

Oct. 17, 1961

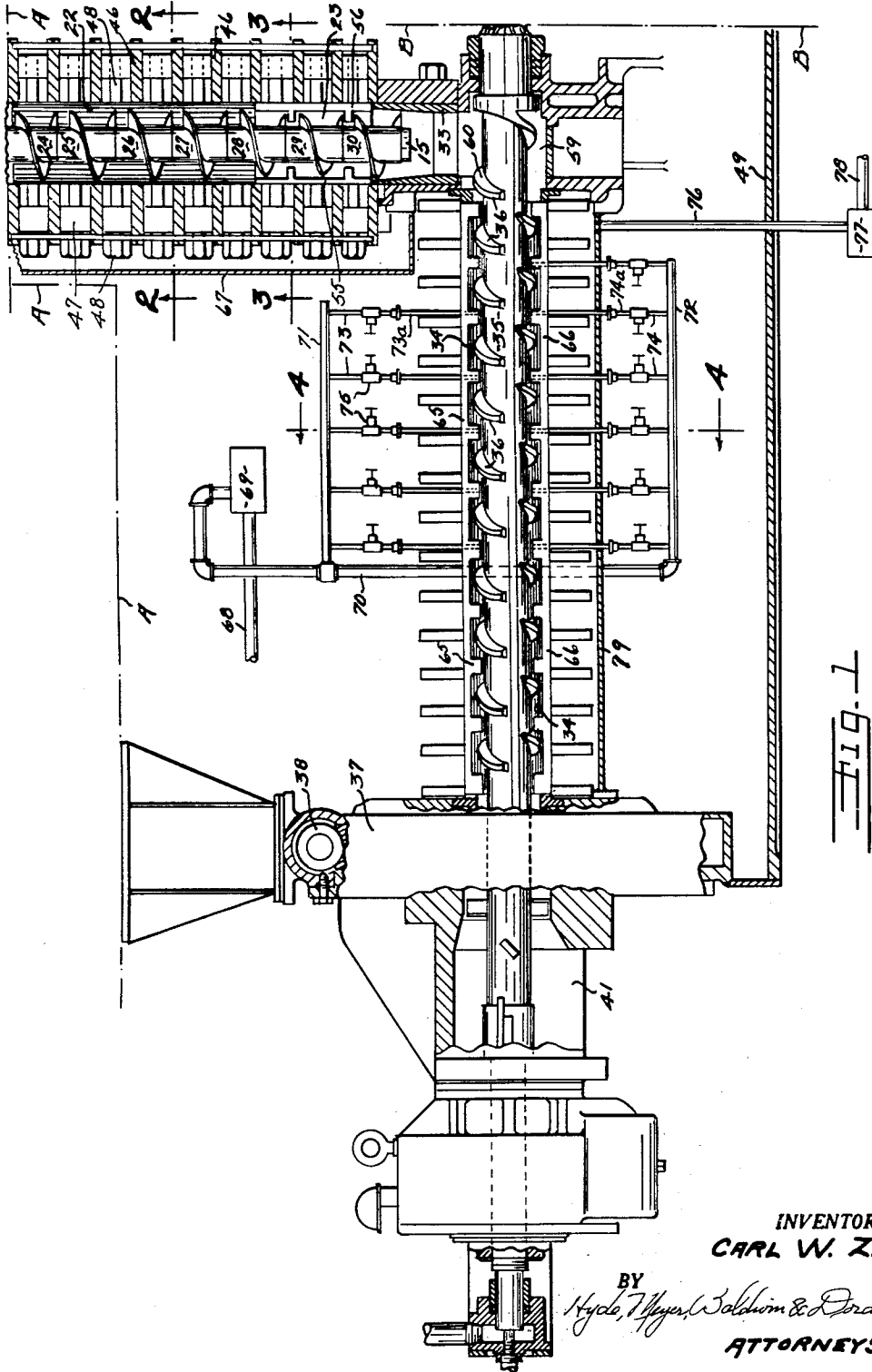
C. W. ZIES

3,004,876

METHOD FOR WASHING FIBROUS MATERIAL

Filed March 20, 1957

5 Sheets-Sheet 1



Oct. 17, 1961

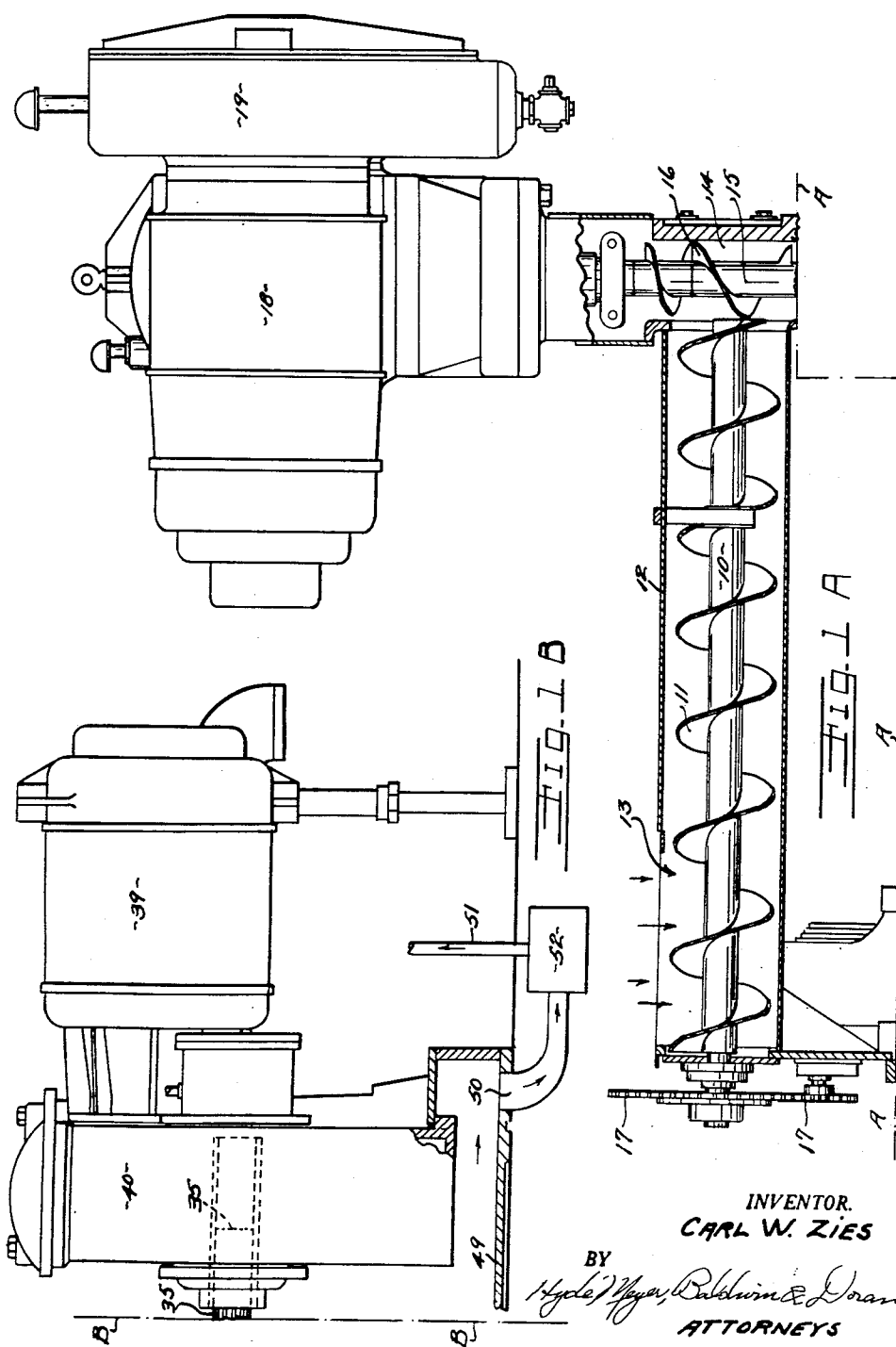
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METHOD FOR WASHING FIBROUS MATERIAL

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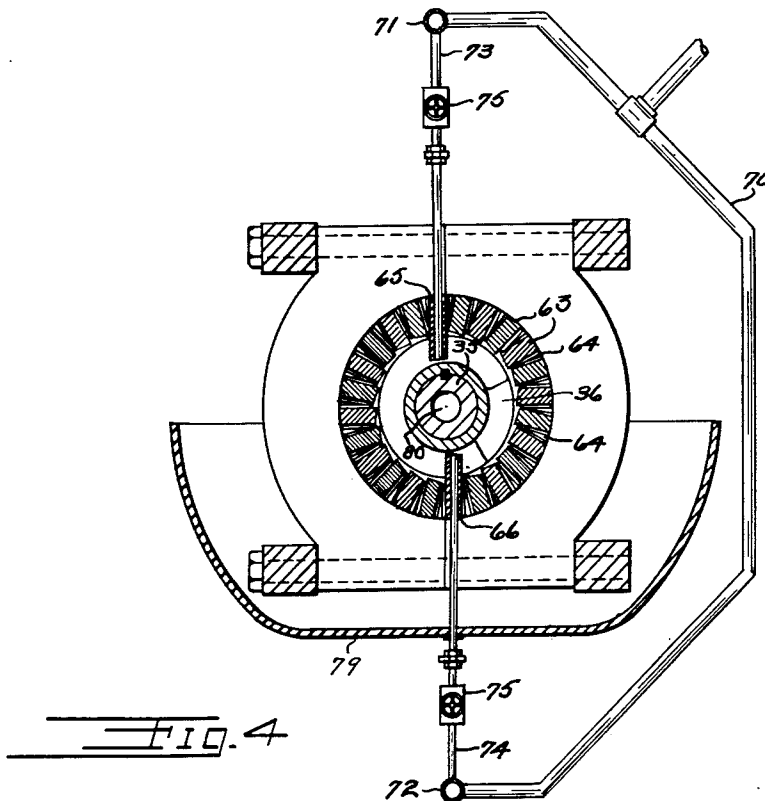
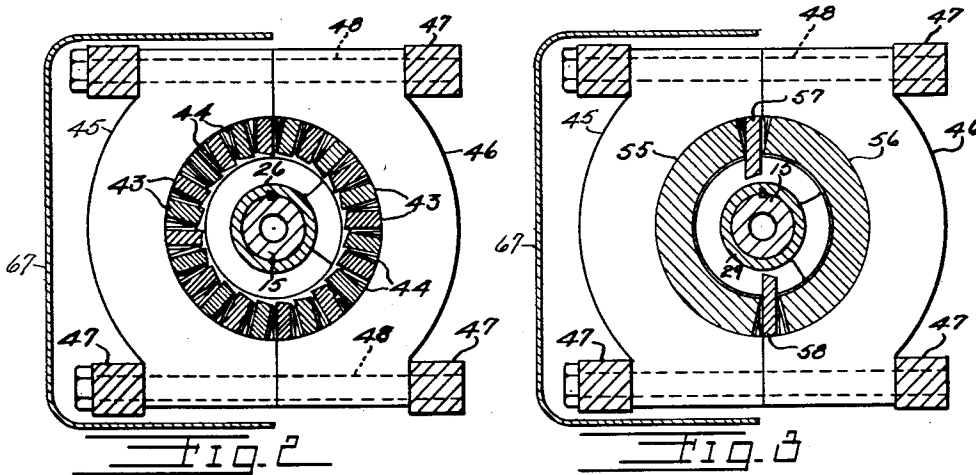
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METHOD FOR WASHING FIBROUS MATERIAL

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5 Sheets-Sheet 3



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METHOD FOR WASHING FIBROUS MATERIAL

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5 Sheets-Sheet 4

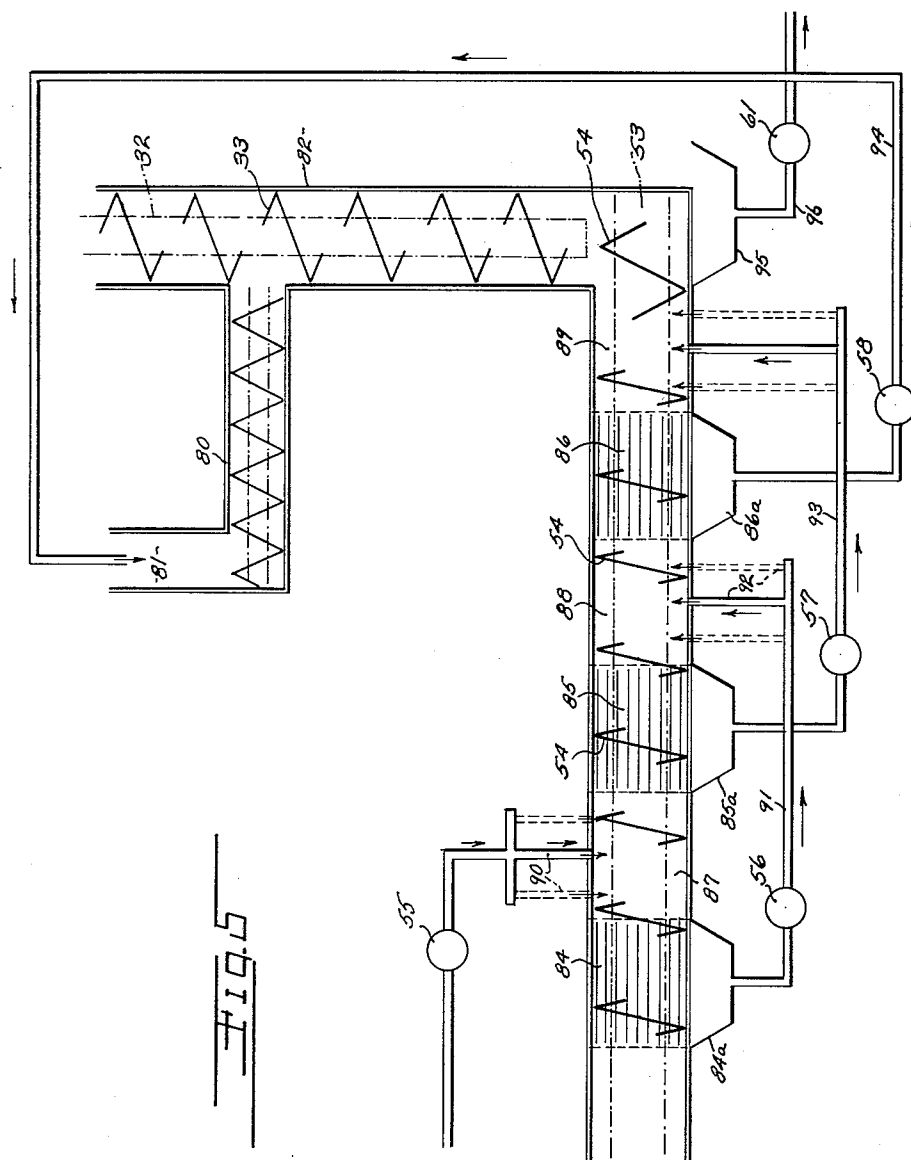


FIG. 5

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METHOD FOR WASHING FIBROUS MATERIAL

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5 Sheets-Sheet 5

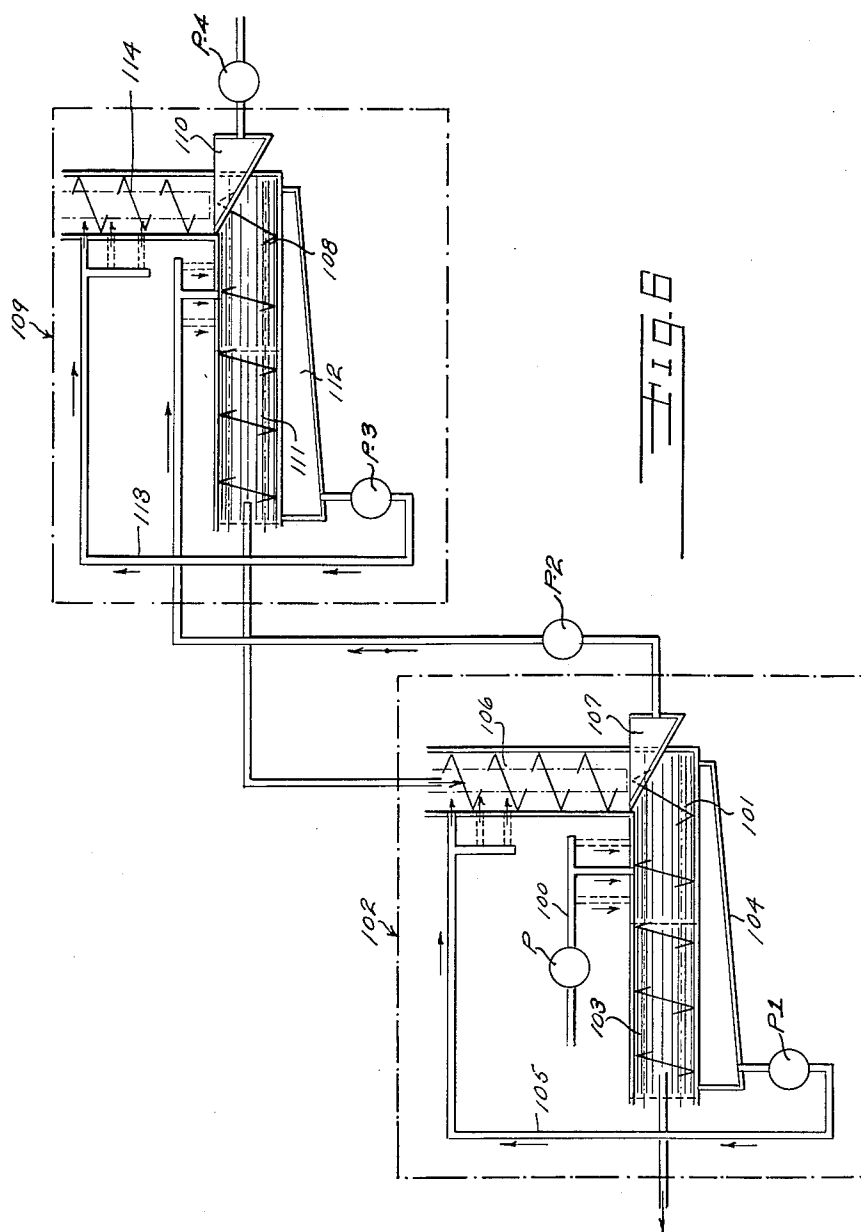


FIG. 8

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3,004,876

METHOD FOR WASHING FIBROUS MATERIAL
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Filed Mar. 20, 1957, Ser. No. 647,276
5 Claims. (Cl. 134—25)

This invention relates to novel and improved methods for processing materials in the barrel of a continuous mechanical screw press by injecting liquid under pressure thereinto and subsequently removing liquid therefrom. More particularly, this invention relates to novel and improved methods whereby fibrous materials may be deliquified and washed under conditions of high-pressure multi-stage washing in a single continuous mechanical screw press.

In the pulp and paper field there is an ever increasingly acute problem in the removal of contaminating liquors from pulps prior to the production of paper from these pulps. Not only are these liquors injurious to the production of the subsequent papers, but their reclamation in a concentrated form is presently impossible. In many instances wherein these liquors are recovered, they have been emptied into nearby streams since the relatively low concentration of contaminating materials in these liquors prevent their reclamation. There is, however, an ever increasing attempt to prohibit this practice because of the high biological oxidation demand of the materials in the liquors discharged into the streams.

It is well known to those skilled in the art that continuous mechanical screw press machines constitute a practical means for expressing liquids from fibrous materials. It is further well known that these liquids, for example black liquors that exist in a paper pulp mill, may be washed from fibers with excessive volumes of water in equipment known as vacuum drum washers.

In the first instance, mechanical screw presses now employed for deliquifying of fibrous materials in paper mills fall into two classifications; the first classification consists of those presses which can dewater a fibrous material to a pressed pulp containing approximately 65% moisture. When presses in this classification are employed, three or four different presses in series normally constitute a wash system wherein fresh water is added to the fiber material ahead of, for example, the fourth press in the line. The effluent from this fourth press is then added to the fiber being conveyed to the third press in the line, and so on back to the first press, in an attempt to attain as efficient a washing as possible with the minimum amount of water. It is apparent to those even unskilled in the art that such a series of machines constitutes a high capital investment in an effort to attain a certain degree of washing efficiency.

The second classification consists of those presses which can dewater a fibrous material to approximately 40% moisture. One of these presses alone is capable of removing approximately 70% of the contaminating liquor from a fibrous material wherein higher degrees of removal of contaminants is required. Two different presses in this classification used in series constitutes a wash system wherein fresh water is added to the fiber material ahead of the second press in the line. When, for example, neutral sulphite semichemically digested wood chips are being washed in such a two-stage wash system, 5-20 minutes time must be provided for this fresh water to become uniformly absorbed into the first pressed fibers before introduction into the second stage press. The effluent from this second press is then added to the fibers being conveyed to the first press in the line. Again in the case of neutral sulphite semichemically digested chips, 30-60 minutes retention time should be permitted for

uniform diffusion of this dilute liquor into the chips entering the first press. Although for efficient washing in a two-stage system as above, a considerable amount of time is required for diffusion of wash waters into the fibrous materials, the primary disadvantage of this system lies in the effect of the two-stage pressing on the quality of the pulp subsequently made from the fibers thus treated. There is considerable evidence that two-stage pressing with high pressure presses as in classification 2 above has a deleterious effect upon the strength of pulps subsequently made from fibers treated in this manner.

In a second instance of prior art practice, units known as multi-stage vacuum, rotary drum washers may be employed for the washing of liquors from a highly refined or fiberized pulp. In this instance a large volume of water is required to attain the removal of a high percentage of the liquors in the pulp.

The process about to be described and the novel apparatus whereby it can be accomplished permit, among other features, the inherent advantages of a multi-stage, counter current continuous mechanical screw press washing without the disadvantages of the numbers of machines required for this type of system and without the excessive amount of water required in the multi-stage, rotary vacuum drum washing system.

One object of this invention is to provide methods for introducing operating liquids under pressure into the working confines of the barrel of a continuous mechanical screw press.

A further object of this invention is to obviate the necessity of multiple units in a multi-stage washing system.

A further object of this invention is to provide methods for washing of liquors from fibrous materials with a minimum amount of dilution water.

A further object of this invention is to provide methods for introducing a working liquid or a digesting liquor into a preceding zone of a mechanical screw press barrel and mechanically extracting this same liquid and/or liquor in a succeeding zone of the screw press barrel.

In the wood pulp industry, there are three general classifications of pulps produced whereby the original wood in chip form is digested with chemical liquors prior to refining the digested wood into pulp form. These three general classifications are termed semichemical, sulfite, and kraft processes. In the first process the digested chips issue from the digester in chip form. Before these chips can be washed free of their liquors by any means presently known in the art, they must be refined to pulp form. Those mills using the second process above to produce high yield sulfite pulp are confronted with the same problem. This problem consists of transporting the digested chips in a large volume of the digestion liquor through pumps and pipe lines, which of necessity must be fabricated of non-corrosive material such as stainless steel because of the corrosive nature of these liquors. These chips, still in the presence of corrosive liquors, are then refined in any one of the refining systems conventionally used for this purpose. This, however, requires further use of stainless steel pipe lines, pumps, valves and stock chests.

A further object of this invention is to provide methods whereby fibrous aggregates, as in digested wood chips, may be washed free of their contaminating and corrosive liquors directly and in one single operation.

Other objects and advantages will be apparent from a study of the following description in conjunction with accompanying drawings in which;

FIG. 1 is a view, partly in vertical section and partly in side elevation, showing a working assembly suitable for use in the performance of the methods herein disclosed, including vertical and horizontal screw press bar-

rels and associated elements. For convenience in illustration, because the complete assembly is extensive, several parts of said assembly have been cut away and are shown in FIGS. 1A and 1B as follows:

FIG. 1A is a drawing, partly in section and partly in side elevation, showing feeding and driving mechanism for the vertical press barrel, the plane of separation between FIGS. 1 and 1A being along the broken line A—A in both said figures;

FIG. 1B is a drawing, partly in section and partly in side elevation, showing driving mechanism for the horizontal barrel, and other associated elements, the line of separation between FIGS. 1 and 1B being along the plane B—B in both said figures;

FIGS. 2, 3 and 4 are sectional views taken respectively on the lines 2—2, 3—3 and 4—4 of FIG. 1;

FIG. 5 is another embodiment of the present invention, but schematically showing counter-current washing in a single press.

FIG. 6 illustrates schematically the use of two or more presses in series for multi-press, multi-stage, counter-current washing.

The main structural features of a machine such as would be achieved by combining FIGS. 1, 1A, and 1B, are shown, for example in U.S. Patent No. 2,471,920, granted May 31, 1949 to Raymond T. Anderson.

Referring to the drawings, FIG. 1 shows a screw press assembly wherein a material such as neutral sulfite semichemically digested wood chips may be processed for the recovery of digestion liquor (black liquor). Since the general type of apparatus is familiar to those skilled in the art, I will describe only briefly the broad function and purpose of some of the main elements of the structure.

The screw press (assembled views 1, 1A and 1B) includes feeding means (FIG. 1A) comprising a horizontal rotatable shaft 10 carrying a helical worm 11, the shaft and worm being enclosed in a tubular housing 12 which has a feed opening 13 at the receiving end thereof. Black liquor bearing material dropped through opening 13 as shown by the arrows is carried to the right and discharged into a vertical cylindrical chute 14 which likewise is provided with a rotatable shaft 15 having thereon screw flight means 16 adapted to force the material downwardly. Conventional drive means is provided for shafts 10 and 15. Shaft 10 is driven from cooperating sprockets 17 which in turn are driven by a motor, not shown. Drive of shaft 10 does not require much power since loose material is merely being advanced laterally into chute 14 where incipient pressure begins to be applied. Shaft 15 is driven from motor 18 through a gear reduction train in housing 19, and then through a worm and gear or a bevel gear and pinion to shaft 15, this driving gear being conventional and therefore not shown.

Forming a downward continuation of chute 14 is a vertical barrel section 22 (FIG. 1) coaxial and coextensive with chute 14. This barrel section will be more explicitly described hereinbelow. Shaft 15 continues downwardly through barrel section 22, and carries thereon a plurality of screw hubs 24, 25, 26, 27, 28, 29 and 30, each having its respective helical screw flight thereon, the periphery of which closely approaches the inner face of the barrel wall.

At the lower end of the vertical barrel is an impermeable collar 23 within which the advancing material is compacted into a liquid-seal plug by gradually increasing downward pressure exerted by the screw flights.

The leading end of the plug is progressively forced into the right end of horizontal barrel 34 within which rotates a shaft 35 having interrupted helical screw flights 36 thereon. The purpose of this construction is to advance the material along barrel 35 towards its left end while gradually increasing the pressure. This increase of pressure is achieved in various ways, all of them previously recognized in the art, for example by decreasing

the pitch of screw flights 36 towards the left end, or by increasing the shaft root diameter towards the left, or by restricting the escape opening within an automatic choke assembly 37. This automatic choke assembly is not shown in detail, but structural features of one suitable embodiment are well shown and described in U.S. Patent No. 1,752,054 to Raymond T. Anderson. Briefly, rotation of a worm 38 produces co-acting rotation of a peripheral gear which through the operation of further cooperating parts results in the constriction of inner peripheral parts so as to produce a change in the diameter of a choke aperture somewhat similar to the operation of the so-called "iris diaphragm" which is used in some optical elements, for example certain camera lenses.

The drive for shaft 35 is here located at its right end (FIG. 1B) and consists of a motor 39 and a train of reduction gearing in housing 40.

Returning to FIG. 1, deliquesced fiberized fibrils proceed through the automatic choke and drop through port 41.

I will now describe more fully the structures 22 and 23 of the vertical barrel, and the horizontal barrel 34 with reference to the wash treatment of the material in the horizontal barrel.

The general structure of barrel zone 22 will be better understood by reference to prior patents to Raymond T. Anderson, including for example, U.S. Patents Nos. 1,722,882, and 1,773,771. This vertical barrel part is built up from an assembly of barrel bars 43, lying side by side (FIG. 2) and all fitted together in keystone-like fashion, having V-shaped spring clips 44 therebetween, and tightly maintained by semicircular frame members 45 and 46 which in turn are clamped longitudinally by bars 47, transversely retained by tie bolts 48.

The barrel bars 43 are disposed in such close mutual lateral contact as to prevent solid material from escaping radially outwardly therebetween, but to permit liquid to be squeezed through the minute interstices when the pressure is heavy. The spaces between the barrel bars may be adjusted depending on the fibrous material being pressed.

Assume that black liquor-bearing digested chips are being forced downwardly through barrel zone 22, as the pressure increases a considerable portion of the black liquor is squeezed outwardly between the barrel bars, and it flows down into a trough 49 whence it proceeds to the right (FIG. 1B) and through a discharge port 50, and it is then impelled through conduit 51 by a pump 52. This black liquor is full strength and proceeds to a temporary storage tank. This upper zone 22 of the vertical barrel is sometimes referred to as a "pre-press" or "drainage" zone.

Zone 23 of the vertical barrel might be termed the "sealing" zone since no drainage occurs therefrom and the plug therein formed provides a liquid seal for liquids originating in the horizontal barrel as will appear. In certain instances, it might be advantageous to extend sealing zone 23 upwardly into the vertical prepress zone. In one instance this extension of the sealing zone may be obtained by assembling two semicylindrical portions of tubing in the lower section of prepress zone 22 in place of the barrel bars normally employed. This same effect may be attained merely by using barrel bars in this same area without spacers between the bars.

At the junction of the vertical and horizontal barrels there is a short space 59 where the material movement changes direction, under the motive influence of worm flight 60. The material thereupon is forced to the left by rotation of shaft 35 as hereinabove mentioned. Horizontal barrel 34 is similar in construction to the drainage portion 31 of the vertical barrel, its cross sectional construction being best shown in FIG. 4 which shows shaft 35, screw flights 36, barrel bars 63, and spacers or clips 64. In the present embodiment this structure runs the full length of the barrel. A pair of opposed knife bars

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65 and 66 are provided, which are perforated at spaced longitudinal points for a purpose soon to appear.

I have provided means for injecting washing liquid into about the right half portion of the horizontal barrel, such means comprising a pipe 68 from a supply source (not shown), a pump 69, and end header 70, a top manifold 71, a bottom manifold 72 and branch pipes 73 and 74 constituting injection nozzles. Each branch pipe feeds into a respective aperture extending radially inwardly through a knife bar, the disposal being such that the liquid is discharged into the barrel near the shaft surface. Each branch pipe is provided with a valve 75 for possible individual control. The right portion of the horizontal barrel of this embodiment may therefore be termed the wash liquid injection portion.

Continuing the present exemplification in which wash water is to be used for providing a washing effect on the digested wood chips being compressed, the water is introduced under pressure near the shaft, between screw flights, and as the fiber bundles and water are advanced into the next worm flight, the pressure of the worm forces the water to move through the compacted fiber bundles towards the outside of the barrel. As the water moves through the fiber bundles, it picks up the black liquor which remained in the fiber bundles and together they are pressed out of the barrel. As shown in the drawing, the six injection zones represented by the six upper-lower branch nozzles, cause this water washing operation to be repeated six times. This, of course, could be multiplied as many times as seems advisable or desirable.

A deflecting shield 67 prevents the concentrated liquor issuing from zone 22 from intermingling with washed liquors issuing from the washing section of the horizontal barrel 66 and pressing section 34. A collecting trough 79 collects liquors from the horizontal barrel which issue from the screw press by means of pipes 76, and from this trough they proceed to intermittent storage tanks (not shown). This arrangement of concentrated liquor and wash liquor separation is utilized wherein a multi-stage two-press system is employed. If a multi-stage single-press system is employed, baffle hown in FIG. 1 for separation of concentrated liquor and wash liquor are not employed.

The fibrils continue onwardly in the barrel towards the automatic choke 37 and the discharge point 41. In its trip through the horizontal barrel the material has been simultaneously exposed to mechanical expression and water washing, and each effect supplements the other. By controlling the temperature within the barrel, which can be done by pressure control and/or supplemental heating means, along with the multi-stage washing means thus provided, very efficient washing of fiber bundles and fibers is attained.

In this new process it has been discovered that the amount of wash water injected into horizontal wash section 66 of FIG. 1 is completely pressed from the fiber bundles in the wash section and in the subsequent press section 65 so that no more liquid as water remains with the fiber bundles than if the water had not been injected in the first place. The injection of wash water into the screw press, therefore, does not lower the efficiency of mechanical expression of liquid from the fibers. By greatly aiding in the removal of contaminating liquors, however, it does greatly increase the washing efficiency of the unit.

The apparatus above-described and shown in the drawings can be modified in various helpful ways for specific purposes merely by further consideration of the operations already described. The vertical barrel or at least the drainage portion thereof may be made longer to provide more drainage space and more liquor removal during the preliminary pressure application. Since a wide range of fibrous materials can be processed in this apparatus, it is recognized that it will be desirable to prepress a greater quantity of liquor from fibrous materials which originally contain a greater quantity of liquor. For example, in

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using the apparatus and means of this invention for washing of liquor from kraft pulp, these pulps contain four times the amount of liquor as does a neutral sulfite semichemical digested chip. Therefore, an extended drainage portion in the vertical barrel would be desirable.

The horizontal barrel is subject to even greater flexibility than the vertical barrel; for example, referring to FIG. 1, it might be desirable to inject wash water into the barrel through injection lines 73a, 74a, the lines closest to the vertical section. The section of barrel around the succeeding worm may then be blanked off by using a solid section of barrel so that the wash liquid must be retained by the pulp under pressure during this time of passage along this section of barrel. Alternate drainage and solid barrel injection sections may be, therefore, employed wherein materials that absorb wash liquids or give up liquor fractions with difficulty are being processed. In addition to arranging the drainage of the horizontal barrel to meet specific requirements, the entire horizontal barrel may be lengthened by 1 to 3 feet, or more, as required by materials that give up contained contaminants with difficulty.

By way of example, but not of limitation, neutral sulfite semichemically digested aspen wood chips were processed in the apparatus of this invention as illustrated in FIG. 1. 1.6 pounds of water were employed for every one pound of fiber on the oven dry weight basis. The digested wood chips processed contained 32.2% soluble solids on the dry weight basis. After processing through the apparatus of this invention and washed with the aforementioned amount of water by means of this invention, the fiber bundles thus produced contained only 6.5% soluble solids on a dry weight basis. In a second control test another quantity of the same neutral sulfite semichemically digested aspen wood chips were pressed in the mechanical screw press not employing the novel washing means of this invention. The fiber bundles from this control test contained 11.75% soluble solids on the dry basis, or almost double the quantity as that when the methods of this invention were practiced. Another control test was made wherein another sample of the same neutral sulphite semichemically digested aspen wood chips were mixed with three parts of water per part of oven dry fiber. This amount of water is almost double that used in the washing text involving the methods of this invention. These digested chips, along with the abundant amount of water mixed with them, were pressed in a standard screw press. The fibers issuing from the discharge of the screw press contained 8.82% soluble solids on the dry basis. This latter test demonstrates that even with the use of almost double the amount of water as required when using the novel means of this invention, the washing efficiency when employing standard screw presses known to the art is far less efficient than when employing the means of this invention.

Further proof of the values of the methods of this invention may be illustrated by commercial scale tests conducted on neutral sulphite semichemically digested aspen wood chips that contained 60% moisture after the digestion step. The contaminating black liquors with these digested chips contained 17.5% soluble solids or 940 pounds of soluble solids per one ton of dry weight soluble free fiber. These neutral sulphite semichemically digested chips were pressed in a standard screw press like that illustrated in FIG. 1, but without employing the methods and means of this invention. In this test the chips were pressed to fiber bundles containing 50% moisture. Under these conditions the pressed pulp retained 540 pounds of soluble solids per oven dry ton of solubles free fiber. The condition "oven dry" is usually briefly characterized as "O.D.," and may be defined as moisture free pulp. In a second test, 1.2 pounds of water for each pound of oven dry solubles free fiber was added continuously to the neutral sulphite semichemically digested chips prior to their being conveyed to the press

used above. This mixture of digested chips and wash water was likewise pressed to fiber bundles containing 50% moisture. These pressed fiber bundles then contained 302 pounds of soluble solids per O.D. ton of solubles free fiber. A third test was conducted wherein the neutral sulphite semichemically digested chips were pressed in a first stage press so that the resultant fiber bundles contained 50% moisture. 1.2 pounds of water per pound of oven dry solubles free fiber was then continuously added to the pressed fibers from the first press as they were being conveyed to a second press. The second press operation was so conducted that the fiber bundles were also pressed to a material containing 50% moisture. The resultant fiber bundles from this test contained only 250 pounds of solubles per ton of O.D. solubles free fiber. A fourth test was then conducted employing the methods and means of this invention whereby 1.2 pounds of water heated to a temperature of 150° was pumped into six ports of the horizontal barrel as illustrated by pipe lines 73, FIG. 1, per pound of oven dry solubles free fiber. The press was so operated that the resultant fiber bundles also contained 50% moisture. Under the conditions of this press, the resultant fiber bundles contained 250 pounds of solubles per ton of O.D. solubles free fiber.

The above series of tests clearly indicate that through the use of the methods of this invention, one press when employing the wash system described in this invention, is as effective as two presses in series. Further, two presses in series require an appreciable amount of time to permit diffusion of wash water into the pulps being processed. On the other hand, it has been discovered that the diffusion of the wash waters into the pulps under the methods and means of this invention is almost instantaneous. This instantaneous diffusion is a result of maintaining a mechanical pressure upon the materials in process, which permits a high hydrostatic head up to 1,000 p.s.i. on the wash water being pumped into and through the fiber bundles within the confines of the press barrel 66, FIG. 1. This high hydrostatic head of wash water on the pulp in process not only permits an extremely rapid rate of diffusion of the wash water into the fiber bundles, but also permits the filling of voids between fiber bundles with water instead of air as the fiber bundles continue their passage along the horizontal barrel of the apparatus shown in FIG. 1.

By increasing the mechanical pressure exerted on the fiber bundles in the horizontal section of the apparatus shown in FIG. 1, more moisture may be pressed from the fiber bundles. For example, when this pressure is increased so that only 40% moisture remains with the fiber bundles, only 150 pounds of soluble solids per ton of O.D. solubles free fiber remains. Not only does this represent a greater removal of soluble solids than that attained in a two-stage press system, but also the single pressing has no deleterious effect upon the pulps subsequently made from the fibers.

Referring now to the embodiment shown in FIG. 5, I illustrate schematically an arrangement in which the horizontal barrel is equipped with alternate wash and drainage sections so arranged as to furnish direct counter current washing within the same horizontal barrel. The showing of FIG. 5, while simply schematic, will be clearly understandable to one now familiar with FIGS. 1 to 4, in view of the following description.

Neutral sulphite semichemically digested chips with black liquor entrained therein are introduced into the feeder 80 at the point 81, and are conveyed into the vertical pre-press barrel 82 which is equipped with the usual shaft 32 having screw flights 33 thereon. The relatively free and easily removable fraction of the black liquor is pre-pressed from the chips in this vertical barrel.

The horizontal barrel in the present instance is provided with a shaft 53 having screw flights 54 thereon and is shown as having drainage sections 84, 85 and 86 alternating with sections 87, 88, and 89 which are non-drain-

age or solid wall sections. Under the drainage sections are troughs 84a, 85a and 86a to catch the liquid pressed through the barrel bar interstices in these drainage sections. Fresh wash water is advanced by pump 55 into washing section 87 through one or more injection nozzles 90, and as the material in the barrel is impelled from right to left, this wash water with some black liquor in solution is exuded through the barrel bars in drainage section 84 and drops into trough 84a from whence it is advanced by pump 56 through pipe 91 and through nozzles 92. This dilute water-liquor solution pervades the material in wash section 88 and advances to drainage section 85 from whence it is expressed into trough 85a. It will be obvious that as the liquid regresses from the left end towards the right, in countercurrent relationship to the solid material, the liquid acquires a higher percentage of black liquor.

From trough 85a the liquid is advanced by pump 57 through line 93 into the first wash section 89 at the entry end of the horizontal barrel, and again it is carried one step to the left into drainage section 86 and then is squeezed into trough 86a. From trough 86a, the liquor, now having been considerably enriched with black liquor, is pumped through pipe 94 by pump 58 to the original point of entry 81 of digested chips, and discharged into the feed conveyor 80. As previously indicated, a fair proportion of the excess concentrated liquor is expressed in the travel through the vertical barrel. This may be collected in a trough 95 and pumped through pipe 96 by pump 61 to any convenient disposal point.

There are certain cases wherein commercial mills require an even more complete removal of soluble liquors than possible in a multi-stage washing operation utilizing a single press as described hereinabove when practicing the methods of this invention.

FIG. 6 is a schematic showing of a multi-stage, multi-press washing system, although in this particular instance, for simplicity, two stages are indicated in the drawing. Obviously the system can be enlarged to any extent desired by the use of additional units or stages.

Referring to FIG. 6, fresh water is pumped by pump P through pipe 100 to wash section 101 of the second press enclosed in broken lines 102. The effluent from sections 101 and 103 is collected in drainage pan 104 and advanced by pump P₁ through pipe 105 to prepress section 106 of the vertical barrel. The liquors drained from section 106 are intercepted by pan 107 and are advanced by pump P₂ to the wash section 108 of the press enclosed in broken lines 109, the first press in this series. The liquors collected in drain pan 112 from the wash and press sections 108 and 111 of this first press 109 are advanced by pump P₃ from pan 112 through pipe 113 to vertical pre-press barrel 114.

The liquors collected in drain pan 110 represent the total wash effluent from the multi-stage pressing system just described, and these liquors are pumped by pump P₄ to an evaporator or to any end use or means of disposal known in the art.

Each of the wash sections 101 and 108, for example, may represent any plurality of stages, for example between two and twelve stages. In addition, and bearing in mind the embodiment shown in FIG. 5 and heretofore described, it is apparent that each of the screw presses in the present series (FIG. 6) may be equipped with a counterflow wash system within each press. A counter-current, multi-stage washing would, of course, be more efficient, than for example a pair of presses in series with only single point introduction of wash water in each of the presses. It will, therefore, be apparent to those skilled in the art that by using the method and means disclosed in the present specification, multi-stage counter-current washing is now possible by using only one or two items of equipment under conditions such that a minimum amount of wash liquid is required to obtain a high degree of washing efficiency.

It will be apparent from the foregoing to those acquainted with the art that there are many specific arrangements within each continuous mechanical screw press and arrangements of two or more presses which will make possible the removal of a calculated amount of contaminating liquors from any fibrous material under study. For example, it will be perfectly obvious to those acquainted with the art that wash liquids may be pumped into either a vertical or a horizontal barrel at points other than through the knife bar lugs illustrated in FIG. 1. For example, water could be pumped into the barrel at any point on the periphery of the barrel, or it could be pumped to the barrel at either end of the barrel, but, of course, preferably to the feed end of the barrel. It will, however, be apparent to those skilled in the art that the most efficient use of wash liquors is only attained when these liquors are pumped to the innermost parts of the materials being processed in the barrel of the screw press as is accomplished through the means and methods of this invention.

Although examples to illustrate the methods of this invention have been drawn from the pulp and paper field, these specific examples by no means limit the scope of this invention. These same principles may be applied to any natural occurring or synthetic fibrous material. They may be applied to any material so processed in a screw press which permits the diffusion of liquid between the interstices of the material being processed.

The processes described herein may be facilitated or accelerated by subjecting the conglomerate mass of liquor-bearing material to planned variations in temperature as it moves through the horizontal barrel. Such variations may be achieved, for example, by injecting steam through injection nozzles similar to those shown herein for injecting wash liquid, and the steam may be developed either at atmospheric pressure or may be super-heated to higher temperatures and pressures. Since rates of diffusion are increased with temperature, the values of the methods and means of this application may be enhanced by conducting the washing thus attained at temperatures above room temperature. For example, because of a mechanical pressure imposed upon the pulp within the apparatus of FIG. 1 and because of the hydrostatic pressures that may be employed, it may attain values as high as 5,000 p.s.i. Water under these pressures may be heated above 212° for injection into the apparatus of this invention. A further illustration of the use of temperatures by injection of steam or super heated water by the methods and means of this invention may be illustrated by a commercial scale processing of waste papers for dispersion of asphalt bodies. By using the injection means of this invention, steam under 150 p.s.i. pressure has been injected into the vertical barrel of the apparatus shown in FIG. 1 to increase the temperature of the waste paper pulp before it reaches the transition section 59 shown in FIG. 1. By this steam injection, a waste paper pulp initially at 100° F. may be raised to a controlled temperature, for example 165 to 200° F., depending upon the requirements of the subsequent operations to be conducted in the horizontal barrel of the press.

The wash water temperature can also be varied, and additional injections of water at any desired temperature can be made at any desired points along the barrel.

What I claim is:

1. A method of washing residual digestion liquor from a digested mass of fibrous material, said method com-

prising passing said material through an elongated enclosure from an entry end to a discharge end thereof, applying pressure continuously to the material in a direction adapted to simultaneously compact the material and assist in moving it in the direction aforesaid, arranging said enclosure into a series of operating sections, each section consisting of a washing zone and a drainage zone, providing apertures in the enclosure wall in registry with each drainage zone, injecting liquid into each washing zone, collecting drained liquid which escapes through the apertures in each drainage zone, re-injecting the collected liquid-liquor solution into a respective washing zone in a section nearer to the entry end of the enclosure whereby to establish a flow of washing liquid gradually increasing in liquor concentration in a direction counter to the direction of movement of the material being washed, prepressing the material to remove a relatively readily removable fraction of liquor from the material, continuously charging the prepressed material into said enclosure, and injecting into the material being prepressed the drainage liquid from a drainage zone of said enclosure.

2. A method of washing residual digestion liquor from a digested mass of fibrous material, said method comprising passing said material through an elongated enclosure from an entry end to a discharge end thereof, applying pressure to the material in a direction adapted to simultaneously compact the material and assist in moving it in the direction aforesaid, injecting a wash liquid into a zone of said enclosure near said entry end, said wash liquid being capable of leaching out said liquor, injecting steam into said enclosure between said entry end and the zone where said wash liquid is injected, and providing drain apertures in a drainage wall portion of said enclosure through which the aforesaid pressure drives the solution of liquid and liquor.

3. A method as defined in claim 2 wherein said steam is at a pressure between atmospheric pressure and 150 pounds per square inch.

4. A method as defined in claim 2 wherein said fibrous material is raised to a temperature of between 165° F. and 200° F. by said steam injection.

5. A method of washing residual digestion liquor from a digested mass of fibrous material, said method comprising passing said material through an elongated enclosure from an entry end to a discharge end thereof, applying pressure continuously increasing to between 1000 p.s.i. and 5000 p.s.i. to the material in a direction adapted to simultaneously compact the material and assist in moving it in the direction aforesaid, injecting a wash liquid into a zone of said enclosure near said entry end, said wash liquid being capable of leaching out said liquor, and providing drain apertures in a drainage wall portion of said enclosure through which the aforesaid pressure drives the solution of liquid and liquor.

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