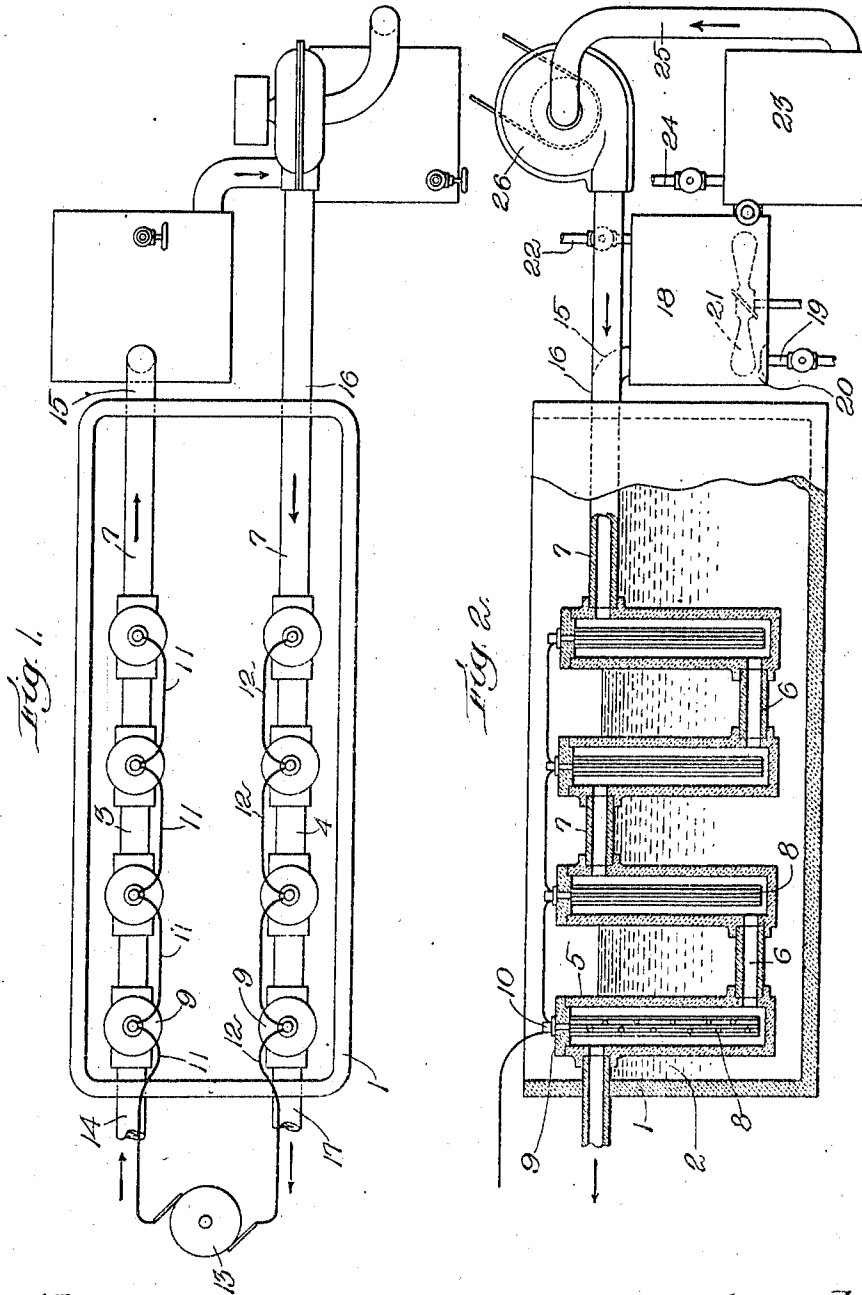


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ELECTROLYTIC APPARATUS FOR THE PREPARATION OF PAPER PULP.
APPLICATION FILED JUNE 10, 1910.

1,059,322.

Patented Apr. 15, 1913.



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UNITED STATES PATENT OFFICE.

FREDERICK F. STRONG, OF ST. PETERSBURG, FLORIDA.

ELECTROLYTIC APPARATUS FOR THE PREPARATION OF PAPER-PULP.

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Specification of Letters Patent.

Patented Apr. 15, 1913.

Application filed June 10, 1910. Serial No. 566,219.

To all whom it may concern:

Be it known that I, FREDERICK F. STRONG, a citizen of the United States, residing at St. Petersburg, in the county of Hillsboro and State of Florida, have invented an Improvement in Electrolytic Apparatus for the Preparation of Paper-Pulp, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an apparatus for the electrolytic treatment of plants, tissue, etc., in the manufacture of pulp therefrom, from which paper may be made or artificial hard rubber, ivory, vulcanized fiber and various other finished products.

One object of my invention is to provide means for the disruption, separation and isolation of the cellulose ultimates by partially saponifying the oils and resinous binding material. This is accomplished in the absence of heat, or in other words, I provide means capable of handling the material and producing the desired results cold and at the ordinary atmospheric pressure, one resulting advantage being that the resins are only partially removed, a portion thereof being left, which in the subsequent manufacture therefrom of paper, for instance, under the hot rolls of the paper machine serves to bind the same together into a tough web, producing in other words a self-sizing paper. This is especially the case with palmetto stock, which is unusually rich in resinous binding material.

I have aimed to eliminate to a large extent the use of chemicals, especially strong chemicals, heretofore commonly used in the manufacture of wood pulp and the like, my object being also to produce what may be termed a textile-fiber-pulp, similar in quality to that obtained from new linen rags.

A further object is to produce a non-hygroscopic pulp whereby it at once parts with its water on the paper machine, avoiding the extreme difficulty at present experienced in freeing ordinary pulps from their water content. Furthermore, pulp produced as hereinafter explained is extremely light in weight and "felts" so readily and intimately that longer fibers may be used in making the pulp than would otherwise be possible, thereby giving the resulting paper the durability of a finely woven fabric. The process as such is described at length and

claimed in a copending application Serial No. 566,220, filed June 10, 1910.

My electrolytic apparatus provides means for a continuous flow of the pulp solution in the presence of but separated from a moderately strong salt solution. The passage for the flow of the pulp has porous walls, in which I provide at frequent intervals suitable electrodes, preferably carbon, around which the pulp solution flows, said passage being preferably made up of a series of porous jars having connecting passages alternately at their tops and bottoms. These jars or porous passages are arranged in two sets, one connected to the negative pole and the other to the positive pole of the source of energy. The pulp in passing from one set of jars or passage to the other, is treated in a series of settling and agitating tanks, all as will be more fully explained and better understood from the following description taken in connection with the accompanying drawings, in which I have shown a preferred embodiment of the invention, Fig. 1 showing the apparatus in top plan; and Fig. 2 in side elevation, partly broken away and sectioned for clearness of illustration.

In a tank 1 lined or composed of acid and alkali-proof material and filled nearly to the top with moderately strong salt solution 2 are immersed two pulp-solution conveyers 3, 4, each herein shown as composed of a series of porous jars 5 of clay or unglazed porcelain, joined alternately at top and bottom by tubes 6, 7, preferably of similar material. In each of these jars is an electrode, preferably a fluted and transversely apertured carbon 8 attached to an insulating cover 9 fitting tightly in the mouth of the jar and provided with a suitable binding post or terminal connection 10 for connecting the carbon with the conductor wires 11, 12, deriving current from a battery or other suitable source, herein shown for convenience as a generator 13 of continuous current. All the electrodes of the jars in the tortuous pipe or passage 3 are connected in parallel to the negative pole of the dynamo and the terminals of the jars in the tortuous pipe or passage 4 are connected in parallel to the positive pole of the dynamo. The current passes through the porous walls of the jars but the solutions which carry the pulp-material do not pass therethrough to mingle with the solution in the large tank. The

pulp solution enters through an inlet pipe 14, flows through the porous tubular members forming the passage 3 and thence out at 15, and having passed through the intermediate apparatus, enters the tank again at 16 and thence flows through the porous tubular members forming the passage 4 and out at the outlet pipe 17. The pipe 15 enters the upper portion of a settling tank and washer 18 where it is separated from the soda solution, the latter being drawn off through a drainage pipe 19. A strainer 20 holds back the pulp, which is kept somewhat agitated by a stirrer 21, washing water being introduced through a pipe 22. When thoroughly washed, the pulp is permitted to flow into a concentrator and collecting tank 23 where it is treated a second time with strong salt solution admitted through a pipe 24 (the previous strong salt solution having been mixed with the pulp prior to its entrance at 14) and is thence elevated through a pipe 25 by any suitable means as a pump 26 and delivered through the pipe 16 to the pipe or passage 4 and its positive electrodes and jars for the bleaching process.

In use, the crude pulp which has previously been washed and mixed with strong salt solution in a suitable mixer or kneader and then diluted with a large volume of salt solution somewhat less dense than that used in the mixer, is caused to pass in a continuous stream through the row of jars, *i. e.*, through the tortuous conduit or passage 3 where the pulp is refined both mechanically and chemically by the action of the liberated hydrogen and the caustic soda. The cathode electrolysis of the brine liberates minute bubbles of hydrogen gas in and around the interstices of the pulp body which is against the cathodes, and these bubbles, together with the electrical activity, tend to burst apart or loosen the small fibers and cell masses, rendering them easily separable by subsequent treatment, aided of course by the chemical products of the electrolysis. The caustic soda which is simultaneously formed still further effects the isolation of the cellulose ultimates by partially saponifying the oils and resins. Especial attention is directed to the fact that this is a partial saponification. As the treatment is cold and at ordinary atmospheric pressure, there is only a partial solution or removal of the oils and resins, as previously stated. The peculiar nature of the plant material, the finely divided and actually dissected cellular bits, and the bringing thereof, when impregnated with brine as the only source of the chemical agents, into direct intimate contact with the electrodes, in the cold, without pressure, permits the disruptive action mentioned. The partially loosened cells of the dissected mass have an electrically conductive film in the surfaces

and crevices of the pulp bits because their cell walls have been osmotically impregnated with salt, and, as the spaces or passages for said cellular mass in the series of electrode chambers, between the porous walls of the electrode surfaces, is small, the pulp bits at some point of their passage are sure to make contact with the electrodes and become temporarily extensions or conducting branches of said electrodes, so that the electrolysis actually occurs and the hydrogen bubbles and caustic soda are actually formed or liberated on the surface and in the interstices of the bits of pulp which are against the electrodes. Having thus effected the subdividing and disintegrating of the cell-masses, etc., and the isolation of the cellulose ultimates as stated, the crude pulp mass is now ready for the bleaching process by nascent chlorine gas. The pulp at this stage is nearly white and consists of practically pure cellulose almost entirely free from lignin, the substance which causes the rapid rotting or deterioration of papers made from wood pulp. After emerging from the negative jars the pulp, suspended in a solution rich in caustic soda, is freed therefrom by the settling and washing operation in the tank 8 and is then again treated to a strong salt solution in the tank 28 and passed along by the circulation pump 26 to the jars of the passage 4 where the anode electrolysis current evolves therefrom nascent chlorine, which bleaches and whitens the pulp as it flows continuously along, thereby decolorizing any remaining green matter retained in the pulp cells. After leaving the tank, the pulp is thoroughly washed in fresh water and may then be run into sheets, dried, baled and shipped to the paper mills the same as is now done with sulfite paper pulp from wood, or it can be run into an ordinary beating engine and treated so as to be at once made into paper without intermediate drying. The passages 3 and 4 are preferably made of sufficient capacity and length of joints or turns to handle the fibrous portion of the plant stock as well as the cellular tissue or pulpy part thereof, if desired, and it will be understood that instead of making the passage tortuous it can be straight, the former being preferable for supporting the electrodes and avoiding a long tank. In the case of relatively long fibers, the large structural fibers are readily broken up when the caustic soda solution containing them reaches the washing tank, so that they are delivered therefrom in the form of small, fine, silky fibers suitable for spinning.

As already mentioned, besides the advantage of strength and non-rotting, already mentioned, I have also mentioned the fact that the resultant paper is practically self-sizing, due to the retention in the pulp of a

sufficient portion of the natural resinous material thereof for this purpose. Another peculiarity of the paper made by my process and apparatus is the readiness with which the pulp parts with its water on the paper machine, *i. e.*, its non-hygroscopic character. In other papers the prolonged treatment in the beating and refining engine not only breaks up the ultimate fibers but renders them water-soaked so that great difficulty is experienced in freeing ordinary papers from the contained water. My process is intended to deal primarily with such raw materials as the cabbage palm or palmetto, the saw palmetto, the everglade saw grass, the century plant, plantain, New Zealand flax, Adam's needle, Spanish bayonet, pineapple, banana, and other "inside-growers" (although not limited thereto) in which the ultimate fibers are pointed with the very small lumens naturally closed and the fiber naturally more or less water-proof. Hence by eliminating the digestion and the refining-engine treatment and providing means which leaves a sufficient amount of this insoluble resin coating or waterproof covering to size the paper and bind together the small fibers, the result is that the web of paper is practically non-hygroscopic, and whatever water or moisture is carried along mechanically therein is readily parted with on the paper machine. Also the resulting paper is extremely light in weight and because of its longer fibers and its non-rotted or decomposed condition it has extreme durability, approximating that of a finely woven fabric. Practically all the usual chemical baths and processes commonly employed in paper manufacture are eliminated and the slight chemical action required for the refining and bleaching of the pulp is liberated electrolytically from a solution of common salt or sea-water. This is possible because the pulp material is not only brought to the apparatus in as nearly as possible its original structural elements but the active power of the chemicals is enormously increased by the fact that the latter are liberated in a nascent condition and in intimate relation with the plant cells and small fibers thereby, as already explained, producing the combined mechanical and chemical effect, the mechanical effect being to disrupt or subdivide the mass by the generated gas bubbles and the chemical effect being to further free the cellulose.

Before entering upon the electrolytic portion of the process, the pulp or prepared plant-material or "half-stuff" is thoroughly impregnated with a strong solution of salt. Having thus filled the material with a strong salt solution, it is suspended in a weaker salt solution and then conducted through the electrolytic channels. As a strong salt solution is a better conductor of electricity than a weak salt solution, it results that as the

fibers thus impregnated with salt are conveyed in a weaker salt solution past the cathode electrodes in the conveyer 3, said fibers brush against the electrode surfaces, so that the electrolysis at that moment affects the cells and fiber elements of the bits of pulp which are in direct contact with said electrodes. Then having by this means produced the mechanical disintegration and chemical disintegration of the fibrous elements, as previously explained in detail, the mass is washed thoroughly free of its caustic soda before being subjected to the bleaching process. This is necessary in order that the bleaching process may be effective. Having been washed thoroughly and thereby freed of its caustic soda, the cleaned fibers are again impregnated with a strong salt solution, so that when it then passes through the bleaching conveyer the electrolytic action is primarily a bleaching action. The chlorine expends itself in bleaching the fiber rather than in combining with any free alkali, which would be the case if the caustic soda had not been removed.

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

1. An apparatus of the kind described, comprising supporting means for subdivided plant-material in liquid form, combined with means including electrolytic means including cathodes supported at one end only so as to extend freely into direct contact with the liquid on all sides excepting said end to disrupt the fibers and cell-masses of the plant material and form therein caustic soda for the further isolation of the cellulose constituents of the plant-material.

2. An apparatus of the kind described, comprising a supporting conduit for subdivided plant-material in liquid form, combined with electrolytic means extending into said conduit to loosen the fibers and cell-masses of the plant material, washing means for thereafter washing out the chemicals from the treated plant-material a separate conduit and electrolytic means for thereafter bleaching the previously washed material, and means to maintain the liquid plant material in a substantially continuous forward movement through the entire apparatus.

3. An apparatus of the kind described, comprising means affording a passage for the flow of subdivided plant-material, combined with electrolytic means to loosen the fibers and cell-masses of the plant-material, separate washing means for immediately thereafter washing out the chemicals from the treated plant-material, separate electrolytic means for immediately thereafter bleaching the previously washed plant-material as it continues to flow along, and

means to maintain the liquid plant-material in a substantially continuous forward movement through the entire apparatus.

4. An apparatus of the kind described, comprising means affording a passage for the flow of subdivided plant-material, consisting of a tube having porous walls, a tank containing said tube and provided with an electrolyte to surround said tube, an electrode mounted within said tube to convey current to the subdivided plant-material flowing therethrough, and external electrical connections for supplying current to said electrode.

5. An apparatus of the kind described, comprising a series of porous jars and tubular means connecting the same in series to form a continuous passage for the flow of subdivided plant-material, a tank provided with an electrolyte surrounding said jars,

electrodes mounted within said jars, and a current conductor connecting said electrodes in parallel.

6. An apparatus of the kind described, comprising a series of porous jars and tubular means connecting the same in series alternately at the top and bottom of the jars to form a continuous passage for the flow of subdivided plant-material, a tank provided with an electrolyte surrounding said jars, electrodes mounted within said jars, and a current conductor connecting said electrodes in parallel.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

FREDERICK F. STRONG.

Witnesses:

GEO. H. MAXWELL,
M. J. SPALDING.