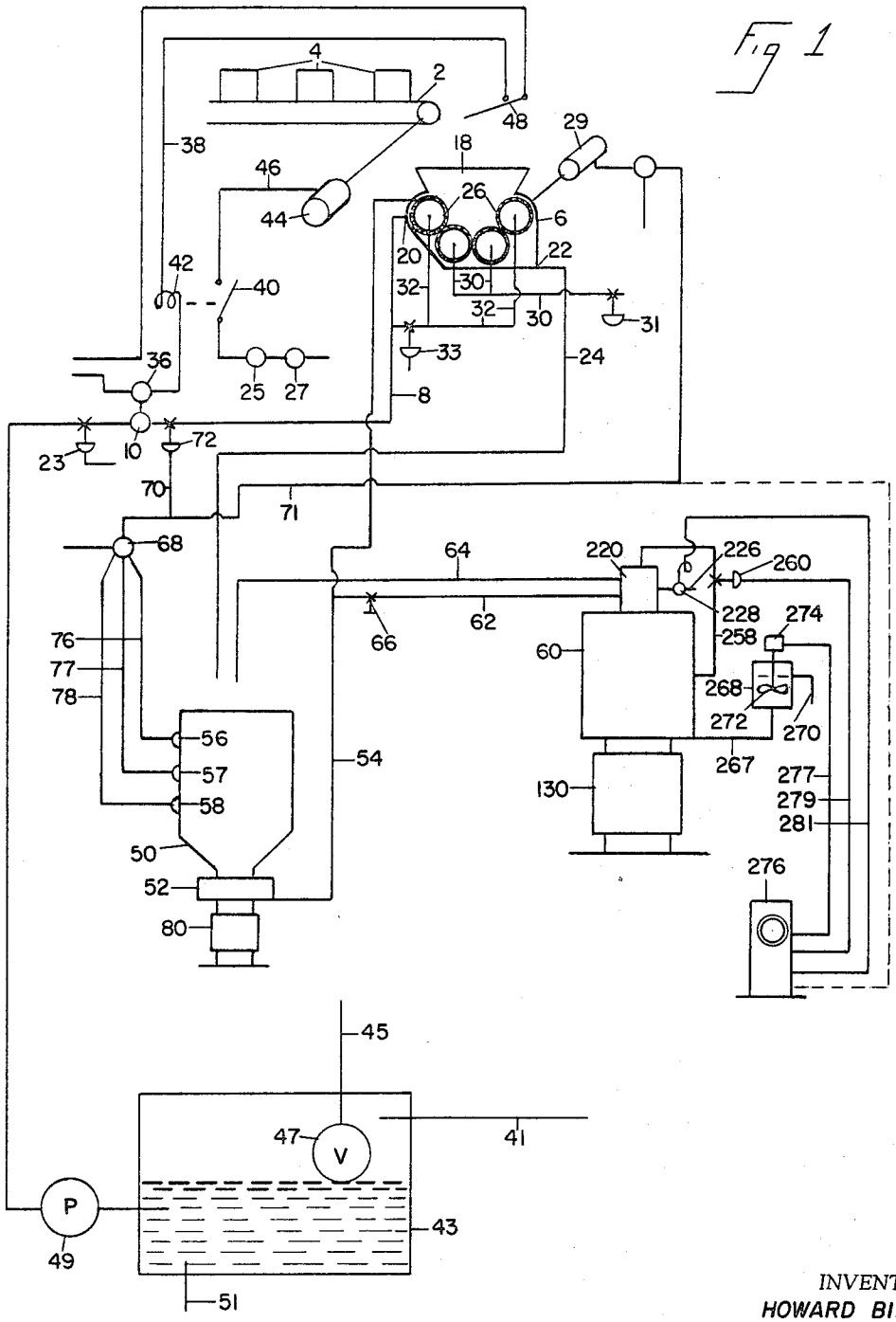
June 11, 1968 H. BIDWELL 3,387,794

METHOD OF THE AUTOMATIC PROCESSING OF PAPER STOCKS

Filed Oct. 11, 1963 4 Sheets-Sheet 1

Fig 1



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METHOD OF THE AUTOMATIC PROCESSING OF PAPER STOCKS

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Fig. 3.

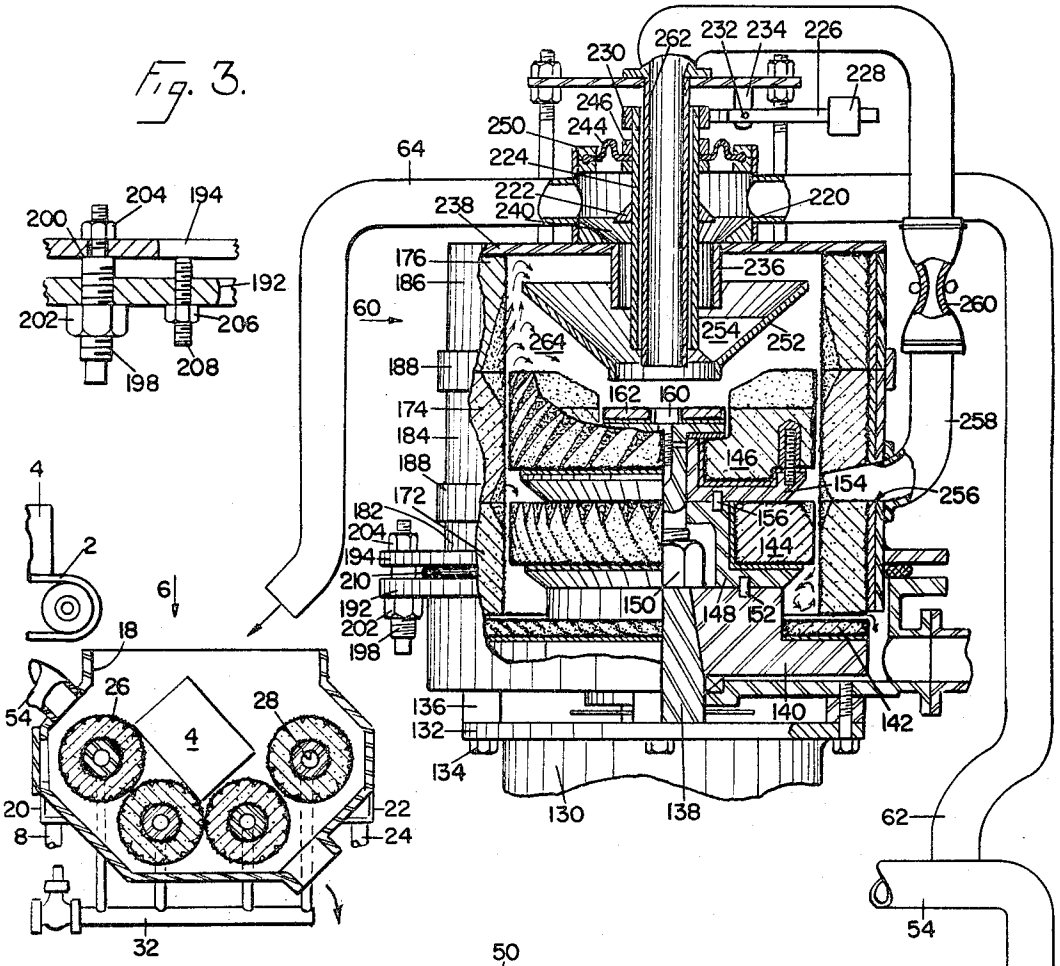


Fig. 2.

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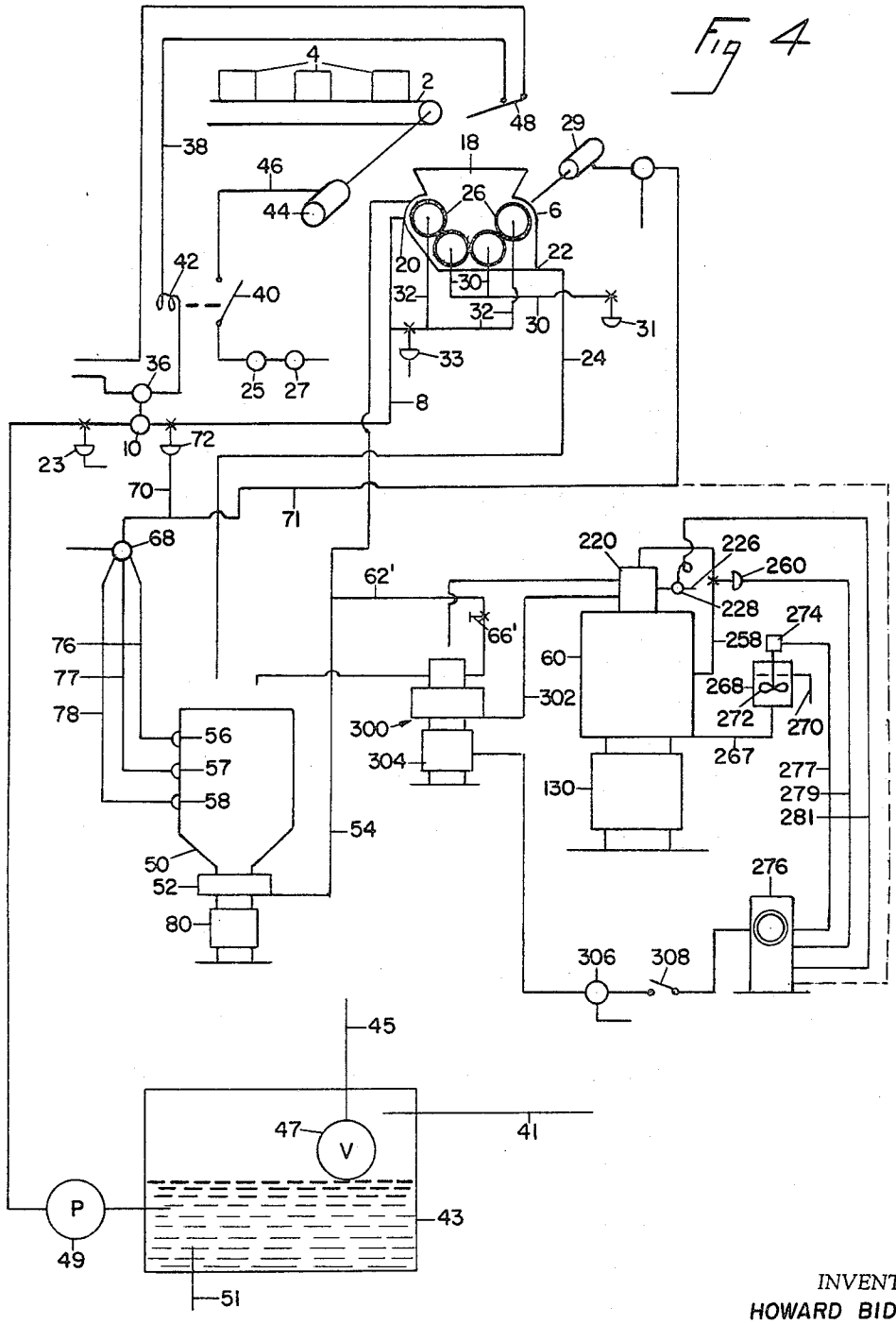
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METHOD OF THE AUTOMATIC PROCESSING OF PAPER STOCKS

Filed Oct. 11, 1963 4 Sheets-Sheet 3

Fig 4



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METHOD OF THE AUTOMATIC PROCESSING OF PAPER STOCKS

Filed Oct. 11, 1963 4 Sheets-Sheet 4

Fig. 5.

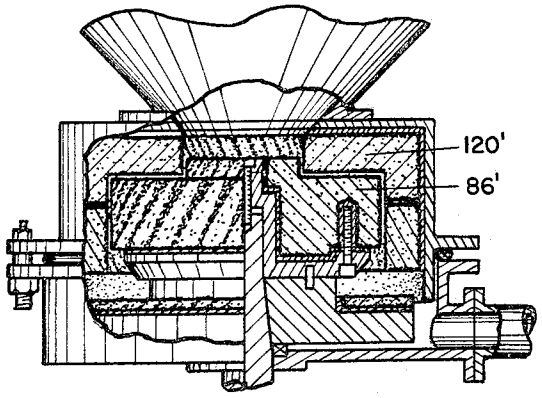
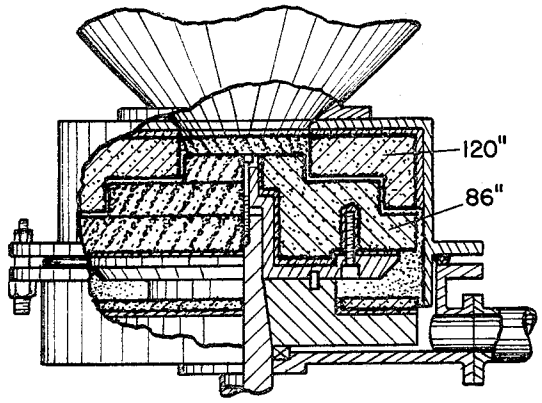


Fig. 6.



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United States Patent Office 3,387,794 Patented June 11, 1968

3,387,794

METHOD OF THE AUTOMATIC PROCESSING OF PAPER STOCKS

Howard Bidwell, Granby, Mass., assignor of fifty percent to Rachel Bidwell, Granby, Mass.

Continuation-in-part of application Ser. No. 118,756, May 5, 1961. This application Oct. 11, 1963, Ser. No. 315,589

4 Claims. (Cl. 241—21)

This application is a continuation-in-part of my copending application, Ser. No. 118,756, filed May 5, 1961, now Patent No. 3,227,606.

The present invention relates generally to new and useful structural refinements in apparatus for, and methods for, the processing of organic fiberous materials, such as may be used in paper stocks, and more particularly aims to provide apparatus and methods for automatically controlling various instrumentalities as parts of an integrated paper stock preparation system, all contributing to the attainment of a rapid conversion of the fiber characteristic of the stock from one of high resistance to separation in the dry state to one of low or nearly nil resistance to separation in the saturated state, and obtaining a separation and removal of the more saturated fibers from the aggregate to a waterborne stock slurry comprising a continuously blended flow stream, having a constant fiber-to-liquid ratio density, and allowing a preconditioning-blending of the slurry for effecting an improved feeding to the refiner and further allowing a refining of the blended slurry in a continuous flow to an accepted stock condition of a constant stock viscosity.

Stated in broadest terms, the teaching hereof shows an arrangement of apparatus and a sequence of steps employing same in the preparation of stock which provides for the maintenance of conditions of constant density and constant blending to contribute to the constant viscosity of the end product and exploiting the heretofore unknown and unappreciated fact that by the utilization of granular surfaces in certain of the instrumentalities of the arrangement and/or system a consistently high freeness for a given tensile value is obtainable. Insofar as tensile is concerned, for a given standard of fiber development, papermaking equipment can now be operated at higher running speeds for the salient reason that by the teachings hereof, the heretofore aggravating problems encountered in dealing with slow stock are alleviated, if not totally eliminated.

The invention teaches methods directed to tempering, altering and changing the characteristics of the fibers of stocks, preliminary to the processing thereof, wherefor the fibers are more readily and rapidly separated to an individualized state and directed further to the processing of the so-readied stock fibers by novel and advantageous methods and means wherewith the separated and fibrillated fibers are blended into a flowable slurry preparatory to refining to the desired fiber development accepted state for the conventional sheeting at the wet end of a papermaking machine.

The structural part of this invention shows and describes apparatus embodying interrelated components each having features of construction and arrangements of parts contributing to the effecting of the steps in the system, all as exemplified in this disclosure and supporting claims.

The methods disclosed in this invention teaches a process consisting of a plural number of steps in a predetermined order, said steps being interrelated as to each other, all as defined below appended specification and subjoined claims.

In general, the several items of apparatus in this invention are kindred to the apparatus for aiding and improving the pulping and refining of paper stocks through

means employing granular surfaced working faces and processing elements of types such as are exemplified in my Patents No. 2,912,174 of Nov. 10, 1959, No. 2,936,128 of May 10, 1960, No. 3,058,678 of Oct. 16, 1962, No. 3,116,208 of Dec. 31, 1963 and No. 3,193,206 of July 6, 1965, and in my copending application Ser. No. 93,272, filed Feb. 28, 1961 and now abandoned.

The existing practice in the trade, as exemplified by the known prior art, conventionally entails the use of large amounts of energy in the form of power applied to the stock for the purpose of "distintegrating," "cutting" and "hydrating" the stock during the pulping, beating and refining operations of conventional processing all without preconditioning of any kind, and with the omnipresent disadvantage that the fibers, being in a dry state, offer unfavorable physical characteristics as respects the application of power or energy in connection with their conditioning, and further offer, in maximum degree, resistance to fiber separation with the result that the very fiber processing means employed serve deleteriously to damage and weaken the fibers.

The individualizing of fibers has never been accomplished conventionally, much less in a so-called preconditioning phase as here taught, wherefor the normally pulped stock is constituted by unindividualized fibers fed to the refining equipment, which fibers will have been cut, brushed, bruised, broomed, hydrated, and otherwise damaged.

In contradistinction, I have devised novel means and methods whereby these difficulties and objections are overcome by way of completely eliminating the disintegration and cutting phases with most standard stock materials according to procedures which provide adequate preconditioning means for receiving most standard sized shipping bales and bundles of stock and reducing same into a flowable slurry preparatory to the application of power in the refining phase.

It is first to be noted that my invention provides means and methods in an integrated automated system of receiving at a preconditioner any of the most standard forms of raw dry fibrous aggregate as delivered by an automatically-controlled conveyor and a supply of liquid as delivered by an automatically-controlled delivery conduit, said deliveries to the preconditioner for the preconditioning phase being effected under the surveillance of a cooperant fiber-to-liquid ratio-governing devices incorporated as component parts thereof for reducing the aggregate to a continuously-free-flowing slurry stream having a constant density of a predetermined value according to the regulation of the ratio-governing devices, blending and conditioning the fibers to what is best identified as "an individualized state" free of any cutting or like detrimental effects while the so-individualized fibers are saturated in a pre-conditioning phase, and pre-conditioning and blending the so saturated material to a degree sufficient to resist cutting action during the subsequent refining phase wherein the material is refined to an accepted stock condition, with cooperant automatic feed controlling devices for preventing refiner overloading and the glazing and loading of the granular-surfaced processing surfaces of the refiner as well as regulating and controlling the refiner energy input rate to a predetermined value, all for the purpose of maintaining uniformity in accepted stocks.

Without intending to place undue limitations upon the scope of the invention, beyond what may be required by the state of the prior art, the particular embodiments exemplified herein may be briefly described as embracing the concept of means and methods for controlling the in seriatim delivery of bundles of the air-dry raw stock aggregate with the bundles being spaced along a suitably operated and automatically controlled conveyor means

which is interconnected to and integrated controlwise with a liquid supply means in manner such as to assure, in normal operation, a delivery of a specified unit by weight of stock furnish aggregate with each delivery of a specified unit volume of liquid for achieving a free-flowing slurry of constant and continuous flow with a constant density and consistency, whereby is obtained improved operation of the refiners and other equipments used in the pulping, refining, beating, fiberizing and fibrillating so inherent in the processing of organic and other forms of fibrous materials in passage from the raw, unbeaten state to an accepted stock condition preliminary to employment in Fourdrinier, cylinder, and other types of papermaking and/or paper-product-making machines, and further whereby is allowed the reuse of white water flowing from the papermaking and/or paper-product-making machine operation properly blended with adequate quantities of fresh makeup water if same proves to be needed.

The above elucidated concept has been embodied into a consolidated, integrated, unitary, continuous, automated system incorporating the various phases of paper stock preparing and refining inherent in dry, raw aggregate reduction, and so organized as to provide stock of an accepted condition (i.e. with a predetermined constant stock viscosity value).

Contributing to the broad purpose, among the objects of the invention are to provide means for automatically obtaining and maintaining a predetermined degree of accepted stock condition, as represented in Mullen, tensile, and other fiber characteristic values, by the regulating of each of a plurality of interrelated system instrumentalities for effectuating changes in feed flow, recycling, and regulating of the blending and reblending of the moistened portions of freshly-loosened aggregate resulting from and obtained through the preconditioning means disclosed in said parent application, Ser. No. 118,756, now Patent No. 3,227,606, operative as herein taught in combination and in conjunction with various mechanisms novelly arranged so as to offer slurries more homogeneous than have been heretofore obtainable by the known and conventional devices, with the advantageous feature that, in the case of a given slurry, a portion thereof may be diverted for processing to an accepted stock condition and a remaining portion thereof may be diverted for blending with fresh raw stock material and make-up raw water and/or white water, all so as to allow a continuous uniform flow of a predetermined density ratio of air-dry fibers to liquid according to a desired degree of fiber development of the slurry fibers for meeting desired values of fiber freeness, viscosity, Mullen, tensile strength, and the like.

It is a salient object hereof to teach methods and means for expanding the field of potential resources represented in commonly available materials by exploiting the phenomenal effects which granular-surfaced processing surfaces which impart to fibers which are properly "preconditioned," as revealed in accepted stocks of my production offering consistently high freeness-to-tensile strength ratios, and as demonstrated by other stocks of my production as being capable of being carried to superstrong fiber development values, beyond any range realizable with any other means, and yet still showing relatively high freeness values, and as particularly evidenced in the processing of low grade substances and materials, normally considered as waste, but now proven to be reclaimable under properly controlled conditions so as to offer relatively strong bonding characteristics without the benefit of additives of any kind, this last representing an exciting potential in connection with certain special fields of interest, as for example well board, packing containers, and the like.

Another object hereof is to provide means of the character indicated wherewith are reclaimable such normally non adhesive materials as barks, slash and the leafy portions of vegetable growths, constituting in fact the major portion of available fiber sources which materials are

notoriously wasted by presently known techniques and practices due to a lack of recognition or appreciation of the potentialities there represented and a lack of adequate means for converting such materials into products worthy of recognition. These materials, by the teachings hereof, are easily reclaimable, and incidentally, are readily convertible into hard and dense compacts permitting impressive reductions in transportation costs.

The invention possesses objects and features which are of advantage in relations other than the herein disclosed preferred embodiments which are presented by way of exemplifications, it being appreciated that the invention is susceptible of incorporation in other structurally modified forms coming equally within the scope of the claims hereof, even when operated in conjunction with conventional types of apparatus to meet any special condition when so required.

Numerous other objects and advantages will become apparent to those skilled in the art from the following description of preferred embodiments of the invention taken together with the accompanying drawings wherein:

FIG. 1 is a schematic flow diagram showing a simplified form of arrangement of structures embodying the teaching of an integrated automatically-controlled continuously-operated paper stock preconditioning/blending/refining system for maintaining constant factors of stock density and uniformity in blending to the end of achieving accepted stock of uniform constant viscosity of a predetermined Mullen, tensile, freeness and other fiber development values;

FIG. 2 is an enlarged fragmentary side elevational view of certain of the instrumentalities shown in FIG. 1, with parts being broken away, and being representative of a minimum of apparatus requisite for a paper stock processing system for accommodating some average and normal requirements, it being noted that most of the details of the interconnecting and control means are herein omitted in order to render the showing more easily readable;

FIG. 3 is an enlarged sectional view of a form of safety stop serving to prevent the opposed moving and stationary members from making actual contact with each other during changes in clearance adjustments;

FIG. 4 is a schematic flow diagram, similar to that illustrated in FIG. 1, and showing another arrangement of structures incorporating one or more auxiliary apparatuses as component parts of an integrated automatically-controlled system of fiber development to produce an accepted stock condition according to a particular standard or standards, such as Mullen and other values, in a continuous flow non-retention system; and

FIGS. 5 and 6 are enlarged fragmentary side elevational views of modified forms of the blending units shown in the arrangements of FIGS. 1 and 4 with parts being broken away.

In the following description and in the appended claims, various components and details thereof will be identified by specific names for purposes of convenience. Such specific terms and expressions are employed in a generic and descriptive sense only. They are not intended to exclude any reasonable equivalents of the features shown and described or portions thereof.

With reference first to FIG. 1 of the drawings, which illustrates a typical and preferred embodiment of the invention for the purpose of disclosure and forms a part of this specification, I have shown an endless conveyor 2 upon the upper run of which opened bales of aggregate material 4 to be processed are placed in spaced relation, whereby predetermined quantities by weight of air-dry raw stock may be charged in seriatim into a preconditioner 6, strategically positioned adjacent and beneath the conveyor discharge end.

Such aggregate discharge will be at a rate of speed according to what the preconditioner will successfully handle with a given quantity of fluent material or liquid, and according also to the passage into said preconditioner of a

predetermined quantity of that liquid as it is delivered from a suitable source of supply via a conduit 8 having a discharge terminal communicating with the preconditioner, according to control means which shall include a liquid meter of suitable design equipped with adequate and suitable selective impulse-contact programming device or devices disposed in the conduit.

Said liquid meter will incorporate a cooperant impulse type register device, subsequently to be identified, for initiating the delivery of a predetermined unit quantity of aggregate in synchronism with the passage of a predetermined quantity of liquid.

Preconditioner 6 will be understood to comprise a preconditioning fiber saturator of a type, such as exemplified in my parent application, Ser. No. 118,756, wherefore a detailed explanation thereof, beyond that in the next succeeding paragraphs, is deemed unnecessary for the purposes of this disclosure.

Said preconditioner, shown fragmentarily in FIG. 2, provides apparatus for preconditioning the raw air-dry stock preliminary to its introduction into cooperant apparatus for the fulfillment of subsequent pulp preparation procedures and more particularly it effects the reduction of dry, raw, fibrous aggregate of all types to a flowable stock in manner such that the fibrous characteristic of the stock, whatever its nature, is rapidly transformed from a rigid, stiff, unyielding condition, to a "tempered" condition in which the fibers are characteried by their softness, pliability and toughness, it being demonstrated that tempered fibers are more resistant to cutting and reduction of their length than conventionally processed fibers and can be readily separated into individual fibers and fibrillated, by water-borne flow contact with and impingement against granular surfaces.

As a significant contribution to the art, I have determined that superior reduction of a dry, raw, fibrous material can be obtained by moisture-penetrating or tempering a portion of the aggregate and continuously separating the-so-tempered or penetrated portion of the aggregate from the remainder thereof.

Accordingly, preconditioner 6 will be noted to comprise an upwardly-opening chamber 18 to permit the introduction thereinto of units of raw paper stock from the conveyor. Communicating with the chamber are an inlet opening 20 connected to conduit 8 and an exit opening 22 for discharging water-borne stock therefrom through a conduit 24.

Disposed within the chamber are a plurality of cylindrical rolls 26, mounted as shown in a side-by-side spaced relation with the axes thereof in parallelism, and each formed of a porous or moisture-pervious, coarse, granular material to present a granular outermost periphery and mounted on a tubular shaft 28 provided with a plurality of radially-extending perforations for the forcement of a fluid through said perforations and through the porous granular material for discharge radially from the outer periphery of the roll and blending with the fluid already within the preconditioner.

As shown in FIG. 1, low-pressure steam may be admitted to the shafts of the intermediate rolls as by suitable piping 30 connected thereto and to a suitable supply source, and the fluent material may be admitted to the shafts of the outermost rolls as by suitable piping 32 connected thereto and to conduit 8.

If desired, steam may be employed with all of the rolls 26, instead of only the intermediate rolls, as shown in FIG. 1, and as shown in FIG. 2, the piping 32 may lead to each of the shafts, in which instance, no steam is employed.

The essential point is that under automatic or manually controlled means, such as valvings 31 and 33, there may be bled a certain portion of the incoming white water-makeup water via piping 32 and valve 33 to the rolls with other fluid or fluid mixtures such as steam being bled via piping 30 and valve 31 to the rolls, as desired, the steam or liquid so introduced to the rolls passing through the apertured shafts and radially-outwardly through the porous material of the rolls for discharge outwardly from the roll surfaces. Accordingly, such rolls may be delineated as granular-surfaced vapor-fluid-emitting rolls, and may be variously interconnected to use either liquid or steam or both simultaneously, or other fluid solutions, steam, I having determined, being essential only for relatively hard fibers.

Shafts 28 will be observed to extend through suitably aligned openings in the opposite side walls of the chamber and to be journalled in suitable bearings for rotation by any conventional means, not shown, through a preconditioner motor 29 to which the shafts are drivingly connected.

Preferentially, the rolls will all rotate in the same direction, counterclockwise as viewed in FIG. 1, so as to present their upper ascending quadrants moving toward the inlet opening.

Preferentially, the rolls are rotated at relatively slow speeds with the greatest speed of rotation being imparted to the roll, at the right end of the apparatus as viewed in FIG. 1, adjacent the discharge end, in order that, in operation, the major portion of the vapor-moisture penetrated aggregate will be carried toward the first roll adjacent inlet 20. By such arrangement, the slowest moving roll acts as an anvil against which the major portion of the vapor-moisture-penetrated stock is carried and introduced to the fluid flowing into the chamber from conduit 8 and to the blending fluid from a conduit 54, subsequently to be identified.

The chamber contour is preferably shaped with outermost walls which substantially encapsulate the rolls wherefore, as the stock is charged thereinto, it is continually forced against and over the rolls so as to be subjected to the action now to be described.

The surfaces of the rolls may be deeply scored or contoured to provide efficient fiber separation and motivation with a minimum damage or breakage of the individual fibers as the aggregate is tumbled, mauled, revolved and otherwise agitated into a state of its mush from contact with the upper surfaces of the rolls and in the presence of the combined streams of blending slurry, makeup fluids and vapor-fluid-admitting rolls.

That is, in operation, the dry fibrous aggregate, charged or introduced into the chamber through its top opening, comes to rest directly upon the upper surfaces of the granular-surfaced rolls. Fluid and/or low-pressure steam is introduced into the tubular shafts under sufficient pressure as to be emitted radially from the surfaces of the rolls. The steam rapidly penetrates the fibers of the stock aggregate contiguous the roll surfaces. The steam tempers the fibers, in effect, paving the way for more rapid saturation when the stock comes into contact with fluid introduced into the vessel through the conduits.

The effect is to separate the tempered portions of the fibrous aggregate with a minimum of fiber damage.

The tempering effect serves by rendering the fibers more pliable, more resistant to cutting actions, possessive of increased tensile strength, and more easily handled, wherefore is allowed a more rapid rate of saturation when the stock comes into contact with the fluid introduced into the chamber through conduit 8. That is, the more saturated, and concomitantly, more tempered portions are readily separable from the remainder of the fibrous aggregate composed of the untempered fibrous mass, and all with a minimum of fiber damage.

Continued rotation of the granular-surfaced, vapor-moisture-emitting rolls serves further to separate the tempered fibers to an individualized state, without their suffering from any cutting action or other detrimental effects, and to transport same into the fluid flowing below the rolls in a state of wettability wherefor they quickly become moisture-saturated, and to advance the water-borne pulp under conditions of turbulence toward outlet

22 and conduit 24 via which the conditioned pulp may be introduced to cooperant instrumentation for carrying out subsequent phases in the pulp-making process.

The degree of tempering may be controlled according to the rate of speed of delivery of the air-dry stock and fluid to the preconditioner, the rate of rotative speed imparted to the rolls, the amount of vapor-emission through the rolls, and other factors hereinafter to be identified.

Within the limitations that all opposed working surfaces be sufficiently spaced from each other to avoid cutting of the fibers, the relative position and spacing of the rolls to each other and of the rolls to the stators may be varied, so as better to control the rate or volume of flow of the stock in conformity with the nature of the aggregate being preconditioned.

Liquid meter 10 serves to measure the flow of incoming liquid, admitted to the stock system via conduit 8, by virtue of its integration with a selective electrical impulse-type programming mechanism 36 of suitable design which is operated by and calibrated to the liquid meter, wherewith the gallonage of fluent material passing through conduit 8 may be controlled in the respect that a predetermined quantity of fluent material may be passed therethrough and the rate respective to the system as a whole may be controlled.

The programming mechanism is operative to close an electrical programming circuit 38 upon the passage of a predetermined quantity of liquid through liquid meter 10, which closing action serves to actuate a normally-open magnetic circuit controller switch 40 to closed position by means of an energized magnetic coil 42 connected in the programming circuit. The circuit controller switch, thus energized, actuates a gear head low output speed conveyor motor 44 connected in an electrical conveyor motor circuit 46 therewith conveyor 2 is motivated for achieving the delivery of the unit quantities of raw aggregate 4 to preconditioner 6.

Conveyor motor circuit 46 is preferably energized by DC current through a rectifier 25 with selective speed variations being attainable by means of an adjustable rheostat 27 for suitable synchronization with other flow rate adjustments such as fluid flow rate. Control valve 23 adjusts the fluid flow rate to approximately the capacity of the processing system with a reasonable excess that is further controlled and limited by a flow rate valve 72, subsequently to be identified. Rheostat 27 and fluid control valve 23 serve as means for regulating the conveyor speed and liquid flow rate to approximate the system capacity and thereby avoid erratic and hunting action.

Delivery of a charge to preconditioner 6 effectuates a momentary opening of a normally-closed trip switch 48 so as to open programming circuit 38 and conveyor motor circuit 46 by effecting a deenergization of magnetic coil 42 of circuit controller switch 40, thereby momentarily stopping conveyor 2 upon the delivery of each unit quantity of air-dry stock to the preconditioner, with the conveyor motor circuit being reenergized therefollowing due to the passage of a suceeding measured unit quantity of liquid through liquid meter 10 in conduit 8, wherewith the cycle is repeated. The repetitive cycle continues so long as units of air-dry stock are delivered via the conveyor and units of fluent material are delivered via the conduit.

It is to be understood that white water from the wet end of the paper making machine is passed via a conduit 41 to a collecting tank 43 where it is collected and mixed with a charge of fresh makeup water leading thereto via conduit 45, which conduit is provided with a float controlled valve 47 so that all available white water is first used and is made up as necessary with fresh water, the mixture being pumped therefrom by means of pump 49 through conduit 8. Tank 43 may be provided with a drain 51, as is common.

Conceivably, only fresh makeup water from a source through conduit 45 may be pumped through conduit 8, although preferentially, though not obligatorily, white water will be used whenever possible.

With a predetermined sufficiency of properly-proportioned quantities of air-dry stock and liquid having been introduced to the preconditioner and the to-be-described components of the system therefollowing, I establish a suitable normal flow volume from preconditioner 6 through conduit 24 for discharge into a stock chest reservoir 50 of a blending unit 52.

Blending unit 52 is of a design serving to break up coarse aggregate particles delivered thereto from the preconditioner via the reservoir preliminary to delivery from the blending unit of a continuous supply of a blending flow in a retrograde or return movement to the preconditioner via a blending flow conduit 54.

Admission of liquid from conduit 8 to the preconditioner and the charge of fresh aggregate thereinto from conveyor 2, will be observed to be in synchronism according to the dictates of the activated one of a plurality of vertically-aligned automatic level control signal devices 56, 57 and 58 arranged in spaced relation relative to the inner wall of the reservoir according to a modulating valve 68, subsequently to be referred to, wherefor a continuous supply of constant density stock slurry is assured of discharge from the preconditioner in a predetermined ratio of air dry stock-to-liquid, all according to programmed impulses emanating from programming device 36, the impulse being preferentially programmed so as to be operative so long as conveyor 2 is kept loaded with bundles of properly-weighted raw stock in spaced relation therealong preparatory to charge to the preconditioner.

According to the phase of the system so far delineated, I am able continuously to moisten the raw aggregate within the preconditioner and to blend same with freshly loosened and freed raw aggregate and to continue to saturate same while in transit to and within reservoir 50, with blending unit 52 allowing sufficient recycling of the stock for achieving a uniform constant density thereof and still further allowing the delivery of a quantity of blending flow from blending flow conduit 54 to a refiner 60 via a blending feed conduit 62 intersecting the blending flow conduit intermediate its terminals.

Blending feed conduit 62 may be suitably valved as to maintain a continuous surplus flow therein to stock chest reservoir 50 or to preconditioner 6, as desired, via a return conduit 64, said valving being hereinafter referred to in connection with a detailed description of refiner 60.

Blending unit 52 will be of a design to maintain an adequate swirl within its adjoining cooperant stock chest reservoir for effectuating a proper agitation and blending of its contained material including the raw aggregate fiberous particles being freshly supplied thereto from preconditioner 6 and for passing such blend between the granular-surfaced components of the blending unit, as will be defined, all the while maintaining an adequate flow volume therefrom, not only as dictated by the requirements of the preconditioner which it feeds so as to allow a consistent blending thereat, but also as dictated by the processing demands of refiner 60, likewise fed thereby with a sufficient flow volume of well blended stock, all in the attainment of a constant and continuous operation producing a uniform accepted stock of a constant viscosity.

To meet the stock flow capacity and demand or rate of flow, as required by refiner 60, a control valve 66 may be disposed in blending feed conduit 62 for regulating the flow volume, according to the desired and necessary flow rate of both air dry raw stock and liquid flow.

Modulating valve 68, previously referred to, is identified as a controller, and is connected at one side via suitable circuitry 70 with conduit 8, and circuitry 71 with preconditioner motor 29, with a flow rate valve 72 disposed within said circuitry 70, and is connected at its other side via conduits 76, 77 and 78 with level control

impulse signal devices 56, 57 and 58 respectively in stock chest reservoir 50.

As one of the signal devices is activated, i.e. device 58 sensing a requirement for an increased flow, device 56 sensing a requirement for decreased flow, or device 57 sensing a mean as respects flow, the intelligence is delivered to modulating valve 68 in the form of signals emanating from the thus activated one of the devices.

Modulating valve 68, so activated, effectuates activation of flow rate valve 72 into an opened or closed position wherewith an accordingly increased or decreased flow of liquid through conduit 8 to the preconditioner and a concomitant rate of delivery by conveyor 2 of air-dry raw stock are achieved.

With particular reference now to FIG. 2, blending unit 52 is shown, fragmentarily, as comprising a fibrous material processing apparatus inclusive of a driving motor 80 suitably secured to the equipment as by flanging to preclude end play of its motor shaft 82 and a flywheel 84 suitably keyed to the shaft for taking any thrust loads imposed during operational use.

The flywheel will be provided with an uppermost planar face for the mounting thereupon and driving thereby of a processing rotor 86 secured to said flywheel as by a centrally-located granular-faced washer 88 and cap screw 90, said screw being in threaded engagement with the motor shaft to maintain the motor/shaft/flywheel/processing rotor integrity in conventional manner.

Preferentially, processing rotor 86 is comprised of a specially prepared vitrified or other suitable type of bonded structure of aluminum oxide, or silicon carbide and/or other appropriate granular composition, prepared and finished as exemplified in my copending application, Ser. No. 93,272, and bonded and secured in its lowermost area to a flanged metallic mounting member 92 with suitable reinforcement means for insuring against heavy working loads or other stresses, in accordance with the teachings of my copending application, Ser. No. 89,423, now Patent No. 3,193,206, and by means of a plurality of strategically-located flywheel drive pins 94 interconnecting and holding stationary as to each other the said mounting member and flywheel.

Flywheel 84 is so configured as to present an upwardly-facing outermost annular peripheral recess, upon the horizontally-disposed face of which a granular-surfaced annular processing ring 96, which may comprise a unitary member or a plurality of fitted-together arcuate segments, is fixedly mounted.

Said processing ring may be prepared and finished in accordance with the exemplification in said application, Ser. No. 93,272, and may be bonded to the flywheel, as taught in said application, Ser. No. 89,423, now Patent No. 3,193,206.

A flywheel housing 98 will encase the flywheel in conventional circumscribing manner, will have a suitably-located discharge outlet 100 for connection to blending flow conduit 54, and will be securable to a flange 102 of driving motor 80 as by mounting lugs 104 and cap screws 106, in known manner.

A lower stator casing 110 of suitable construction, located upwardly of housing 98, is adjustably secured relative thereto as by a plurality of peripherally-arranged clamp bolts 112 and nuts 113 threadedly engaged therewith, and will circumscribe in enclosing manner an annular granular-surfaced lower stator 114, which stator may be bonded to its casing by any suitable bonding means and will be concentrically arranged as to processing rotor 86 to allow the passage of stock therebetween and with its lowermost horizontally-disposed planar face being positioned in spaced relationship with the oppositely-facing uppermost horizontally-disposed planar face of ring 96, also to allow the passage of stock therebetween.

A compressible gasket 115 may be disposed between casing 110 and housing 98 to provide a water-tight seal therebetween.

An upper stator casing 116 of suitable construction, located upwardly of lower casing 110, is adjustably secured relative thereto as by a plurality of peripherally-arranged clamp bolts 118 with cooperant nuts 119, and circumscribes in enclosing manner an annular granular-surfaced upper stator 120, which stator may be bonded to its respective casing by any suitable bonding means and will be concentrically arranged as to lower stator 114 and processing rotor 86 with appropriate spacings therebetween for the passage of stock therethrough.

Said upper and lower stators may be prepared and finished in accordance with the teachings of my application, Ser. No. 93,272, to provide the all-important granular-surfaced processing faces, so vitally essential to the instant invention, the dimensions and contourings of the said faces being proportioned as to each other to satisfy the dictates of anticipated performance.

As aforesaid, the upper and lower stators are strategically positioned as to each other so as to allow a clearance between their confronting surfaces, which clearance may be varied as will appear.

The lowermost downwardly-facing face of the upper stator will have an annular downwardly-facing peripheral recess for the seating of a compressible gasket 122, formed of sponge rubber or like material, in manner so as to be sandwiched between the lower and upper stators for functioning as a compensating medium for the above referred to variations in rotor spacing.

Clearance adjustments will normally be effected first, by an adjusting (loosening or tightening) of bolts 112, wherewith is attained an adjusted spacing between processing rotor 86 and lower stator 114 so as to accommodate a desired flow rate, and second, by an adjusting (loosening or tightening) of bolts 118, wherewith is attained an adjusted spacing between the upper and lower stators according to the degree of blending desired.

It is to be mentioned that the precise relationship of blending unit and reservoir shown is merely illustrative, they being otherwise relatable to each other. For example, the blending unit may be disposed upon a horizontal axis or even in a vertically inverted position, as in the instance of blending a multiplicity of already processed stocks to an accepted or nearly accepted stock condition for a multi-stock furnish preparatory to delivery to a paper making machine, by any suitable type of conventional stock chest connections with suitable auxiliary chest agitation being provided. Conceivably, a duplex set of blending chests with supporting blending apparatus may be used for certain multi-stock furnish requirements.

Furthermore, reservoir 50, upwardly of blending unit 52, may be independently supported or may be connected thereto with the blending unit and motor 80 being suspended therefrom via an annular tapered flanged cone outlet 124 or equivalent interconnecting medium.

The intensity of the reservoir swirl and agitation, as induced by the cooperating blending unit, will vary in direct ratio with the dimensions of the interconnecting orifice therebetween, which dimensions may be varied to meet any particular stock density as by the insertion into that orifice of an orifice plate (not shown) having an opening therethrough of a size such as to be most suitable for achieving the specifically desired degree of swirl and agitation and other stock movements within the reservoir.

As a further refinement, where an extremely high flow rate of discharge from the blending unit is desired, the vertical dimension of the lower stator may be decreased so as to allow a larger unrestricted flow between the operating surfaces of the flywheel and lower stator.

As concerns fiber blending, preliminary fiber development and stock volume flow, myriad effects may be achieved with a variety of types of contouring of the granular surfaced processing faces of the flywheel, processing rotor, and upper and lower stators, wherewith it is possible to meet any particular type of stock requirement or condition, and to induce or retard flow, or to

achieve a combination of induced and retarded flow, as may be essential for a given purpose.

That is to say, the peripheral surface of the upper portion of the processing rotor and the lower portion of the upper stator may be provided with similar channels or contours which are inclined in directions such that rotation of the processing rotor enhances the advance of the stock along certain contours or channels while the outer side portions of the processing rotor and the lower stator may be provided with other channels or contours which are inclined in reverse directions to those of the upper portion of the processing rotor and upper stator to thereby retard the flow of stock.

The type of contouring employed on the upper stator will depend on the static head value normally intended to be imposed on its granular surfaced areas. In processing chemical pulps having low and easy beating characteristics, such as some of the sulphite and soda pulps, induced flow contouring of all granular surfaces may be employed. For harder kraft chemical pulps having a higher beating index, a more desirable combination of induced flow and retarded flow contouring may be combined in manner whereby the lowermost face of the upper stator, opposing the face of processing rotor **86**, may be contoured for effecting a retarded flow while the opposing surface of the upper stator may be contoured for effecting induced flow.

Further, the perimetral granular-surfaced face of upper stator **120** may be contoured for effecting induced flow while the opposed granular-surfaced bore inwardly-facing wall lower stator **114** may be contoured for effecting retarded flow.

Likewise, the granular surfaced ring **96** bonded to flywheel **84** may be contoured for effecting induced flow, while the opposed granular surfaced face of lower stator **114** may be contoured for effecting retarded flow.

For tougher, high beating index fibers, such as those of the hair seed family, and including the general run of rag stocks, cotton linters, and flax fibers, all granular surfaced faces of the processing elements having direct fiber contact may be of the retarded flow type.

The essential point is that any combination of contouring effects is easily attainable herewith, it being appreciated that the type of fibers being processed will govern the type of granular surfaces of the processing elements, their arrangement and relationship with each other, and the type and nature of the contouring employed for establishing certain definite stock flow characteristics.

It is advantageous that the blending unit be fitted with granular-surfaced elements so contoured as to create flow characteristics consistent with the requirements of refiner **60**, except in instances where special results may be desired or a more extensive system of additional auxiliary apparatus may be involved.

When motor **80** is of the variable speed type, a wider range of result is allowable by virtue of the variances thus permitted.

The discharge volume rate of the blending unit will be in direct relationship with the type of contouring employed or incorporated in the granular surfaced processing elements with which the equipment is fitted.

Refiner **60**, as shown in FIG. 2, is one form of refiner that includes granular surfaced rotor and stator elements arranged similar to that shown in my Patent No. 3,058,678, and utilizes the principle of free flowing a water-borne paper stock over unopposed granular surfaced processing surfaces, as taught in my Patents No. 2,912,174 and No. 2,936,128, for accomplishing objectives beyond the scope of each of said patents, by exploiting the free flow as a means for automatically controlling the volume of inlet feed of stock entering the refiner to match some predetermined energy input rate and viscosity value at the refiner discharge point.

The refiner includes a suitable driving motor **130**, the frame of which has a suitable mounting flange **132** for mounting the processing components superimposed upon the flange and secured by cap screws **134** and lugs **136**. Motor **130** has a suitably extended shaft **138** on which is stationarily fixed a stepped flywheel **140** to the upwardly-facing peripherally-located step of which is suitably bonded an annular-granular-surfaced processing ring **142**. The flywheel is further provided with a suitably extended face for mounting a compound rotor assembly consisting of lower and upper porous granular surfaced processing elements **144** and **146** respectively. Lower element **144** is bonded to an annular driving and mounting member **148** suitably recessed to fit over a flywheel securing nut **150**, which driving and mounting member is driven by flywheel **140** by its interengagement therewith through suitably positioned drive dowel pins **152**.

The driving and mounting member also supports and drives a mounting and bonding member **154** to which upper element **146** is bonded and secured and reenforced by means of reenforcing pins **156**.

Upper element **146** and its mounting and bonding member **154** are clamped to each other as by a cap screw **160** and washer **162**, each provided with granular facings.

Granular-surfaced stators **172**, **174** and **176** are suitably secured to and held in proper relationship by respective housing members **182**, **184** and **186** which are joined together through annular bands **188** secured thereto whereby a housing is provided.

Flywheel **140** is housed within a suitable separate housing having a suitable flange **192**.

Housing member **182** is also provided with a suitable flange **194** and clearance is maintained between the uppermost surface of processing ring **142** and the lowermost surface of stator **172** by means of peripherally-located clamping and locking bolts or jack screws **198** and safety limit socket head screws **208**, the details of which are shown in FIG. 3. Said bolts **198** each allow a shoulder at **200** which unisonly support the entire stator housing assembly, they being arranged in suitable number, as for example four arranged at 90° as to each other.

Jack screws **198** will have nuts **202** and **204** threaded on opposite ends thereof, and screws **208** will have a nut **206** threaded thereon for purposes now to be described.

When lock nuts **202** and **204** are backed off on jack screws **198**, and lock nut **206** and safety limit socket head set screws **208** are also backed off, the jack screws being equi-spaced as to each other carry the entire weight of the stator assemblies.

By applying a wrench to the square shank end of each of the jack screws **198**, stator **172** may be set just out of contact with ring **142** at all points.

At this setting, set screws **208** are brought into contact with flange **194** and lock nuts **206** are tightened. Set in this position, the set screws function to prevent any accidental positioning of the jack screws which would allow the granular surfaces of ring **142** and stator **172** to come in contact with each other.

Jack screws **198** may additionally serve as a means to vary the clearance between ring **142** and stator **172** to a wider opening as by turning the jack screws into flange **192** with lock nuts **202** and **204** being backed off, and when the desired setting has been attained, lock nuts **202** and **204** are then tightened.

The flow volume at the refiner discharge, to be defined, is determined to a large extent by the amount of clearance between processing ring **142** and stator **172** and according on the type of contouring provided at the confronting surfaces thereof.

A compressible gasket **210** interposed between flanges **192** and **194** compensates for any variation in the clearances between flanges **192** and **194** due to adjustments of clearances at ring **142** and stator **172**.

The means for adjusting the opposed surface clearances is for convenience only, substitute means being equally employable, and is shown here merely to dramatize the fact that the precise rotor and stator arrange-

ment shown, as similarly shown in my Patent No. 3,058,-678, functions in manner such that changes in clearances are not necessarily required in obtaining varying degrees of fiber refinement or in changing from no-load to full-load operation, a feature not within the scope of and capability of conventional apparatus.

Fresh refiner feed material, delivered by blending unit 52 through blending flow conduit 54 and blending feed conduit 62, enters an automatic valve chamber 220 enclosing a floating valve 222 consisting of a suitably tapered ring attached to and located on a floating valve tube 224 carried in adjustable position by a supporting lever 226 and counter balanced by means of a counter weight 228 on the free end of the supporting lever, the other end thereof being forked to support the valve tube through means of pivot pins (not shown) suitably attached to a floating tube collar 230. Supporting lever 226 is in turn supported by a fulcrum pin 232 and a fulcrum bracket 234.

The upper end of an inlet valve tube 236 serves as a stock inlet valve seat and is fixedly secured to a refiner inlet cover 238. A cone ring 240 forms the bottom of valve chamber 220 for facilitating the self-cleaning thereof.

The top of valve chamber 220 is sealed off with a flexible diaphragm 244 secured to floating valve 222 by suitable clamp rings 246, and to the valve chamber housing by other clamp rings 250 wherefor the valve chamber is enabled to serve as a suitable fluid tight enclosure for receiving paper stock feed supply through blending feed conduit 62 to assist in the regulation of the feed supply to refiner 60, and in the allowance of any surplus feed to return to reservoir 50 or to preconditioner 6 via return conduit 64, as same may be directed.

In FIG. 1, return conduit 64 is shown as being directed to reservoir 50, and in FIG. 2, it is shown as being directed to preconditioner 6.

To the lower end of valve tube 224, a funnel 252 is fixedly secured by any conventional means such as a trio of triangularly disposed gussetts 254.

A recycle outlet 256 directs stock to be recycled through a conduit 258 in which a recycle regulating valve 260 is disposed and having a re-entry tube 262 fitted to its outboard terminal for the conduct of the recycled stock through the valve means and returnably into the refiner interior, said reentry tube fulfilling the additional service of guiding valve tube 224.

Refiner 60 is of the impact type in the sence that a large portion of the fiber development to accepted stock condition is due to the high impact resultant from the acceleration of the water borne stock to a high velocity as induced by the rotating components and an abrupt deceleration as induced by the stationary components, effects highly intensified due to the nature of the contouring employed in the granular surfaces of the said components.

As water borne stock is delivered to valve chamber 220, it is free to flow directly through valve 222 and valve tube 236, and through the opening in the bottom of funnel 252 to the center of the upper element 146 (which in normal operation, by virtue of provided deep V cuts accelerates the stock to a high velocity with a minimum of surface travel) and is impinged against stators 174 and 176 (which are contoured for maximum deceleration with a minimum of surface travel), with the advantageous result that the major portion of stock flow expelled by upper element 146 piles up along the inner surface of stator 176 before losing its kinetic energy.

As the volume of water borne stock accumulates against the inner wall of stator 176, a portion thereof commences a spillage over the funnel top edge so as to flow down the funnel interior to the center of upper ement 146.

Counterweight 228 is adjustably movable toward or away from fulcrum pin 232 so as to increase or decrease the volume of water borne stock being accelerated and decelerated within an impact chamber 264 above upper element 146, and if desired, the counterweight may be motorized to allow a push button control. Likewise it may also be made automatically adjustable by the employment of a reversible type of motorized arrangement suitably connected with an appropriate ammeter of the contact type on the circuit of motor 130, so that when said motor draws current in excess of a predetermined value, counterweight 228 will be actuated toward fulcrum pin 232 sufficiently to cause a further restricted rate of flow into the refining apparatus.

The granular-surfaced processing elements arrangement and the method of contouring, as taught in my Patent No. 3,058,678, is exploited herein to the fullest in order to permit a large degree of fiber development above the radial contoured face of upper element 146 achievable because of the very rapid acceleration and deceleration over this type of granular surfaces.

The upper radial face of upper element 146, being contoured, as for example to allow six deeply cut V's, accelerates a large volume of water borne stock against the tapered decelerating V's in stators 174 and 176 so as to divert a larger portion of stock, accelerated by upper element 146, upwardly for a continuously repetition of this accelerating decelerating action with velocities that cause high impact.

A portion of the flow discharge past upper element 146 finds its way downwardly through the annular gap between rotor section 146 and stator 174 due to the perimeter face of rotor section 146 being contoured so as to induce a downward flow.

The perimetrical face of the lower element 144 is preferentially contoured to retard flow (assuming that the rotation is of the usual counter clockwise direction), wherefor it follows that, due to the opposed flow influences of the two rotor sections, a pressurized condition is set up within the stock confined between the rotating and stationary granular surfaced elements, all so as to cause a severe fiber-against-fiber action within the annular gap formed by the rotor and stator sections.

The extent of the pressurizing effect within the annular gap may be regulated by valve 260 and the flow of stock initiated by pressurization induced within the annular gap and regulated by the valve will be such as to cause a high velocity jet of stock to be returned to and impinged against the center of top rotor section 146 by way of conduit 258 and tube 262 in a continuous flow, thereby subjecting a portion of stock flow from the annular space between the rotor and stator to a re-entry to the impact chamber of the refiner for further fiber development.

With excessive volume within impact chamber 264, high velocities cease to be developed with a consequent loss of impact, and power is increased in the form of fluid resistance and fluid breaking effects which are not conducive to economy under excessive flow cross section dimensions.

For such reasons, a suitable flow, of the order of a film of moderate thickness, is observed to be more effective wherewith every fiber within the flow stream is exposed and subjected to the effectiveness of the fiber developing characteristics of the granular-surfaced elements.

It is for this reason that the automatic flow control, herein comprehended, is essential in the obtaining of ultimate effectiveness via maximum fiber development with a minimum energy input in an impact type of apparatus.

With a reasonably close clearance between processing ring 142 and the lowermost face of stator 172 under conditions of some static and hydraulic head on the refiner discharge, a reasonably constant flow is maintained for a particular speed with which the refiner may be driven, with an escapement means being provided such as through the recycling means.

Assuming motor 130 to be of a constant speed type, the

discharge rate will be reasonably constant for a given setting at this point, with any excess flow being shunted through the recycling means.

With further reference now to FIG. 1 again, with the refiner discharge under some hydraulic head, a constant rolling film action is thus assured within a chamber, and as the stock discharged from the refiner is elevated somewhat while it is being directed via conduit 267 into the bottom of flow box 268, it flows by gravity therefrom through an overflow pipe 270.

Flow box 268 will be proportioned for and fitted with an impeller 272 driven by a suitable low voltage sensing motor 274, the current for which is fed through a controller 276 via lead line 277.

Any appreciable change in stock viscosity within flow box 268 will cause a change in amperage drawn by motor 274.

With suitable amperage sensing devices incorporated within controller 276 and suitably connected to valve 260 as by lead line 279, valve 260 may be caused to open or close so as to call for more or less recycling through conduit 258 and more or less impact to be expended on the fiberous material being refined.

Likewise, the intensity of the impact may be controlled within the refiner impact chamber 264 by the shifting of counterweight 228 on lever 226 through any suitable reversible controlled miniature motorized counterpoise suitably connected to controller 276 as by lead line 281 and acting unisonly with the signal impulses influencing the action of valve 260 as controlled by the aforesaid controller mechanism and as initiated by the variations in stock viscosity when and as detected by motor 274.

Laboratory analyses of samples taken from trial runs of paper stock processed according hereto have disclosed that Mullen values are extremely sensitive to the high impact feature allowed herewith. Impact being the result of velocity, the Mullen values of accepted stock vary with the velocities resulting from the attained rotative speeds of the refiner. It has also been determined that other fiber development properties such as tear, tensile and fiber length ratios are not so sensitive to the effects of such high impact and that a reduction in the driven rotative speeds of the refiner has only slight effects on the accepted stock qualities other than Mullen which has proven to be developed in a definite ratio with the stock velocities resulting from these rotative speeds. For instance, if the refiner speed is reduced by 33%, say from 1800 r.p.m. to 1200 r.p.m., the Mullen value of the accepted stock is accordingly reduced 33%, while concomitantly the other fiber characteristics will not have been correspondingly effected.

Reference will now be made to FIG. 4, showing another arrangement of structures incorporating one or more auxiliary devices as component parts of a modified integrated system of fiber development designed to meet predetermined standards via an automatically controlled continuous flow non retention system which utilizes the aforedescribed phenomenon.

Parts which correspond with the parts shown and described in connection with FIG. 1 are given identical numbers and will not be herein redescribed for purposes of brevity.

I have determined that the refining of paper stocks to a specified given standard of accepted stock condition can be accomplished within refiner 60 at considerably reduced speeds with the required Mullen value being increased to a specified rating by having the stock, passing through a control valve 66' in conduit 62' interconnected with conduit 54, feed initially into a small diameter rotor, variable speed, high volume type of processing unit 300 which in turn feeds refiner 60 via conduit 302, in which case, the speed of a motor 304 driving the processing unit is varied by a speed regulating means 306 reactive to amplified signals emitted by controller 276 responsive to motor 274 so as to vary the speed of motor 304, that is to effect a decrease of its speed on a lighter viscosity of stock in flow box 268, and to effect an increase of its speed on a heavier viscosity of stock therein.

If desired, the operator may open switch 308 and control the speed of motor 304 from visual signals of torque values indicated by motor 274 or energy consumption values drawn by this motor, which values will vary in accordance with the viscosity and consequently Mullen values at a constant density.

By processing stock to accepted stock condition with a slow speed process or with the exception of Mullen and boosting the Mullen value within a small diameter high flow variable speed processing unit such as 300, less power is consumed due to the relative small rotor diameter size for the equivalent velocity-impact treatment and the increased passes through unit 300 due to the higher flow rate of feed recycles through conduits 62' and 302 as may be required to boost the Mullen values to a desired standard.

For extremely hard-to-process fibers, any desired number of such processing elements, similar to that represented by 300, may be arranged in series between blending unit 52 and unit 300 for any particular desired accepted stock condition at flow box 268.

The speed of preconditioner 6 may be controlled by either controller 68 or controller 276, as desired, through a 3-way switch for effecting a modulating motorized rheostat in series with a vari-speed motor and its energy supply which may be of DC current or other suitable arrangement.

Viscosity sensing motor 274 may be of the torque type operating at constant speed. Since the stock density is constant, any variation in stock viscosity will effect the resistance of impeller 272 causing a change in torque at motor 274 and its current consumption for a uniform speed, both effects being employed to initiate the impulse signals emanating from controller 276.

While customarily, in conventional practice, stocks are processed to a given freeness value, stock freeness is not necessarily a reliable or true index of fiber development so far as Mullen is concerned whereas viscosity values bear a more consistant relationship to Mullen values. Various degrees of freeness may be obtained for a given Mullen value and relative high freeness may be consistantly obtained for a given Mullen over that made possible by conventional means. Stock freeness may therefore be considered as an easily controllable variable for a given fixed Mullen value, obtainable by the mode of processing and refining which may permit increased paper making machine speeds over that possible with conventional stock processing methods.

Additionally, it should be stressed that where numerous types of fibers make up a given furnish, the blending may be handled in various ways. Each type of fiber material may be refined to its particular accepted stock condition separately and then the various accepted stocks may be blended by a separate blending system of batching the proper portions of the accepted stocks from the respective stock chests.

Still further, comment should be made that whereas blending unit 52 and refiner 60 are represented as having rotor perimeters and stator bores disposed in parallelism with the respective shaft axis, neither item is to be considered as being limited to such a parallel arrangement. Too, blending unit 52 may be equipped with a rotor having tapered perimetral wall and stators having tapered inner walls, in which case ample clearance should be provided between the top face of the rotor and the lower face of the stator so as to provide for adjustable annular clearances between rotor perimeter and stator inner surface. Likewise, refiner 60 may be fitted with tapered perimeter rotor granular surfaced members and tapered bore stators in which case ample clearances are provided between the flywheel and the lower stator. Also, the stator of the refiner need not necessarily be of the multiple piece type,

but may be of a uniform taper, or if of the multiple piece type, may be of a stepped taper type with tapered rotors to provide for extremely close clearance adjustments.

The method of securing the single or multiple sectional type stators need not be confined to the rigidly bonded in housing casing method shown as used in either the blending unit or the refiner, but may be of the readily-demountable type allowing for easy and rapid change and renewal, by having the stator of thinner wall construction as to permit encasement and bonding within a plain suitable steel band, insertable within the permanent outer housing, centered and secured thereto by any number of adequate socket head set screws properly located in a permanent outer housing.

While Mullen values have been found to be effective and respond to impact against granular surfaces and the velocities employed, the apparatus is not necessarily confined wholly to such techniques of fiber development but the various available physical modes of treating fibers may be rearranged, altered and combined as to obtain various degrees of effectiveness, granular surfaces depending on the mode of application.

The precise arrangement of the granular surfaced processing elements, as illustrated and defined in connection with blending unit **52** and refiner **60**, need not be slavishly followed.

For instance, an alternative arrangement found to be particularly effective in the reduction of saturated fibrous materials to separation to an individualized fibrous state or condition, without suffering any cutting action or other detrimental effects in the fiber separation and blending operation, more particularly within a belnding unit **52'** such as shown in FIG. 5 and within a blending unit **52''** such as shown in FIG. 6.

In each arrangement, the fiber slurry is caused to pass through one or more, preferably two, abrupt and successive changes in flow direction of a full 90°, or nearly 90° angle, within the confines of a single pair of rotor and stator opposed processing elements, such as the stepped upper working face of the rotor **86'** and the complementally stepped lower working face of the upper rotor **120'**, as shown in FIG. 5, so that the flow of fibrous material is caused to enter in an, axiswise, downwardly flowing direction, only to be abruptly caused to be changed to flow in a radial direction, then again to be caused to be abruptly changed to flow in an axiswise, or nearly axiswise, direction within the confines of a single pair of opposed processing surfaces, or such as the double stepped upper working face of the rotor **86''** and the complementally double stepped lower working face of the upper rotor **120''**, as shown in FIG. 6, so that the flow of fiberous material is caused to enter in an, axiswise, downwardly flowing direction, only to be abruptly caused to be changed to flow in a radial direction, then again to be caused to be abruptly changed to flow in an axiswise direction, and then again to be caused to be abruptly changed to flow in a radial direction, following by still another abrupt change to be caused to flow still again in an axiswise direction.

These abrupt changes in flow direction within the confines of a single pass between any givn pair of opposed, granular-surfaced processing elements having suitable clearances therebetween allow phenomenal fiber separation effectiveness and fiber development capacities without any suffering of cutting or other detrimental effects, a feature not possible of attainment by any other means.

Because of these effects, it has been found of paramount importance to obtain the maximum angularity of change up to 90° in flow direction within a single pair of opposed granular surfaces in a continuous unbroken flow action, with means permitting adjustable clearances, preferably at a single pair of opposed surfaces to satisfy the dictates of ease of adjustment and practicality, wherewith may be effectuated changes in either one or both of the axis and radial flow clearances via a single unitary adjustment.

Where such pairs of abrupt, right angle, or nearly right angle, stock flow directional changes are so provided over granular surfaces, wider clearances are then allowed to be maintained between the granular element surfaces of the flywheel processing ring and the lower or bottom face of the lower stator with the advantage of a saving in energy input consumption, more particularly when the flywheel chamber is lined with a granular surface against which the flywheel discharge may be impinged with greater freedom and higher velocity and with less energy input due to the aforesaid less restricted clearance.

While my Patent, No. 2,936,128 teaches the advanages in refining by such stepped-in-flow changes, the effects obtained with such stepped-in arrangement causes a restriction in the flow that gives compressive effects on the fibers with a consequent more intensive fiber-against-fiber friction effect which, with the porous granular structure used, encourages a liquid short circuiting desirable in the refining phase for fiber development of Mullen, tensile and tear values, whereas, in the fiber separation phase, herein of paramount concern, and when employing a stepped-out effect relative to directional flow, has an expanding effect, that is directly opposite and an improvement over that effect obtained in my Patent No. 3,058,678, so far as fiber separation effect is concerned.

The expanding effect as used in the separation phase is obtained in the stepped-out flow directional change by bringing about a fiber to liquid transfer "suspensionwise" relationship, due to the difference in specific gravity of the vehicle liquid to that of the fiber, in which case the liquid separates from the fibers to hydraulically cushion their impingement over the granular surfaces in the abrupt change in flow direction with a fiber expanding effect with nil cutting action augmented by the vehicle reinjection taking place at each stepped-out change in flow direction.

While the integrated automatically controlled stock processing system has been described as converting dry rain stock aggregate to an accepted stock condition in a continuous flow, the methods and apparatus are not necessarily confined to the processing of dry aggregate, but may be adaptable for the handling of any moist products such as rag drainer stocks and other types of stocks, in wet or dry condition.

I claim:

1. An automated method of preparing paper stock comprising:

(A) the steps in a preconditioning phase,

(1) of controlling the input flow to a preconditioner of predetermined-quantity charges of unrefined bulk fibrous material and of liquid by measuring flow of the latter for effecting a flow variance of the former according to a predetermined fiber-to-liquid ratio, and

(2) of reducing the so-proportioned fiber-to-liquid mass to a continuously-flowing slurry of a selected density value,

(B) simultaneously with the steps in a blending phase,

(1) of charging the so-reduced slurry into a saturating reservoir of a blender with the reservoir volume serving as the determinant of the input rates of flow of the charges of unrefined bulk fibrous material and of liquid to the preconditioning phase,

(2) of further individualizing the fibers of the so-reduced slurry into a continuously-flowing blended slurry, and

(3) of delivering a continuous flow of the so-blended slurry returnably to the preconditioner while drawing off a portion thereof for delivery to and according to the feed demand of the refining means of the system,

(C) and simultaneously with the steps in a refining phase,

(1) of flowing the so-blended slurry through the refining means for achieving a uniform accepted stock condition of a predetermined selective viscosity value by automatically varying the refiner inlet feed flow rate for effecting variations in the rate of retention within the refining means according to the viscosity value variation at the discharge of the refining means while maintaining a constant energy input rate of a predetermined value at the refining means,

(2) of automatically varying the re-entry flow of refiner bled stock at modulated corrective rates responsive to the viscosity value variation at the discharge of the refining means, and

(3) cooperantly automatically correcting viscosity value variation at the discharge by varying the refining means rotor speed.

2. An automated method of preparing paper stock comprising the steps:

(A) in a preconditioning phase,

(1) of controlling the input flow of predetermined-quantity charges of unrefined bulk fibrous material and the simultaneous input flow of predetermined-quantity charges of liquid by measured flow of the latter for effecting a flow variance of the former for maintenance of a predetermined fiber-to-liquid ratio, and

(2) of reducing the so-proportioned fiber-to-liquid mass to a continuously-flowing stock slurry of a selected density value reflective of the measuring assuring the fiber-to-liquid ratio,

(B) in a blending phase,

(1) of charging the so-reduced stock slurry into a reservoir with the volume within the reservoir serving as the determinant of the input rates of flow of the charges of bulk fibrous material and of the charges of liquid to the preconditioning phase,

(2) of simultaneously further individualizing the fibers of the so-reduced stock slurry into a continuously-flowing blended slurry, and

(3) of directing a portion of the so-blended slurry to and according to the feed demand of the system refining means to which the portion of the so-blended slurry is to be delivered and of directing the balance of the so-blended slurry returnably to the reducing unit of the preconditioner phase for automatically maintaining a continuous flow proportioned to the feed demand of the refining means, and

(C) in a refining phase,

(1) of refining the portion of the so-blended slurry to an accepted uniform stock condition with a predetermined selective viscosity value at the rate controlled by and responsive to the demand of the system to which the portion of the so-blended slurry is delivered, and

(2) of simultaneously directing a portion of the so-refined stock to the refiner outflow while directing a portion of the partially-refined stock returnably to the refiner according to the viscosity sensing means with increases in the return of the refiner-returned-to-the-refiner stock being reflected in decreases in the blender-to-refiner flow and with decreases in the refiner-returned-to-the-refiner flow being reflected in increases in the blender-to-refiner flow.

3. An automated method of preparing paper stock comprising the steps:

(A) in a preconditioning phase,

(1) of controlling the input flow of predetermined-quantity charges of unrefined bulk fibrous material and the simultaneous input flow of predetermined-quantity charges of liquid by the metering of the flow of the latter for effecting a flow variance of the former to realize and maintain a predetermined fiber-to-liquid ratio, and

(2) of reducing the so-proportioned fiber-to-liquid mass to a continuously-flowing stock slurry of a selected density value reflective of the initial fiber-to-liquid ratio metering,

(B) in a blending phase,

(1) of charging the so-reduced stock slurry into a reservoir with the volume within the reservoir serving as the determinant of the input rate of flow of the charges of bulk fibrous material and of the liquid to the preconditioning phase,

(2) of simultaneously further individualizing the fibers of the so-reduced stock slurry into a continuously-flowing blended slurry, and

(3) of directing a portion of the so-blended slurry to and according to the feed demand of a refining means of the system to which the portion of the so-blended slurry is to be delivered and of directing the balance of the so-blended slurry returnably to the reducing unit of the preconditioner phase for automatically maintaining a continuous flow proportioned to the feed demand of the refining means.

4. An automated method of preparing paper stock in a preconditioning phase comprising the steps,

controlling the input flow of predetermined-quantity charges of unrefined bulk fibrous material and the simultaneous input flow of predetermined-quantity charges of liquid by the metering of the flow of the latter for effecting a flow variance of the former to realize and maintain a predetermined fiber-to-liquid ratio,

and reducing the so-proportioned fiber-to-liquid mass to a continuously-flowing stock slurry of a selected density value reflective of the intial fiber-to-liquid ratio metering and at a rate responsive to the demand of the system to which the so-reduced stock slurry is to be delivered.

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