

May 22, 1962

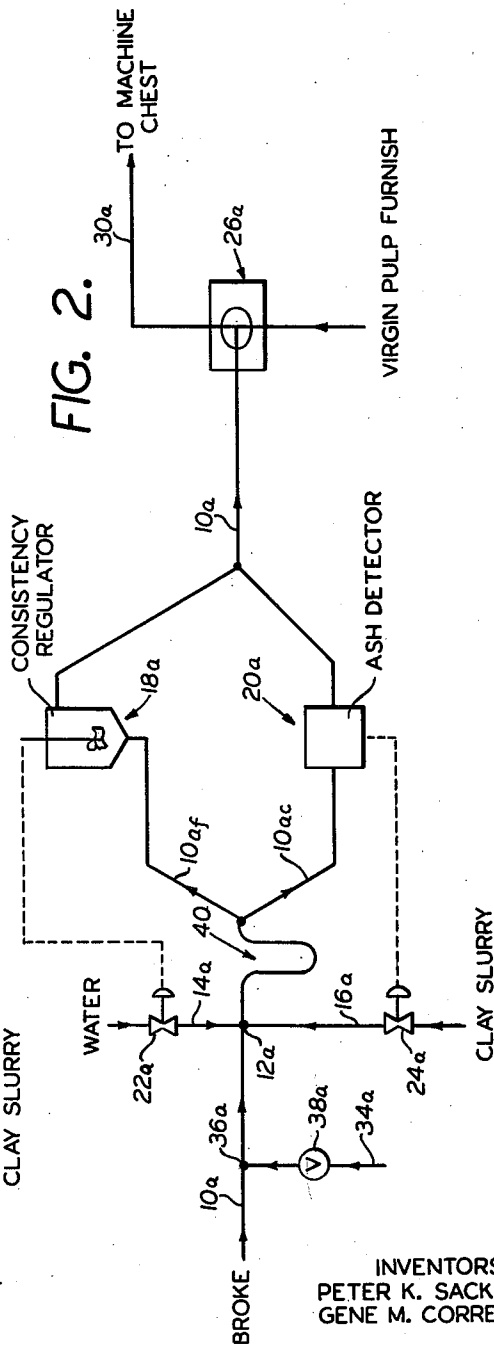
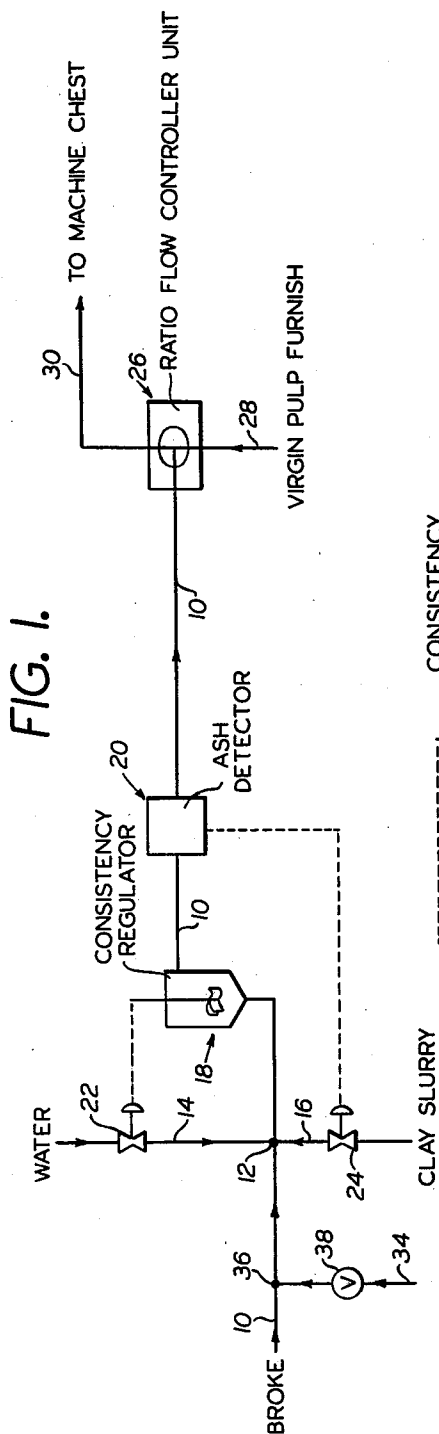
P. K. SACKSEN ET AL

3,035,967

PROCESS AND APPARATUS FOR REGULATING CONSISTENCY
AND MINERAL FILLER CONTENT OF PAPERMAKING STOCK

Filed June 9, 1960

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 3.

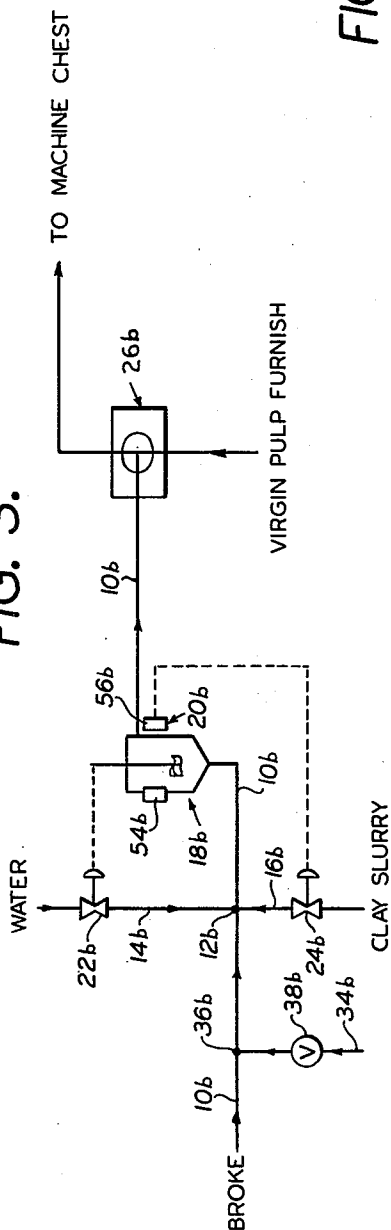


FIG. 5.

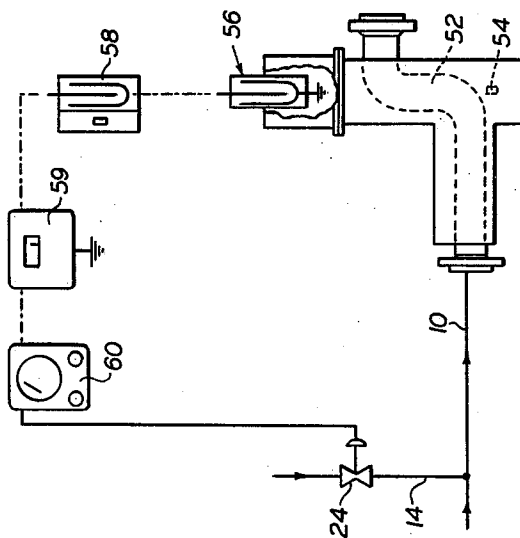
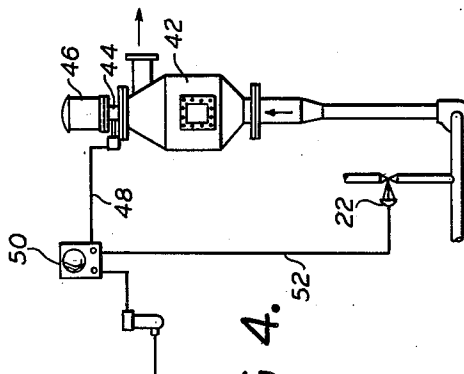


FIG 4.



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1

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PROCESS AND APPARATUS FOR REGULATING CONSISTENCY AND MINERAL FILLER CON- TENT OF PAPERMAKING STOCK

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This invention relates to the concurrent regulation of the pulp consistency and the mineral filler content of a paper machine furnish. While the problem of uniformly securing a desired total consistency and at the same time providing a prescribed percentage of mineral filler, is of interest even where virgin pulp is exclusively used, the inclusion of pulp from broke in a furnish presents a problem of particular difficulty. Applications involving broke furnish will be used, therefore, for the purpose of illustration.

In paper making there is inevitably a very considerable amount of broke. While pulp from broke is inferior to virgin pulp, a considerable percentage of broke fibers can be used in most papers, the percentage varying with the kind and quality of the paper required. The particular problem here under consideration is the inclusion of broke fibers, including filler in the broke, in a paper furnish in which filler is to be employed.

The broke develops day by day, and for obvious reasons it must be disposed of, through utilization if possible, without unnecessary delay. Paper specifications vary from run to run, an important variable being the percentage of mineral filler specified. The broke available for use in a current run may therefore contain a greater or lesser percentage of mineral filler than that specified for the current run. It is highly desirable to feed the auxiliary stream of broke pulp into the main stream of virgin pulp with a percentage of mineral filler content that will provide the combined stream of stock with a filler content in accordance with the specifications for the particular run.

In accordance with the present invention, care is taken to assure that before regulation the initial fiber consistency of the broke pulp will be too high and that the initial mineral filler content will be too low, and automatic corrective means are provided for thereafter concurrently reducing the fiber consistency and increasing the mineral filler content of the broke pulp. It is a simple matter to provide a broke furnish which is of an abnormally high fiber consistency. A broke pulp having an initial deficiency of mineral filler can be provided by adding to the broke pulp, if necessary, a sufficient quantity of virgin pulp having no filler in it. This can also be accomplished by washing the broke by running the broke over a conventional type of thickener after dilution of the broke.

The required adjustments for bringing about the exact fiber consistency and the exact percentage of mineral filler required present a problem of some difficulty. The apparent viscosity of the pulp suspension is a function of the fiber consistency, i.e., of the ratio of fibers to water. The apparent viscosity is not increased, however, by an increase of mineral filler, because the filler has a lubricating effect upon the furnish. As the filler content is increased, therefore, the measure of the apparent viscosity tends to be relatively constant. Since the filler in all instances constitutes but a minor ingredient of the furnish, perhaps of the order of 10% of the pulp on a dry basis, no important inaccuracy results if the indicated apparent viscosity is taken as the actual measurement of the consistency.

2

The mineral pigment is of substantially higher specific gravity than the suspension water, and therefore increases the average specific gravity of the suspension, the average specific gravity being substantially a direct function of the proportion of mineral filler present at a constant fiber consistency. It is possible, therefore, to measure the specific gravity of the flowing suspension and utilize the measurement to control the addition of mineral filler slurry to the suspension in such a way as to bring about the exact filler content desired.

Since the water supplied for adjusting the fiber consistency affects the specific gravity of the furnish, and the water admitted as a part of the added mineral filler slurry affects the fiber consistency of the furnish, it is of prime importance that the viscosity measuring device and the specific gravity measuring device be so related to the flowing stream that each can perform its intended function without interference by the other.

To this end it is a feature that the water added in response to the apparent viscosity measurement and the slurry added in response to the specific gravity measurement are both added to the stream before the stream reaches either of the measuring devices. In this way all the water added under the influence of both the viscosity and the specific gravity measuring devices is taken into account by the apparent viscosity measuring device, and all of the same water as well as the mineral filler slurry added under the influence of the specific gravity measuring device are taken into account by the specific gravity measuring device. By the combination of the two measuring devices in the relation set forth, the broke pulp can be brought to, and maintained at, a substantially uniform consistency and filler content closely approximating the conditions specified.

Expressed otherwise, a primary aim is to secure in the end a definite ratio of filler to pulp fibers, but water is the common denominator. It is important, therefore, that the ratio of fibers to water shall be determined and controlled with reference to all the water that is to be added, and that the ratio of filler to water shall be determined and controlled with reference to all the water that is to be added.

Primary objects of the invention have to do with the contriving of practical methods and means of achieving the result indicated.

Other objects and advantages will hereinafter appear. In the drawing forming part of this specification:

FIG. 1 is a diagrammatic view showing one practical and advantageous, illustrative system for adjusting both the fiber consistency and the mineral filler content of broke furnish;

FIG. 2 is a view similar to FIG. 1 showing a second illustrative system;

FIG. 3 is a view similar to FIGS. 1 and 2 but showing a third illustrative system;

FIG. 4 is a diagram showing in somewhat greater detail the viscosity measuring device of FIGS. 1 to 3; and

FIG. 5 is a diagram showing in somewhat greater detail the specific gravity measuring device of FIGS. 1 and 2.

In FIG. 1 broke furnish is transmitted from a suitable source of supply, derived from the broke of a previous run or runs, and is pulped as usual with the object in view of salvaging for use all the fibers and all the filler of the broke. It is important from the standpoint of the present invention that the initial broke furnish have a higher fiber consistency and a lower filler content than are specified for the current run. The first requirement is readily met by limiting the proportion of water initially combined with the broke. The second requirement can be met either by the use of broke containing less filler than that currently

3

prescribed, or by adding a limited amount of virgin pulp containing no filler to the broke pulp suspension, or by washing the broke in a conventional thickener.

A conduit 10 transmits the broke furnish through an addition zone in which an addition point 12 is located. At the point 12 a water addition pipe 14 and a filler slurry pipe 16 let into the conduit 10, the addition of water and slurry being regulated as will be explained.

The conduit 10 carries the furnish from the addition zone into a measuring zone in which the consistency is ascertained by a viscosity measuring device 18 and the mineral filler content is ascertained through a specific gravity measuring device or ash detector 20. Details of the devices 18 and 20 will be explained more fully at a subsequent point. For the present, it is noted that the device 18 continually measures the apparent viscosity, and through the measurement obtained controls a water admission valve 22 to admit the necessary water for producing the prescribed fiber consistency. The device 20 continuously measures the specific gravity and through the measurement obtained controls the mineral slurry admission valve 24 to admit the necessary amount of slurry for producing the prescribed filler content.

It is an important point that both the consistency adjusting water and the filler adjusting slurry are added in advance of both the measuring devices 18 and 20. The device 18, if operated independently of the device 20, could test the furnish as received, and could, through its influence on valve 22, control the addition of water to adjust the furnish to a prescribed fiber consistency. The device 18 would be powerless, however, to control the final fiber consistency if, after passing the device 18, the furnish had a quantity of mineral filler slurry added to it. Similarly, the device 20 could test the furnish independently of 18, and could, through its influence on valve 24, control the addition of mineral filler slurry to produce a prescribed specific gravity and hence a prescribed mineral filler content. The device 20 would be powerless, however, to control the final specific gravity, and hence the final ratio of filler to water, if a quantity of water were independently added for adjusting consistency after the furnish had passed the device 20. With the arrangement shown and described the water added by the valve 22 influences the measurements taken by, and the control effects of, the devices 18 and 20, and the slurry added by the valve 24 influences the measurements taken by, and the control effects of, the devices 18 and 20.

After passing the devices 18 and 20, the adjusted broke furnish is combined with a virgin pulp furnish by a ratio flow controller unit 26. The broke pulp furnish enters the unit 26 through the conduit 10 and the virgin pulp furnish enters the unit 26 through a conduit 28. The two furnishes, combined and blended in a prescribed and controlled ratio are delivered as a single stream through a conduit 30 to the machine chest.

The arrangement of FIG. 1 as described is generally satisfactory. It depends, of course, upon the accuracy of control which can be provided by the devices 18 and 20. The accuracy of these devices is of a high order. The FIG. 1 arrangement is generally sound in principle, and it has been found to work in a practical and advantageous manner. Because the sensing element of the last measuring device 20 follows the device 18, it is necessarily somewhat remote from the addition point 12, and will not, therefore, be as promptly responsive to changes of initial filler content as it would be if located nearer to the point 12. It is not essential that both additions be made at a common point, so long as both additions are made ahead of the devices 18 and 20.

For assuring that the mineral filler content of the broke pulp arriving at the addition point 12 will be less than that prescribed, a pipe 34 may be connected to let into the conduit 10 at a point 36 under control of a valve 38. Pulp containing no mineral filler or a very low proportion of mineral filler may be supplied through the

4

conduit 34. If desired, the specific gravity of the broke furnish in advance of the point 36 may be measured by a device like the device 20 and the valve 38 may be controlled automatically from such device to admit the filler deficient pulp in correctively varied amounts.

In FIGURE 2 a somewhat different system is diagrammatically shown. The system of FIG. 2 is generally like that of FIG. 1 and accordingly corresponding reference numerals have been applied to corresponding parts with the subscript *a* added in each instance. No detailed description of the unaltered parts will be given.

As before, the broke pulp is transmitted through a conduit 10a past an addition point 12a. After the point 12a the conduit 10a is formed with a U-bend 40 for mixing the furnish which reaches the point 12a with the added water and slurry. After the U-bend the conduit 10a divides between parallel branches 10ac and 10af. An apparent viscosity measuring device 18a is located in the branch 10af for controlling the water admission valve 22a and a specific gravity measuring device 20a is located in the branch 10ac for controlling the slurry admission valve 24a. In all other respects the system of FIG. 2 is like that of FIG. 1. The branch streams are re-combined after passing the measuring devices 18a and 20a.

The system of FIG. 2 retains the salient feature of making both additions ahead of both measuring instruments. In dividing the broke stream for taking the measurement, the system of FIG. 2 improves upon the system of FIG. 1 in that it does not require the measuring devices to be disposed one after the other, and thereby enables both of them to be brought as near to the addition point 12a as may be desired.

In FIG. 3 a further system is diagrammatically shown. The common features of FIGS. 1 and 2 are all retained. Accordingly, corresponding reference numerals have been applied to corresponding parts with the subscript *b* added in each instance, and no general detailed description will be given. After passing the common admission point 12b for water and mineral filler slurry, the furnish is delivered to the interior of the apparent viscosity measuring device 18b. The specific gravity measuring device 20b is associated with the apparent viscosity measuring device 18b, and measures the specific gravity of the furnish as the furnish passes through the device 18b.

This arrangement is preferred over the others because both measurements may be taken at the same limited distance from the common admission point 12b, and this without dividing the stream. The apparent viscosity measuring device 18b, moreover, itself includes an agitator which acts upon the entire stream and thereby maintains homogeneity of the furnish for specific gravity as well as apparent viscosity measurement.

While the combination of apparent viscosity and specific gravity measuring devices illustrated in FIG. 3 is novel, the separate instruments 18 and 20 as used in FIGS. 1 and 2 are of conventional construction and are designed, intended and commonly used for measuring and regulating fiber consistency and filler content respectively, each apart from and without regard to the other.

The viscosity measuring device of FIG. 4 is a De Zurik consistency regulator of the pipe line type as made and sold by the De Zurik Shower Company of Sartell, Minn.

The De Zurik regulator as illustrated in FIG. 4 comprises a feeler agitator unit (not shown) suspended in a suitable flow-box 42 and driven from above by a vertical shaft 44 of a motor 46, the motor being mounted on a ball bearing swivel base. With each slight change of the fiber consistency of the stock coming to the regulator there is a corresponding change in the torque required to rotate the agitator. This torque or rotative force is measured by means of an extremely sensitive pneumatic force balance transmitter mounted on the regulator base. Any slight change of torque is expressed in a change of output air pressure from the transmitter through a pipe 48 to a controller recorder 50. The controller recorder

acts through a pipe 52 to control the adjustment of the air operated dilution valve 22, to correct the rate of water addition, and thereby continuously to adjust the stock to the prescribed fiber consistency.

The specific gravity measuring device of FIGS. 1 and 2 is an Ohmart specific gravity gage. The specific gravity control system of FIG. 1 is an Ohmart specific gravity control system as made and sold by the Ohmart Corporation of 2236 Bogen Street, Cincinnati, Ohio.

The Ohmart specific gravity control system as illustrated in FIG. 5 continuously measures the specific gravity of the flow stream in the conduit 10. The measuring device includes a continuous pipe section 52 of the same internal diameter as the adjacent portions of the conduit 10, said pipe section having two horizontal segments and an intervening vertical segment, the vertical segment being connected to the horizontal segments through reverse 90° bends of small radius. The specific gravity is measured as the stream flows upward through the vertical segment of the pipe section 52. The arrangement of the pipe as described is designed to avoid slow-down of the flow and resulting sedimentation in the measuring area, and to promote homogeneity of the furnish at that point.

Below the vertical length of pipe 52 there is provided a capsule 54 which contains a source of gamma radiation, and above the vertical length of pipe 52 a measuring cell 56 is provided, so that the measuring cell is exposed to radiation from the source contained within the capsule 54. The amount of radiation absorbed by the flowing stream is a direct function of the average specific gravity of the stream, and, since the source radiation is constant, variations of radiation reaching the cell 56 are directly related to variations of specific gravity of the stream.

The system includes a compensating cell 58 which may be used to suppress the effect of extraneous constants such as radiation absorption by the pipe wall, etc., although such compensation is not essential. A standard potentiometric recorder-controller 60 is provided. The controller adjusts the setting of the valve 24 for controlling the rate of delivery of mineral filler slurry by the pipe 14 to the conduit 10.

Either of two sources of gamma radiation may be used. These are cesium-137 and cobalt-60. Cesium-137 has a long half life (33 years) and a low energy gamma radiation (.662 mev.) which is readily absorbed. Hence it is used where maximum instrument stability and sensitivity are required. Cobalt-60 has a relatively short half life (5.3 years) and much higher energy radiation (1.17 and 1.33 mev.). Hence it is used where sensitivity and stability are less important than penetration ability.

The source is mounted in a shielded holder which serves both as a container and as protection for persons in the area. The amount of radiation absorbed by the flowing stream is a direct function of the average specific gravity of the stream. The amount of unabsorbed radiation which reaches the measuring cell is therefore equal to the source radiation directed toward the measuring cell, less the sum of the radiation constantly absorbed by fixed structure such as pipes and the radiation variably absorbed by the flowing stream.

The measuring cell 56 is of the type that converts radioactive energy directly into electrical energy. It contains two electrodes which have different work functions. These are separated by a filling gas. When the filling gas is forcibly ionized by exposure to nuclear radiation, positive ions are attracted to the electro-negative electrode and electrons are attracted to the electro-positive electrode, and thus an electric current is spontaneously generated.

The compensating cell 58 is of the same type as the measuring cell but is connected in series aiding relation to the measuring cell for cancelling out the radiation absorbing effect of fixed structures. It is equipped with a small source of radioactivity which is mounted on an adjustable screw that projects into a well in the cell. By

adjusting the position of the radioactive source, it is possible to alter the output current from the compensating cell, and thereby, depending on the circuit arrangement, to augment or cancel the output of the measuring cell to any fixed extent desired.

In FIG. 5 the compensating cell is shown as in series aiding relation with the measuring cell, but this is simply illustrative. The net output is applied to an amplifier-indicator 59. The amplifier-indicator operates the recorder-controller 60 and the valve 24 mechanically, preferably pneumatically.

In FIG. 3 the devices 18 and 20 are combined, the source 54b being placed at one side of the flow box 42b, and the measuring cell 56b at the other side. Both the source 54b and the measuring cell 56b are desirably, but not necessarily located above the level of the blades of the agitator unit. It will be observed that the agitator unit serves a dual function in this kind of organization, (1) it enters into the torque measurement, and (2) it maintains the homogeneity of the furnish stream for the benefit of the density measuring device 20b.

In all systems illustrated the consistency and mineral filler content of the main virgin pulp stream may be controlled in any conventional way or by means of the kind shown and described herein, to meet the prescribed standards.

While certain preferred embodiments of the invention have been illustrated and described in detail, it is to be understood that changes may be made therein and the invention embodied in other structures. It is not, therefore, the intention to limit the patent to the specific construction illustrated, but to cover the invention broadly in whatever form its principle may be utilized.

We claim:

1. The method of continuously correctively adjusting the fiber consistency of a pulp furnish and the mineral filler content thereof to prescribed values which comprises transmitting a furnish stream which is initially of too high consistency and too low mineral filler content, first through a water and filler slurry addition zone and then through a measuring zone, in the measuring zone continually measuring the apparent viscosity of the stream and controlling thereby the addition of water to the stream in the addition zone for lowering the fiber consistency, and in the measuring zone continually measuring the specific gravity of the stream and controlling thereby the addition of a mineral filler slurry to the stream in the addition zone for raising the mineral filler content, the procedure being such that the added water and the added filler slurry continually affect both measurements and thereby enter into the control of both additions.

2. The method as set forth in claim 1 in which the furnish stream is divided in the measuring zone into a plurality of branches, the apparent viscosity measurement being taken in one branch and the specific gravity measurement being taken in another.

3. The method as set forth in claim 1 in which the water addition and the mineral filler slurry addition are effected at a common addition point.

4. The method as set forth in claim 1 in which the apparent viscosity and specific gravity measurements are made continuously at a common point.

5. The method of continuously correctively adjusting the fiber consistency and the mineral filler content of broke pulp to a prescribed fiber consistency and a prescribed mineral filler content, which comprises initially producing a broke pulp of a higher consistency and a lower mineral content than those prescribed, including in the broke pulp, if necessary, a quantity of virgin pulp which is deficient in mineral filler, transmitting said broke pulp first through a water and filler addition zone and then through a measuring zone, in the measuring zone continuously measuring the apparent viscosity of the stream and controlling thereby the addition of water to the stream in the addition zone for lowering the fiber

7

consistency, and in the measuring zone continuously measuring the specific gravity of the stream and controlling thereby the addition of mineral filler slurry to the stream in the addition zone for raising the mineral filler content to substantially the desired level, the procedure being such that the added water and the added filler slurry continuously affect both measurements and thereby enter into the control of both additions.

6. Apparatus for continuously correctively adjusting the consistency of a pulp furnish and the mineral filler content thereof to prescribed values which comprises, in combination, conduit means for transmitting a stream of pulp which is initially of too high consistency and too low mineral filler content, first through an addition zone and then through a measuring zone, means in the measuring zone continuously measuring the apparent viscosity of the stream, means in the addition zone automatically responsive to said measuring means to add water to the stream at a rate determined by the measurement, means in the measuring zone continuously measuring the specific gravity of the stream, and means in the addition zone automatically responsive to the specific gravity measuring means to add a slurry of mineral filler to the stream at a rate determined by the specific gravity measurement for raising the mineral filler content, the construction and arrangement being such that the added water and the added filler slurry continuously affect both measurements and thereby enter into the control of both additions.

7. Apparatus as set forth in claim 6 in which the means for adding water and the means for adding mineral

8

filler slurry let into the conduit means at substantially a common point.

8. Apparatus as set forth in claim 6 in which the conduit means is divided into branches in the measuring zone, the means for measuring the viscosity being disposed in one branch and the means for measuring the specific gravity being disposed in another branch.

9. Apparatus as set forth in claim 6 in which the apparent viscosity and specific gravity measuring devices are disposed in series with reference to the flowing stream, so that the entire stream passes first through one of the measuring devices and then through the other.

10. Apparatus as set forth in claim 6 in which the apparent viscosity measuring device is disposed to transmit a portion, at least, of the stream for viscosity measurement, and in which the specific gravity measuring device is associated with the viscosity measuring device to measure the density of the furnish as it passes through the viscosity measuring device.

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