from which they obtain motion. These wheels or
100 crushers rotate on this circular plane (with sides) and press upon any material between them and the bed-plate. This makes pulp very rapidly, owing to the twisting motion of the crushers or wheels on the material to be
105 disintegrated. I have also used a circular bed-plate, plain and corrugated, in which the chasers or rolls have plain or corrugated surfaces, or their combinations, which are coneshaped—i. e., the chasers at the outer circumference are larger and gradually decrease toward the center. This avoids the twisting motion of the rolls, for as they rotate around the central driving-shaft the surfaces all travel at the same rate of speed. This plan, while taking
110 more time, gives a long and tough fiber.

These and many other devices and mechanical combinations will accomplish my purpose, and I do not limit myself to them or any of their combinations.
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A machine to work my process will be the subject of a separate application for Letters Patent.

This process is very economical in time, labor, machinery, plant, and chemicals, as the
125 entire operation, from the crude fiber or wood to the refined and bleached pulp, fit for the finest grades of paper, can be carried on in one continuous operation and in one machine.

This present process differs from Letters
130 Patent No. 215,728, obtained by me May 27, 1879, in that while I there used water, alkaline solutions, and chlorine, hot or cold, in open air or under pressure, I now describe a

peculiar order in which they are to be used and the particular state of the fibers at the time each of the baths or solutions are to be applied to the material to be pulped, in combination with the process of alternate pressure and expansion, as already described.

In order to operate the crushing-engine—say one constructed upon the principle and after the style of a putty-grinder—so that the various operations described above can be carried on under pressure, the top of the machine can be inclosed with an air and steam tight cap or head, or the whole machine can be inclosed by an air and steam tight shell, the operating-shaft being passed through the shell, and the joint where it passes through being packed.

Man-holes and discharge-openings to put in the fiber and remove the pulp, respectively, and cocks and valves to pass in and take out the water and various solutions and steam-pipes to get up a pressure, can all be provided at such points of the apparatus as are suggested by the attachments to an ordinary pressure pulp-digester and by the above description, or to the mind of any skilled mechanic or person skilled in the art of pulp-manufacture.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The process of manufacturing paper-pulp from wood or other vegetable fibrous material, by soaking such material in water, then crushing, pressing, or squeezing it, then soaking it again, the operation of alternate crushing and squeezing to be continued until the desired cleanliness and disintegration of the clinging fibers are obtained, substantially as described.

2. In combination with the alternate compressing and expanding process described above, the process of washing with water the fibers thus disintegrated, substantially as described.

3. In combination with the alternate soak-

ing, compressing, and expanding and washing-out process, boiling the disintegrated fiber in an alkaline solution, whereby the fiber is converted into a finer pulp, substantially as described.

4. The process of alternately soaking and compressing or squeezing the material to separate the fibers, boiling the same in an alkaline solution, washing out the latter, and then adding a chlorine or other bleaching solution, substantially as and for the purposes described.

5. In combination with the process of alternately crushing or squeezing and expanding wood or other vegetable fibrous material into separate fibers, the further reduction of the same by an alkaline disintegrating solution, substantially as described.

6. The process of soaking and crushing wood and other vegetable material in a chamber furnished with rollers to crush the said material, boiling the same in an alkaline solution, washing out the solution by means of water, then treating the same with a bleaching solution, the whole operation being conducted in the said chamber, whereby at any stage in the process the said rollers can be used to further crush the pulp or to force any of the liquor or solution into it, substantially as described.

7. In the process of reducing wood and other vegetable fibrous material to paper-pulp, crushing it in a chamber containing rollers, and then treating it chemically in the same chamber to further reduce it, whereby the rollers used in the first stage to crush it can be utilized at any subsequent stage in the process to further reduce it, or to force the liquors used in the manipulation into and through the pulpy mass, substantially as described.

WILLIAM E. FARRELL.

Witnesses:

HENRY V. BUCKLEY,
WM. H. CARSON.