

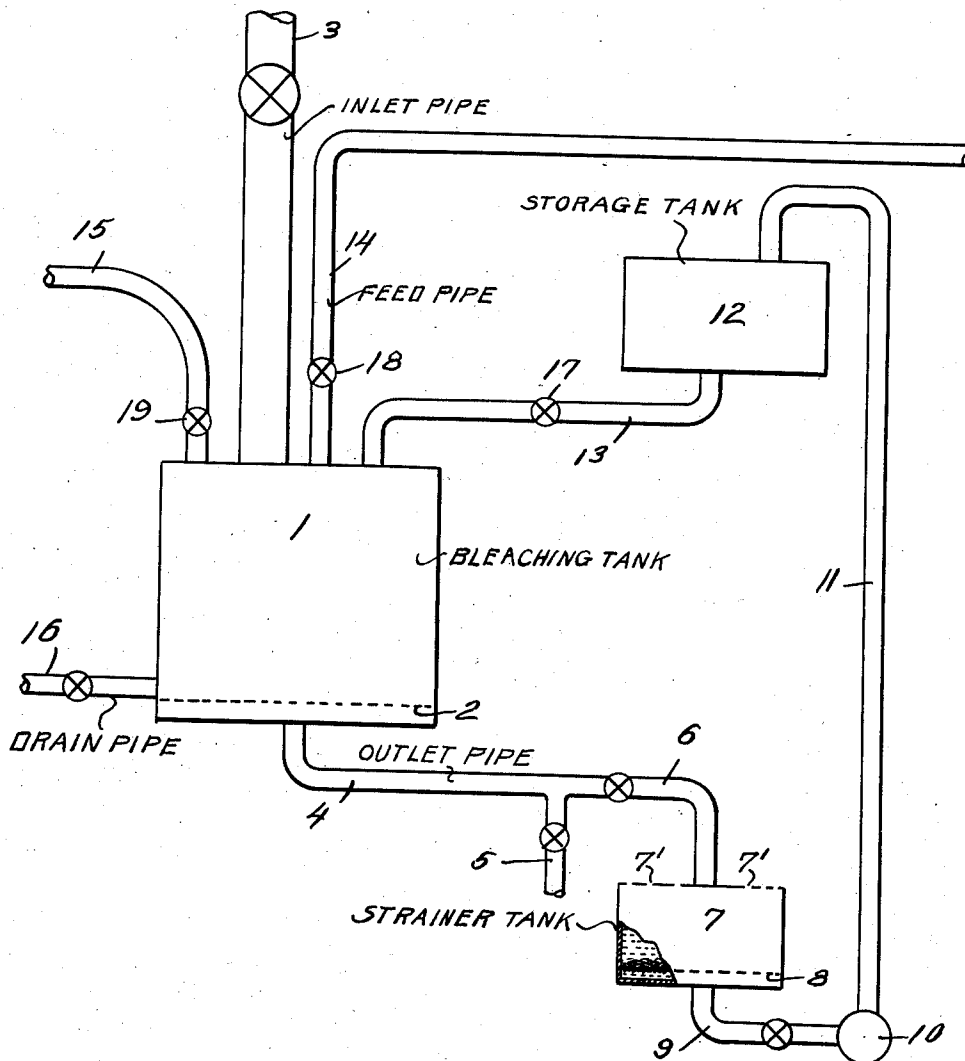
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METHOD OF BLEACHING PULP

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METHOD OF BLEACHING PULP

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This invention relates to a new method of bleaching vegetable fiber pulp and especially wood pulp used in the manufacture of paper.

5 Among the objects of my invention are the following: to provide a simple method for bleaching wood and other vegetable fibers in the form of pulp, to eliminate costly equip-
10 ment, to use a relatively small amount of power, to use relatively small amounts of bleaching medium as compared with present practice, and to produce a pulp with a higher strength and color and lower ash content
15 than can be produced with methods now in use. Other objects and advantages of my invention will become clear from the following description and appended drawing, wherein a form of apparatus which may be
20 used to carry out my improved bleaching process is shown in diagrammatic form.

In the manufacture of pulp and pulp products, such as paper, from vegetable fibers, such as wood, it is often desirable to have a
25 whiter or higher color than can be obtained in the raw products, either cooked or uncooked. It is usual to treat the fibers or pulp with bleaching agents, which are generally oxidizing in character. These agents
30 oxidize or destroy the organic materials which color the fibers, among which is lignin, thereby leaving the pure fiber which has a white color. The bleaching agent which is almost universally used is an alkaline solu-
35 tion of calcium hypochlorite, made by dissolving bleaching powder in water or by passing chlorine into a suspension of calcium hydroxide in water. An excess of calcium hydroxide makes the solution alkaline.

40 From the earliest days of the industry it has been considered imperative that the raw material must be thoroughly mixed by agitation with the bleaching medium. Many devices have been proposed and utilized for
45 this purpose. All of these involve great apparatus expense and all utilize large quantities of power. Furthermore, the operation is slow and often unsatisfactory and calls for skilled supervision and the results are often
50 uncertain in that the color of the finished

product may and does vary. In addition, the bleaching medium is not used efficiently.

In the early days the unbleached raw pulp stock in the form of a slurry containing 97 to 99 per cent water was treated in a circular vat
55 having a middle partition called a midfeather. On one side of the midfeather a paddle wheel served to keep the stock in motion around it. Owing to the great dilution of the stock in this apparatus and the conse-
60 quent dilution of the bleaching medium when this was added to the slurry the process of bleaching was very slow and a multiplicity of machines was necessary for a large capacity. This added greatly to the initial cost
65 of equipment and to the power necessary to turn the paddle wheels which kept the stock in motion.

Very soon attempts were made to thicken the stock by the use of a device which auto-
70 matically removed part of the water from the slurry. The advantages of thicker pulp were immediately apparent but as the slurry was thickened the paddle wheel was unable to perform its function and recourse was had
75 to the ordinary beater or Hollander. Such devices are so built that they will circulate stock of a much thicker consistency than can be circulated with a paddle wheel. This operation was much more satisfactory but still
80 the quantity of bleaching medium required was too large and the results were still unsatisfactory owing to the difficulty of producing bleached stock of a uniform color from day to day or batch to batch.

85 In an attempt to get away from these difficulties a type of bleaching equipment has been on the market for some time very much along the lines of the ordinary beater, except that the vat is much larger and the circulation of the stock around the midfeather is performed by a worm device. When the worm revolves the stock is drawn into it from one side of the midfeather and dis-
90 charged at the other end of the worm on the other side of the midfeather, forcing the stock to travel around and around until the operation is complete. This device has proved far more efficient than any previous
95 equipment and it is widely used today, not- 100

withstanding the fact that the first cost is very high. Special machinery is involved in addition to a specially constructed vat which is usually lined with smooth tile in order to reduce the friction caused by the travel of the stock. By the use of this apparatus, considerable economy in bleaching medium is accomplished and greater uniformity in the finished product is obtained, but the power required to keep the stock in motion is still great.

It has not been unusual to conduct the bleaching operation in a tank in which the stock to be bleached is placed in the form of a slurry. During and after the introduction of the bleaching medium the slurry is pumped out of the bottom of the tank and returned to the top. This circulation is continued until the operation is complete. In some cases the slurry is mixed with bleach liquor in one tank, then pumped through a series of tanks until in the last tank the operation is complete, thus approaching a continuous rather than a batch treatment. The same objections of low consistency, wastefulness of bleaching medium, large power consumption and cumbersome, costly equipment prevent this method from being adopted widely.

In still another method that has been employed to some extent the slurry is formed in a tank containing an agitator, and the bleaching medium added and thoroughly stirred into the stock. The slurry is then removed to another tank with a drainer bottom where the stock is allowed to stand from 12 to 16 hours when the bleaching operation is more or less complete. The bleaching medium is then washed out through the drainer bottom. This method can be accomplished only in a slurry of low consistency. It is open to the same objections of excessive equipment and power cost, high bleach consumption, extremely slow progress, and non-uniformity of product.

Of late years the tendency has been toward bleaching stock with a high consistency and various equipments have been used to accomplish this. While all of them are capable of producing uniform, high grade bleached stock, with a relatively economical use of bleaching medium, they all require special apparatus of a very costly nature, and great quantities of power are consumed in keeping the slurry in agitation after the bleaching medium is added. Such a bleaching equipment for handling 70 to 80 tons of wood pulp per 24 hours costs between \$90,000 and \$100,000. One installation of this type of equipment is in four units lined with expensive glazed tile and each unit is fitted with massive worm conveyors to keep the slurry in motion. For continuous operation 420 H. P. are required. Nevertheless, the relative economy in bleaching medium

and the greater uniformity of product justifies the use of this equipment.

I have discovered and thoroughly demonstrated that any and all of the objections which still pertain to the most modern and advanced method of conducting the bleaching operation can be overcome. My method differs from those referred to above in that: No special expensive equipment is required; the power consumption is less than one tenth of that required by the best equipment now in use; the quality of the finished product is better and of higher color than that produced by any of the methods in use; and great economy in the use of bleaching medium is accomplished, semi-commercial operations indicating a fifty per cent saving.

I estimate that, for a plant to handle 70 to 80 tons per day, the initial cost for equipment will not exceed \$15,000 and the power required will not exceed 60 H. P. and may well be considerably below this figure.

My method of bleaching can best be explained by showing the actual operation of the process in one form of discontinuous apparatus, the preferred type being shown in diagrammatic form in the accompanying drawing.

The bleaching is carried out in a wooden or other suitable box or tank 1 having a false bottom 2. This tank is provided with an inlet pipe 3 and outlet pipe 4. The tank 1 should preferably be built to withstand a pressure of about 20 lbs. per square inch. The false bottom 2 is raised slightly above the bottom of the box. The false bottom may be made of perforated cement or glazed tile, such as are in common use for similar purposes. The perforations should prevent the escape of the fibers, and be large enough to give a fairly free flow of water and bleach liquor.

Pipe 4 is provided with a branch connected to a drain (not shown) and provided with a valve 5. Beyond the branch, the pipe is provided with a valve 6 and this portion is connected to a strainer tank 7 having a drainer bottom 8. The tank 7 may be provided with openings 7' in the top through which air is admitted. The bottom of this tank is connected by pipe 9 to pump 10. The pump is connected to a storage tank 12 by a pipe 11. Pipe 13 extends from tank 12 to tank 1. A pipe 14 is connected to the tank 1 to deliver the bleach liquor thereto. Similarly a water pipe 15 is connected to the tank. The tank is provided with a drain pipe above the false bottom having a valve 16 arranged therein. The pipes 13, 14 and 15 are provided with valves 17, 18 and 19, respectively.

The bleaching operation is carried out as follows: The slurry of stock to be bleached is introduced into tank 1 through inlet pipe 3 or other appropriate means, and rests on

false bottom 2. Valve 5 is open to a drain and valve 6 is closed to permit the escape of water leaving the slurry through false bottom 2. The slurry which is introduced into the tank should be of such consistence that the drainer or false bottom 2 will not plug, as is well known to those skilled in the art. I prefer a slurry containing about 10% to 12% of stock. Any excess entrained water drains and escapes through the false bottom 2. I attribute the success of my process in large part to the uniform thick slurry which allows liquids to drain readily and uniformly through the stock, as is well known in washing stock in blow pits. This condition is readily obtained by the method of filling described. Although I have obtained excellent results when using 4 feet of sulphite pulp in tank 1, the depth of stock may be varied to suit conditions. The valve 18 is then opened and the estimated quantity of bleach liquor, which will be required by the pulp or vegetable fiber to be bleached, is run into tank 1 on top of the slurry. The bleach liquor is preferably a strong solution of alkaline calcium hypochlorite generally used for pulp bleaching. The bleach liquor passes down through the slurry forcing the water downward ahead of it. The water thus finds its way down to the false bottom 2 and out through pipe 4. As the bleach liquor replaces the water of the slurry, careful watch is kept of the effluent escaping through valve 5 and when bleach liquor appears at this point valve 6 is opened and valve 5 is closed. Valve 6 allows the escaping bleach liquor to flow into strainer tank 7. A layer of bleached sulphite pulp or other suitable straining material is arranged in the strainer tank on top of drainer bottom 8. The strained bleach liquor then flows through pipe 9 to pump 10 which delivers it through pipe 11 to storage tank 12.

When a sufficient quantity of used bleach liquor has been collected in tank 12, the valve 17 in pipe 13 is opened, again applying the bleach liquor to the slurry in tank 1. This operation is continued until the stock in tank 1 is fully bleached, and when this point is reached the valve 17 is closed and the used bleach liquor allowed to collect in tank 12. The valve 19 in water pipe line 15 is then opened and careful watch is kept of the effluent passing through pipe 4 into tank 7. When the drained bleach liquor has reached a sufficient dilution to render it unfit for further use, the valve 5 is opened and valve 6 is closed, allowing the liquor to run to waste. Water from pipe 15 is kept flowing until tank 1 is under pressure. The washing under pressure is continued until bleach liquid has disappeared from the effluent indicating that the stock has been thoroughly washed. Valves 5 and 19 are closed. Valve 16 is opened, and the bleached stock is washed out through

valve 16 in the usual manner. The apparatus is now ready for another bleaching cycle. The partially consumed bleach liquor in tank 12 may be used in the new cycle and usually follows a limited amount of strong bleach liquor to hasten the operation.

I have found that when the bleaching medium passes through the relatively quiescent thick drained slurry and displaces a portion of the water contained therein, it flows down through the slurry at a uniform rate throughout the entire tank. I have further found that this uniform flow of the bleaching medium through the drained pulp slurry prevents the bleaching liquid from being diluted to any extent by the water which it replaces and which drains through the bottom ahead of it. With the ordinary alkaline calcium hypochlorite bleach liquor, the movement of the bleaching medium down through the body of the slurry is less rapid than the movement of water. This slow movement is common to most alkaline liquids and apparently retards the dilution of the bleaching medium so that strong bleach comes in contact with each separate fiber within a relatively short period.

About one third of the water present in the drained slurry is replaced by the bleach liquor during the draining action which has been described. As the bleach liquor passes through the pulp it forces out the water between the fibers and surrounds each fiber. Not only does it act upon the exterior of the fibers, but I also believe that it diffuses rapidly into the fibers and acts upon any coloring matter which may be there. The bleach liquor becomes diluted by the water which is not replaced but the dilution is entirely different than in the bleaching methods now used where the bleach liquor is slowly added to a large mass of pulp. The strong bleach liquor first passes between the fibers from which the water has been drained. The exterior of the fibers is therefore subjected to a strong bleach which becomes more dilute as the diffusion into the interior of the fiber goes on. This diffusion must be much more rapid than in the ordinary methods because of the much greater difference in bleach strength between the interior and exterior of the fibers.

I ascribe the excellent chemical results which I have obtained with my method of bleaching to the quick action of the strong bleach liquor on the fibers. It is probable that the strong bleach liquor loosens the organic and inorganic impurities adhering to the fibers and washes them away. Many of these impurities are in a very fine state of division or are colloidal and pass readily down between the fibers and through the false bottom 2. The bleach liquor probably partially oxidizes the coloring matter in its passage down through the slurry but does not

complete this oxidation in that short time. If an alkaline calcium hypochlorite bleach is used with cooked wood pulp, this action is strikingly shown, especially if the bleach liquor remains in contact with the pulp about 20 to 25 minutes during its travel through the slurry. As the calcium hypochlorite bleach leaves the bottom of the tank 1 and comes in contact with the air a precipitate of a reddish brown color is deposited on the filtering medium placed on the false bottom 8 in tank 7. This precipitate may be redissolved by long contact with the calcium hypochlorite bleach. Cooked pulps in general turn reddish brown when first subjected to an oxidizing action and this color disappears with further oxidation. It is apparent that I remove these coloring materials from the pulp by my method of flowing the bleach liquor through the pulp and furthermore I can coagulate or precipitate this coloring matter so it can be filtered from the bleach liquor. In the ordinary method of bleaching these colored organic materials are retained in the pulp and must be destroyed by further oxidation by the bleach liquor to secure a high white color. The destruction of these colored organic products requires additional bleach solution, thereby increasing its consumption. I have not determined exactly why these red-brown organic compounds are precipitated from the calcium hypochlorite solution after leaving the pulp slurry, but I believe, however, that this coagulation or precipitation is due to the entanglement or absorption of the colloidal and other finely divided organic and inorganic substances by calcium carbonate which is formed by the action of the carbon dioxide of the air on the excess calcium hydroxide in the alkaline bleach liquor. Since bleaching operations are usually exposed to the air and since air is often used in the latest type of bleaching apparatus to cool the pulp and prevent the temperature from becoming too high during the bleaching operation, it is apparent that pulp, while being bleached by the present methods, contains a large amount of organic material entangled in freshly precipitated calcium carbonate. The bleaching of this coagulated organic material requires a longer time and a stronger bleach. Often acids are added to dissolve this calcium carbonate and hasten the bleaching operation. In short, in my process a portion of the organic materials is washed from the pulp, then coagulated or precipitated and then removed by an outside filter, as contrasted with the formation, coagulation, and bleaching of all of the colored organic compounds in the body of the pulp slurry by the ordinary methods. The advantages of my process are readily apparent.

The long contact of the excess bleach liquor with the fiber in the ordinary bleaching

processes to decolorize and dissolve these coagulated or adsorbed coloring materials allows the bleach to attack the fibers themselves as is evidenced by a decreased tensile strength. A further detrimental effect is also shown by the increased copper number which is indicative of the amount of oxycellulose formed. Unbleached sulphite pulp which had a copper number of 2.59 had a copper number of 3.95 when bleached by the highest type of commercial bleacher, and had a copper number of 2.78 when bleached by my method.

Furthermore my method greatly decreases the ash content of the pulp. The ash content of a pulp which originally was over 1 per cent was reduced to .38 per cent, while similar pulp bleached by the usual methods contained over 1 per cent of ash. Since the fibers are not packed into a compact mass in my process the finely divided or colloidal organic or inorganic impurities pass readily through the body of the pulp slurry in the tank and out through the false bottom into the pipe 4. They are then removed by the filter 8, especially if they are coagulated or adsorbed by freshly precipitated calcium carbonate. If a suction is put on the false bottom in the bleaching tank the fibers form a solid mat which prevents the flow of liquid, and such a mat may prevent finely divided impurities from being drained off readily with the bleach liquor.

I have found that when calcium hypochlorite bleach is used the bleaching may be carried out by my preferred method with considerable economy in power and consumption of bleaching solution over processes now in use. If necessary, the strong bleach liquor may be diluted with water so that there will be a slight excess of bleach liquor volume over that required to displace the water which drains from the pulp. The weaker the bleach liquor the longer the time which is necessary to secure the proper color. I have found and repeatedly demonstrated that whereas the highest type of bleacher now on the market requires bleach liquor equal in amount to 27% of the weight of a certain type of wood pulp, I can bleach the same pulp by the use of from 15 to 17% of bleach liquor.

The bleach liquor which first passes through the false bottom 2 has a marked yellow color which indicates that this first liquor contains a larger proportion of impurities and oxidized organic matter. This first portion may be discarded to prevent the return of these impurities to the pulp at the top of tank 1.

At the present time the highest types of bleachers require the use of large quantities of power to continuously agitate the thick slurry. In my improved method the pulp is in a relatively quiescent state, that is, the stock will not flow with the water passing

through it, and it is only necessary to circulate the bleach liquor. The saving in capital cost has already been discussed.

My process also facilitates the removal of the bleach liquor when the bleaching is complete. The wash water preferably immediately follows the bleach liquor down through the slurry, without removing the slurry from the tank, thus making additional drainers unnecessary. If preferred, the washing may be done in separate tanks or on washing machines.

Whatever may be the explanation of the results obtained from my improved method of bleaching, the action of the bleach liquor is exceedingly rapid with an excellent economy in material and power. The resulting pulp has a high white color, a low ash content and high strength.

I have described the preferred intermittent apparatus in which I carry out my new method of bleaching, but I do not wish to be limited to this apparatus as it may also be carried out in a variety of continuous and intermittent equipment and the method may also be modified in many ways without departing from the spirit of my invention. Thus, the operation can be carried out in my preferred type of apparatus by introducing the bleach liquor through the bottom, thereby reversing the flow of liquid. In another modification of my process, I filter off the insoluble impurities which appear in the bleach liquor after passing through the slurry by eliminating the filter 8 and returning the bleach liquor directly to the top of the pulp in tank 1. I have found that the top surface of this pulp acts as a filter for the coagulated or precipitated insoluble impurities in the bleach liquor. These impurities accumulate on top of the pulp and may be removed by skimming. I have also found that the bleach liquor need not be recirculated continuously through the pulp as the bleaching operation may be carried out by leaving the bleach liquor in contact with the pulp without circulation after flowing it uniformly into the pulp slurry as hereinbefore described. It is drained from the pulp when the desired color is obtained. The economy of material is lessened by this method since all of the organic matter is destroyed while in the pulp slurry. However, since the air cannot penetrate into the body of the pulp slurry the organic impurities are not coagulated or precipitated and are destroyed much more readily by the bleach liquor than in the ordinary bleaching operation where the air comes in contact with the pulp slurry as it is being agitated. The method of displacing the water in a pulp slurry with strong hypochlorite bleach liquor may be used with other types of bleach liquors which do not precipitate or coagulate the coloring matter when exposed to the air. The method of displacing the water in the

pulp may be further utilized if it becomes necessary to heat the pulp slurry, especially in cold weather, to about 90 to 100° F. to secure more favorable bleaching conditions. Warm water is run on top of a slurry in tank 1 and the cold water is allowed to drain from the bottom until it is entirely displaced by the warm water. Although I have described the process of washing in my preferred method as being carried out under pressure, this is not necessary. The washing may be carried out by gravity without the aid of pressure.

I claim:

1. The method of bleaching vegetable fiber pulp which comprises flowing bleach liquor through a relatively quiescent thick slurry of said pulp at normal pressure and temperature and keeping said bleach liquor in contact with said pulp until said pulp reaches the desired color.

2. The method of bleaching wood pulp which comprises flowing bleach liquor through a relatively quiescent thick slurry of said pulp at normal pressure and temperature, and keeping said bleach liquor in contact with said pulp until said pulp reaches the desired color.

3. The method of bleaching vegetable fiber pulp which comprises flowing bleach liquor through a relatively quiescent drained slurry of said pulp to displace a portion of the water contained therein and keeping said bleach liquor in contact with said pulp until said pulp reaches the desired color.

4. The method of bleaching wood pulp which comprises flowing bleach liquor through a relatively quiescent drained slurry of said pulp to displace a portion of the water contained therein and keeping said bleach liquor in contact with said pulp until said pulp reaches the desired color.

5. The method of bleaching vegetable fiber pulp which comprises flowing bleach liquor through a thick slurry of said pulp to displace a portion of the water contained therein so that the displaced water does not appreciably dilute said bleach liquor, and keeping said bleach liquor in contact with said pulp until said pulp reaches the desired color.

6. The method of bleaching vegetable fiber pulp which comprises flowing bleach liquor through a relatively quiescent drained slurry of said pulp to displace a portion of the water contained therein so that said displaced water does not appreciably dilute said bleach liquor, discarding said displaced water, and keeping said bleach liquor in contact with said pulp until said pulp reaches the desired color.

7. The method of bleaching vegetable fiber pulp which comprises flowing bleach liquor through a thick slurry of said pulp to displace a portion of the water contained

therein so that said displaced water does not appreciably dilute said bleach liquor, and then circulating said bleach liquor through said pulp until said pulp has reached the desired color.

8. The method of bleaching wood pulp which comprises flowing bleach liquor through a thick slurry of said pulp to displace a portion of the water contained therein so that said displaced water does not appreciably dilute said bleach liquor and then circulating said bleach liquor through said pulp until said pulp has reached the desired color.

9. The method of bleaching vegetable fiber pulp which comprises flowing bleach liquor through a thick slurry of said pulp to displace a portion of the water contained therein and to remove impurities from said pulp, filtering said bleach liquor, and then circulating said bleach liquor through said pulp until said pulp has reached the desired color.

10. The method of bleaching vegetable fiber pulp which comprises flowing bleach liquor through a relatively quiescent thick slurry of said pulp to displace a portion of the water contained therein so that said displaced water does not appreciably dilute said bleach liquor, discarding the said displaced water and the first bleach liquor passing through the pulp, and keeping said bleach liquor in contact with the pulp until said pulp reaches the desired color.

11. The method of bleaching wood pulp which comprises flowing bleach liquor through a relatively quiescent thick slurry of said pulp to displace a portion of the water contained therein so that said displaced water does not appreciably dilute said bleach liquor, discarding the water so displaced, filtering the partially consumed bleach liquor, and then circulating said bleach liquor through said pulp until said pulp has reached the desired color.

12. The method of bleaching vegetable fiber pulp which comprises flowing alkaline calcium hypochlorite bleach liquor through a slurry of said pulp, filtering said bleach liquor and again flowing it through said pulp.

13. The method of bleaching vegetable fiber pulp which comprises flowing alkaline calcium hypochlorite bleach liquor through a thick slurry of said pulp to displace a portion of the water contained therein, filtering said bleach liquor, and then circulating said bleach liquor through said pulp until said pulp has reached the desired color.

14. The method of bleaching wood pulp which comprises flowing alkaline calcium hypochlorite bleach liquor through a relatively quiescent thick slurry of said pulp to displace a portion of the water contained therein, filtering said bleach liquor after exposure to the air, and then circulating said

bleach liquor through said pulp until said pulp has reached the desired color.

15. The steps in the method of bleaching wood pulp with alkaline calcium hypochlorite which comprise flowing partially oxidized impurities out of the pulp in the bleach liquor, exposing said bleach liquor to the action of air, and filtering the precipitated impurities from said bleach liquor.

16. The method of bleaching vegetable fiber pulp which comprises suddenly exposing said fibers in a relatively quiescent slurry to a strong bleach solution and flowing impurities from said pulp by means of said bleach solution.

17. The method of bleaching wood pulp which comprises suddenly exposing said pulp in a relatively quiescent slurry to a strong bleach solution and flowing impurities from said pulp by means of said bleach solution.

18. The method of bleaching vegetable fiber pulp which comprises suddenly exposing said fibers in a relatively quiescent slurry to a strong alkaline calcium hypochlorite solution and flowing impurities from said pulp by means of said bleach solution.

19. The method of decreasing the ash content of vegetable fiber pulp during the bleaching operation with alkaline calcium hypochlorite which comprises flowing said bleach liquor through a relatively quiescent thick slurry of said pulp at normal pressure and temperature out of contact with the air except at the surface of said slurry.

20. The method of bleaching vegetable fiber pulp which comprises introducing bleach liquor on top of a relatively quiescent thick slurry of said pulp in a tank, allowing said bleach liquor to pass through the relatively quiescent pulp mass to displace a portion of the water contained therein by draining said displaced water, and keeping said bleach liquor in contact with said pulp until the desired color is obtained.

21. The method of bleaching wood pulp which comprises introducing bleach liquor on top of a relatively quiescent thick slurry of said pulp in a tank, allowing said bleach liquor to pass through the relatively quiescent pulp mass to displace a portion of the water contained therein by draining said displaced water, and keeping said bleach liquor in contact with said pulp until the desired color is obtained.

22. The method of bleaching vegetable fiber pulp which comprises introducing bleach liquor on top of a relatively quiescent thick slurry of said pulp in a tank, allowing said bleach liquor to pass through the relatively quiescent pulp mass to displace a portion of the water contained therein, keeping said bleach liquor in contact with said pulp until the desired color is obtained, and washing said bleached pulp with water while in said tank by allowing said water to pass

through the relatively quiescent pulp mass to displace said bleach liquor contained therein.

23. The method of bleaching wood pulp which comprises introducing a slurry of said pulp into a tank, draining off the excess water, introducing the requisite amount of bleach liquor on top of said drained pulp, allowing the bleach liquor to pass through the relatively quiescent pulp mass to displace a portion of the water contained, and keeping said bleach liquor in contact with said pulp until the desired color is obtained.

24. The method of bleaching wood pulp with alkaline calcium hypochlorite which comprises introducing a slurry of said pulp into a tank, draining off the excess water, introducing the requisite amount of bleach liquor on top of said drained pulp, allowing the bleach liquor to pass through the relatively quiescent pulp mass to displace a portion of the water contained therein, exposing said bleach liquor to air and filtering it to remove the calcium carbonate precipitated therein, and recirculating said bleach liquor through the pulp mass until the desired color is obtained.

In testimony whereof I affix my signature.
DENNIS CUSHMAN ANDREWS.