

Oct. 28, 1952

G. S. WITHAM  
PAPER STOCK ANALYZER

2,615,329

Filed July 16, 1946

2 SHEETS—SHEET 1

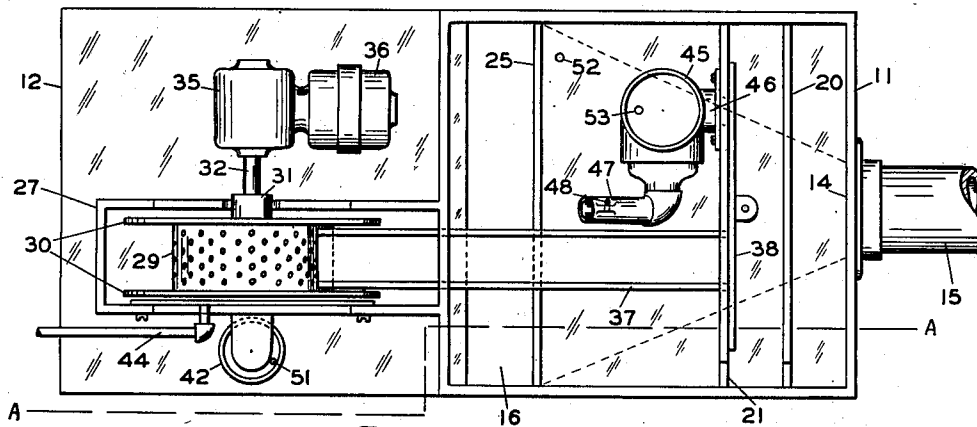


FIG. 1

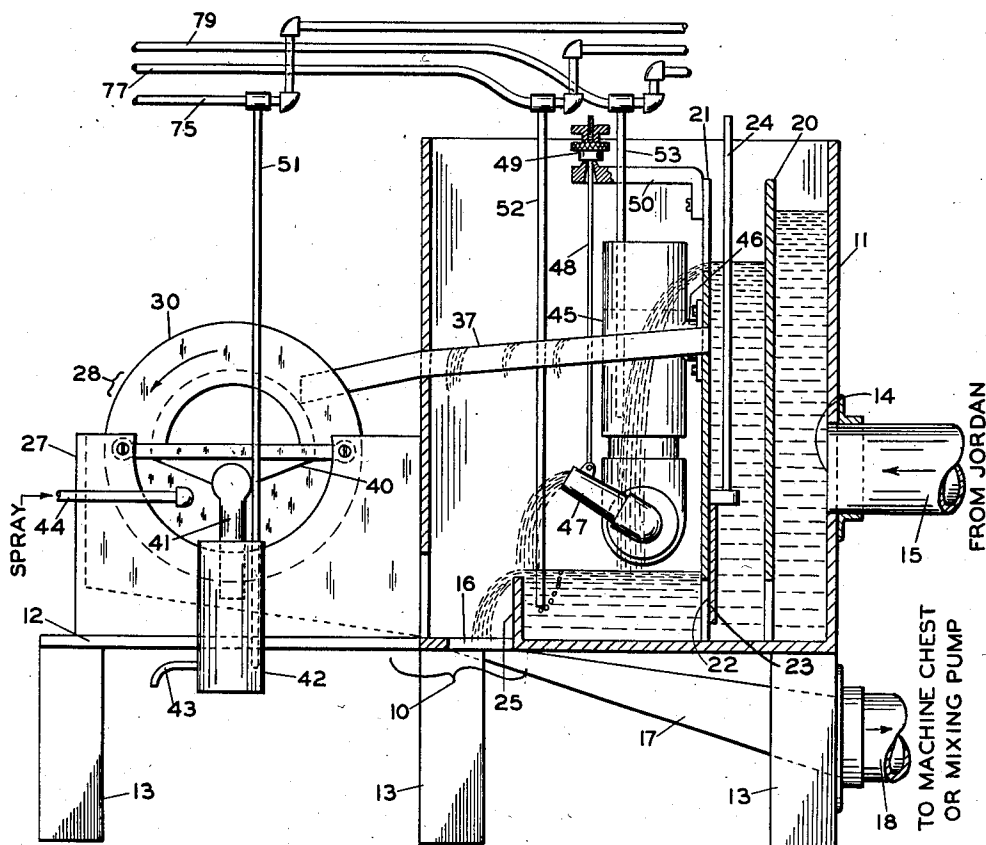


FIG. 2

INVENTOR.  
*George S. Witham*  
BY  
*E. C. Sanborn*  
attorney

Oct. 28, 1952

G. S. WITHAM  
PAPER STOCK ANALYZER

2,615,329

Filed July 16, 1946

2 SHEETS—SHEET 2

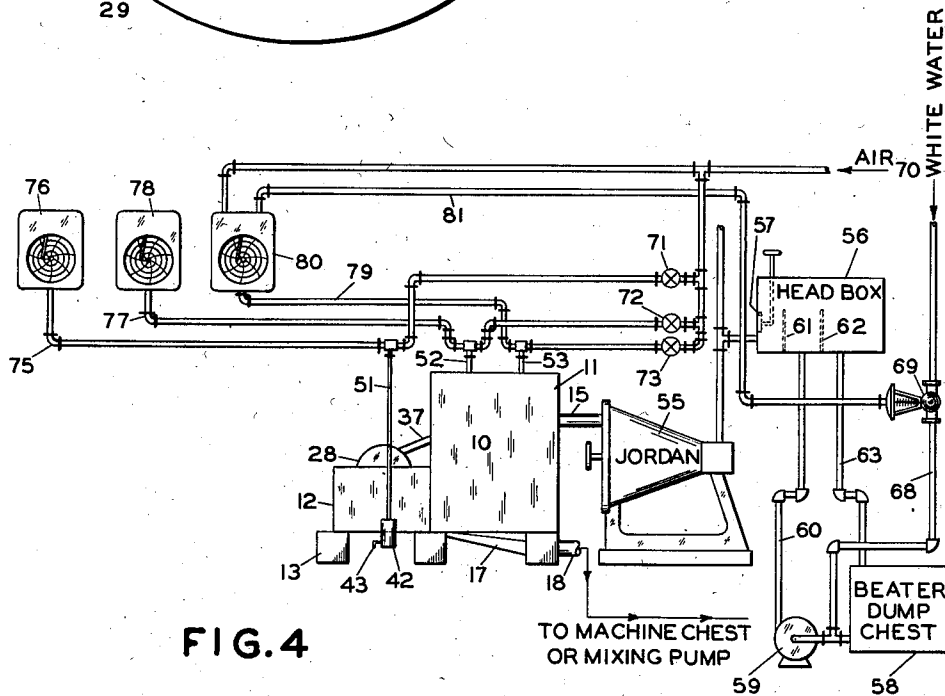
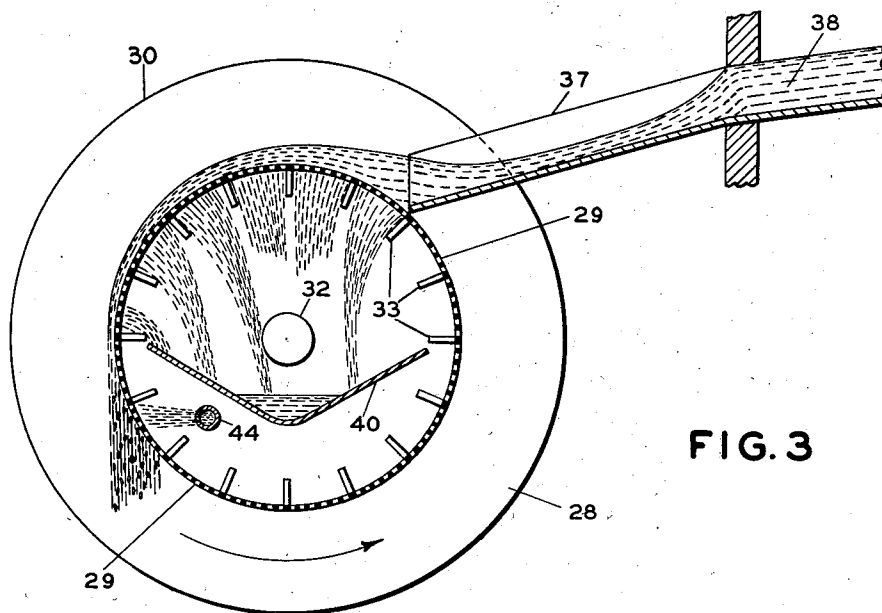


FIG. 4

INVENTOR.  
George S. Witham  
BY  
E. C. Sanborn  
Attorney

## UNITED STATES PATENT OFFICE

2,615,329

## PAPER STOCK ANALYZER

George S. Witham, Hudson Falls, N. Y., assignor  
to The Bristol Company, Waterbury, Conn., a  
corporation of Connecticut

Application July 16, 1946, Serial No. 683,969

3 Claims. (Cl. 73—63)

1

This invention relates to devices for analyzing paper stock, and more especially to instrumentalities for providing a continuous record of interrelated physical characteristics of paper stock during the process of manufacture, whereby regulation and control of these characteristics may be effected with a minimum departure from optimum conditions in the paper machines.

Two important, and interrelated, though distinct, factors in the quality of the stock fed to paper machines are "freeness" and "consistency." The first of these terms is based primarily on the coarseness of the suspended fibres. Free stock is that which consists of coarse fibres. Slow stock consists in general of fine fibres with frayed ends, and may contain a greater or less proportion of one or more of a variety of organic or inorganic "fillers," which impart various desirable properties to the finished paper. A characteristic of slow stock is that it tends to form a dense mat from which water drains slowly. The degree of freeness of stock may therefore be determined by the rate of drainage of water from it; but in order that there be a standard of reference, it is essential that other variable factors be eliminated, or else incorporated in a suitable compensation. The principal variable to take into account before attempting to determine freeness is that of consistency. These two magnitudes are closely associated, and may readily be confused. In fact, they may at times be measured by identical means, the only distinction lying in the range of measurement for which the apparatus is set. Consistency, however, is synonymous with viscosity, and affects the manufacture of paper in quite a different manner from the influence of freeness. Control of consistency is brought about by regulation of the amount of water in the stock, which may generally be effected automatically, while control of freeness requires adjustment of the jordan plug or beater knives, as the case may be, which is generally better done by manual means subject to the observed freeness values.

It is an object of the present invention to provide means whereby simultaneous determination of consistency and freeness on flowing paper stock may be coordinated in a manner to eliminate in the former such variations as might otherwise detract from accuracy of measurement of the latter.

It is a further object to provide means whereby freeness of a selected specimen of paper stock may be determined with an accuracy and precision not heretofore characterizing the art.

2

It is a further object to provide means of the above nature which shall be compact and substantially unitary in construction, and readily adaptable to existing installations of paper manufacturing apparatus.

In carrying out the purposes of the invention, it is proposed to provide, integrated in a common unit, a consistency measuring and controlling instrument, and an improved form of freeness determining apparatus and so to coordinate their performances as to utilize each with maximum efficiency.

In my former Patent No. 1,945,988, granted February 6, 1934, and reissued as No. 19,997, June 2, 1936, I have pointed out that freeness may be effectively determined by maintaining a paper stock at a uniform consistency, establishing a filter mat of material from said stock while maintaining balanced atmospheric pressures on opposite sides thereof, and performing a quantitative measurement on the liquid which drains through said stock. As set forth in said patent and reissue, the forming of said mat is accomplished by the use of a foraminous drum immersed to a predetermined depth in the stock whose characteristics are being determined, and caused to rotate therein to gather on its outside surface a quantity of material from said stock in the form of a mat, from which water may drain into the interior of the drum, and subsequently flow therefrom at a measured rate. In the application of this principle, I have found that the formation of a mat of uniform thickness may be effected with a greater degree of uniformity if the stock be allowed to flow on to the upper surface of the rotating drum at a suitably regulated rate and be carried along with the motion of the drum, over its topmost level, draining meanwhile through the perforations in said drum into a suitable interiorly positioned receptacle, and subsequently dropping off the drum as the extremity of its horizontal diameter is approached.

In carrying out the purposes of the present invention, it is proposed to provide a stock-analyzing unit involving a box assembly through which passes the whole volume of stock being supplied to a paper machine, there being continuously diverted from said stock a representative and measured sample which by means of a suitable trough is delivered to the upper exterior surface of a rotating foraminous drum, the drainage through which, being continuously measured, provides a basis for determination of freeness of the stock. It is further proposed to

include in said assembly a device for measuring the consistency of the stock and regulating the same to a predetermined value, whereby to maintain said consistency not only at an optimum value for the process in hand but also at such a predetermined value as to impart quantitative significance to the freeness measurement obtained on the rotating drum.

In the drawings:

Fig. 1 is a top elevation of a stock analyzer embodying the principles of the invention.

Fig. 2 is a side elevation of the same, shown partly in section, as on the line A—A in Fig. 1.

Fig. 3 is a sectional view of an important element of the invention.

Fig. 4 is a diagrammatic representation of an installation of a stock analyzer incorporating the principles of the invention.

Referring now to the drawings:

The numeral 10 designates an assembly including a box portion 11 and a platform portion 12 integrally mounted upon suitable supporting legs 13, whereby the same may be maintained a convenient distance above the floor upon which it rests. The box portion 11 is provided with a lateral opening 14 adapted for connection to a pipe or conduit 15 through which stock to be tested is admitted to said box. In the bottom portion of said box is a rectangular opening 16 communicating by means of a tapered chute or connection 17 with a pipe or conduit 18, whereby stock may be discharged from the apparatus. Positioned within the box 11, on the side toward the inlet opening 14, but displaced therefrom, are two baffles 20 and 21. The baffle 20 which is the closer to the inlet 14 extends substantially to the top of the box 11, and has a fixed opening in its bottom portion. The baffle 21 is formed at its upper edge into a weir of considerably lower level than the top of the baffle 20, and at its lower portion has an opening 22 whose area may be adjustably varied by means of a gate 23 vertically adjustable with respect to the baffle 21 and movable by means of a rod or screw 24, whereby said gate may be raised or lowered, as required. Between the baffle 21 and the wall of the box 11 remote from the inlet 14 the box is open at the top and adapted to contain elements presently to be described. Along the edge of the opening 16, and on the side thereof toward the baffle 21 is a low weir 25, over which the stock, having reached the top thereof, may flow into said opening and be discharged through the chute 17 into the conduit 18.

Mounted upon the platform portion 12 is a box element 27 having its interior in free communication with the main box portion 11, and with its inside bottom surface sloping unobstructedly toward the opening 16 in the bottom thereof. Journalled for rotation about a horizontal axis in the box portion 27 is a drum member 28, whose construction will be more clearly understood by reference to Fig. 3. The essential part of the drum 28 comprises a cylindrical shell 29 formed of formaminous material, such as perforated sheet brass, bronze or stainless steel, having radially extended flange portions 30 of greater diameter than said cylindrical shell. One of said flanges is of discoid conformation, extending to the center of the drum, and having a hub-portion 31 whereby said flange and the whole drum structure is carried as a cantilever from a rotatable shaft 32. On the inner surface of the cylindrical portion, and serving as supports for the foraminous shell 29 is a series of uniformly

spaced radially disposed fins 33, inwardly directed toward the axis of the drum. The shaft 32 is directly attached to a speed reducing mechanism 35 adapted to be driven by an electric motor 36, so that the drum will be caused to rotate at constant velocity in the direction indicated by the arrow in Figs. 2 and 3.

A sloped trough 37, preferably of rectangular section and open at the top, extends from an opening 38 in the baffle 21, a short distance below its upper edge, across the open space in the box 11 between said baffle and the wall which is remote from the inlet 14, passing through said wall and terminating in a portion positioned between the flanges of the rotatable drum 29, having a minimum of clearance therefrom, to provide a substantially water-tight joint therewith, and terminating in close proximity to the foraminous surface of the cylindrical shell 29 and on a line intermediate the extremities of the horizontal and vertical diameters of said shell, on the "rising" side thereof. The slope of the trough 37 where it crosses the open part of the box 11 is made such that, as the stock is extruded through the opening 38, and flows by gravity along the trough, some of said stock will tend to overflow the edges of the trough, spilling into the box beneath, leaving a stream of substantially the section of the trough to pass through the opening in the wall of the box, and flow along the portion of the trough which is juxtaposed to the drum 28. Said last-named portion of the trough 37 is made preferably of a slightly steeper slope than the first-named portion, so that, with the resulting increased speed of passage therethrough, the level of the stock will be lowered sufficiently that there will be no further spilling over the edges, and the stock will be delivered to the surface of the drum at a substantially constant volume per unit time.

While the trough has been hereinbefore stated as terminating at the periphery of the foraminous shell 29 on a line intermediate the extremities of the horizontal and vertical diameters of said shell, the exact location of the end of the trough is a matter of design, and would be determined partially by experiment, and with consideration of the velocity at which the drum would be operated. In general, the arrangement will be such that, as indicated in Fig. 3, the stock deposited on the shell would be drawn away from the trough in an unbroken mat, without any tendency of the material to pile up at the outlet of the trough or to separate as it passes over the upper surface of the shell.

Internally of the drum, and slightly below the horizontal diameter thereof, is fixed an open trough 40, extending across the drum but clearing the inner ends of the radial fins 33. The trough 40 is connected by means of a suitable drainage pipe 41, shown in Figs. 1 and 2, whereby water falling from the inner surface of the drum into the said trough will be collected and drained therefrom. The drainage pipe 41 passes into a vertically disposed cylindrical receptacle 42 having in its lower portion a discharge pipe 43 of fixed opening. A spray pipe 44 terminating in a radially perforated section positioned within the drum 28 below the trough 40, is adapted to be supplied with water under pressure from an external source, whereby to direct upon the inside of the drum a continuous, and substantially horizontal, spray of water to wash the foraminous surface clear of all accumulation of paper stock.

5

The consistency measuring and controlling device, for which, per se, no invention is herein claimed, comprises a vertically disposed cylindrical vessel 45 having midway of its side a T connection 46 attached to the baffle 21, and communicating with the space to the rear thereof through a suitable opening adjacent to, and at approximately the same level as, the opening 38, whereby said vessel will be supported within the open portion of the box 11, and will receive from the stock-filled space to the rear of the baffle a continuous supply of said stock identical in all characteristics with that passing through the opening 38 and the trough 37 to the drum 28. To the lower portion of the vessel 45 is attached a projecting pipe 47 of smaller section area than said vessel, and preferably made angularly adjustable about a horizontal axis so that its outlet may be positioned at any desired level with respect to said vessel. Suitable adjustment may be effected by means of a vertical rod 48, hinged to the swingable portion of the projecting pipe 47, and at its upper extremity threadedly engaging locking thumb nuts 49 bearing upon a bracket 50 fixed to a stationary part of the box 11. There is thus provided an outlet from said cylindrical vessel characterized by a constricted conformation whereby, with a constant rate of inflow, the level of material within said vessel will vary according to its viscosity or consistency.

In order to provide means for expediently determining the levels of liquid, or semi-liquid masses in various parts of the apparatus described, which levels are functions of the several variables which it is desired to measure, there are provided bubbling tubes of conventional type, these being clearly indicated in Fig. 2. A bubbling tube 51 vertically extended into the receptacle 42, terminating near the bottom thereof, provides means for determining the level of water which may accumulate in said receptacle. A bubbling tube 52 extends into the open portion of the box 11, near the weir 25, whereby may be determined the depth, and hence the volume, of material passing over said weir, through the opening 16, and into the chute 17, to be discharged through the conduit 18. A bubbling tube 53 is vertically extended into the cylindrical vessel 45, terminating some distance below the T 46, whereby may be determined the level of stock within said vessel.

In Fig. 4, is shown diagrammatically the arrangement of an installation whereby the invention may be applied to analysis of paper stock. A Jordan engine 55 is adapted to receive a supply of paper stock from a head-box 56 through an adjustable gate 57. The connections associated with said head-box may be of any one of a number of arrangements well known in the art, and forming no essential part of the present invention. For example, stock from the lower part of a beater pump chest 58, circulated by means of a pump 59 may enter said head box through a conduit 60, the stock level within said box being more or less regulated by partitions 61 and 62 over the top of which a flow of said stock may take place. Over partition 61 the stock flows into a compartment communicating with the gate 57, and thence to the Jordan engine, while surplus stock flows over the top of partition 62 into a compartment, whence, by means of a conduit 63, it is returned to the dump chest. A dilution pipe 68 having therein a pneumatically actuated regulating valve 69, and connected preferably between the beater

6

chest outlet and the intake side of the pump 59 provides for a controlled supply of white water to the stock, whereby the consistency of the latter may be effectively regulated.

The bubbling tubes 51, 52, and 53 are supplied with air from a source 70 through suitable flow regulators or valves 71, 72, 73, respectively. The bubbling tube 51 is connected by means of a conduit 75 to a pressure recorder 76, whereby may be obtained a measure of the depth of liquid in the receptacle 42. The bubbling tube 52 is connected by means of a conduit 77 to a recorder 78, whereby may be obtained a measure representative of the volume of stock passing through the analyzer. The bubbling tube 53 is connected by means of a conduit 79 to a combined recording and controlling instrument 80, whereby may be obtained a measure of the depth of stock within the vessel 45, which measure may also be utilized in a pneumatic device of conventional form to control the supply of compressed air from the source 70 to a conduit 81, communicating with the operating element of the valve 69, thereby to regulate the rate of admission of white water to the stock in the head box 56.

Operation of the apparatus embodying the principles of the invention is as follows: A continuous flow of stock from the Jordan engine 55 is delivered through the conduit 15 and the opening 14 into the box 11, where the baffle 20 acts to reduce its velocity of flow, allowing it to pile up back of said baffle and establish a more or less variable head. The stock will then flow beneath the baffle 20 into the space between the same and the baffle 21, where it will rise to such a height to flow over the upper edge of the latter baffle and spill into the open section of the box. The amount of stock flowing over the top of the baffle 21 may be regulated by adjustment of the gate 23, whereby the area of the opening 22 is varied to an extent to by-pass a suitable volume of the stock and maintain the depth over the weir formed by the top of the baffle 21 at a desired, and reasonably constant, level. The greater portion of the stock entering the box 11 will thus pass either over or under the baffle 21 directly into the open part of the box 11 and thence over the weir 25 and through the opening 16 and the chute 17, to be discharged through the conduit 18.

There being established a reasonably constant head above the opening 38 in the baffle 21, there will flow therethrough into the trough 37 a considerable portion of the stock, and the stream should be of such volume as to overflow the edges of said trough, the surplus spilling into the open part of the box 11, and the remainder passing on to the steeper part of the trough at a substantially constant rate of flow, whence it is delivered to the surface of the drum 28. As the stock delivered to the surface of said drum at a level below its uppermost point is carried upward by rotation of the drum, the water will drain through the foraminous surface of the shell 29 passing to the interior thereof, falling into the open trough 40. The inwardly projecting fins 33 will tend to prevent the water being carried downward along the inside surface of the shell, and will cause substantially the whole volume of water which passes through the openings therein to fall into the trough 40. As the mass of stock is carried further from the trough and over the topmost portion of the drum, the loss of water therefrom will cause it to be deposited upon the outer surface in a mat of continually decreasing thick-

ness, until it has been carried to the remote extremity of the horizontal diameter of the shell. There is thus being continuously established under controlled conditions a mat or layer of the stock, from which the water is allowed to drain for a predetermined time interval; and, since the rate of delivery of material to the surface of the drum is maintained constant, the amount of water collected in the trough 40 will at all times be a measure of the freeness of said stock, subject to the maintenance of a constant consistency value.

After the layer of material accumulated on the surface of the shell 29 passes the extremity of the horizontal diameter thereof, it will tend to become detached and drop into the box portion 27, flowing along the sloping bottom surface thereof to rejoin the principal mass of stock passing into the chute 17. The spray directed from the pipe 44 against the interior of the shell 29 will wash said shell clear of all accumulations of stock or slime, and will leave the foraminous surface clean and ready to receive a further deposit of stock as with rotation of the drum it rises to the position of the trough 37.

As the outlet 43 from the receptacle 42 is maintained constant, it follows that the level of water in said receptacle will vary with the rate of drainage of water through the foraminous wall of the drum 28, and will therefore be a measure of the freeness of the stock carried over the drum. As, according to well known principles, the back-pressure of air in the tube 51 as it is bubbled through the water in said receptacle, is proportional to the depth thereof, it follows that the indication or record obtained upon the instrument 76 will be a measure of the freeness of the paper stock under test, and may be directly expressed in suitable units.

Because the sample of stock diverted into the vessel 45 for purposes of consistency determination is obtained at substantially the same location as the sample which passes through the opening into the trough 37 for freeness determination, and because of the homogeneous characteristic of the stock, assured by the distribution due to the baffles 20 and 21, it may be assumed that the sample subjected to consistency determination is in all respects identical to that whose freeness is measured. Because the rate of outflow of stock from the vessel 45 through the extended and constricted pipe 47 will be dependent upon the consistency of said stock, and since the rate of admission is subject to a substantially constant head, it follows that the level of the surface of the stock in the vessel 45 will vary with said consistency, said level rising as the stock becomes more viscous and vice versa. Because the back pressure of air in the tube 53 as it is bubbled through the stock in said vessel will be proportional to the depth thereof, it follows that the measurement obtained by the instrument 80 will be representative of the consistency of the stock, and may be directly expressed in suitable units.

The control mechanism in the instrument 80 being made subject to the measurement obtained upon said instrument, may be caused to vary the pressure of air applied through the conduit 81 to the regulating valve 69, and thus control the rate of admission of white water to the stock about to be delivered to the Jordan. In this way, variations in consistency of the stock under analysis will be immediately detected, and rectified in a minimum of time from the occurrence of any change.

As the amount of stock which is diverted into the trough 37 for the purpose of freeness determination will generally be a negligible proportion of the whole supply of stock passing through the box 11, the volume of material passing over the weir 25 into the outlet 16 may be taken as representative of the total amount of stock received from the Jordan and later delivered to the paper machines. Since the back pressure in the bubbling tube 52 will be a measure of the depth of stock flowing over the weir 25, the instrument 78 connected to said bubbling tube may be calibrated in terms of rate-of-flow of stock through the analyzer; and, if desired, said instrument may be equipped with any one of a number of well known forms of integrator, whereby the total volume of stock handled by the analyzer in any given time may be accurately determined.

The terms and expressions which I have employed are used as terms of description and not of limitation, and I have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

I claim:

1. In a device for determining the freeness of a semi-fluid stock containing suspended fibrous material, the combination of a drum having a horizontal axis and axially displaced radially extending flanges with a foraminous cylindrical surface therebetween, said flanges extending outwardly beyond said surface, said drum being open to atmospheric pressure both above and below said foraminous surface to expose opposite sides of said surface to said pressure, means for rotating said drum at a substantially constant velocity about said axis, means comprising a compartment for maintaining a supply of said stock under a predetermined head, said compartment having an opening in a wall thereof at a predetermined distance below the top of said wall, a trough communicating at one end with said opening, said trough extending downwardly from said opening and terminating at its lower end between said flanges for delivering stock from said compartment to said foraminous surface of said drum on the ascending side of the latter, said trough having a section adjacent said opening of such slope that stock emerging from said opening under a predetermined head spills over the side edges of said trough, said trough also having a section of steeper slope adjacent said foraminous surface of said drum, and means for continuously determining the rate of drainage of water from said stock through a predetermined circumferential portion of said foraminous surface.

2. In a device for determining the freeness of a semi-fluid stock containing suspended fibrous material, the combination of a drum having a horizontal axis and axially displaced radially extending flanges with a foraminous cylindrical surface therebetween, said flanges extending outwardly beyond said surface, said drum being open to atmospheric pressure both above and below said foraminous surface to expose opposite sides of said surface to said pressure, means for rotating said drum at a substantially constant velocity about said axis, means comprising an inclined trough having an end positioned between said flanges for delivering a continuous stream of stock to the exterior surface of said drum on the ascending side to flow over the top thereof, means comprising a compartment having an opening in

a wall thereof for continuously supplying stock to said trough under a substantially constant head, said trough having a steeper slope adjacent said foraminous surface than adjacent said opening, and means for continuously determining the rate of drainage of water from said stock through a predetermined circumferential portion of said foraminous surface.

3. In a device for determining the freeness of a semi-fluid stock containing suspended fibrous material, the combination of a cylindrical drum rotatable about a horizontal axis and having a foraminous surface normally exposed on both sides to atmospheric pressure, said drum having at opposite ends radially extending flanges projecting outwardly beyond said surface, a conduit having an end positioned between said flanges for delivering to the exterior surface of said drum on the ascending side thereof and above a horizontal plane containing said drum axis, a continuous stream of said stock to pass over the top of said drum, means communicating with the interior of said drum for receiving water draining from said stock through said foraminous surface, and means responsive to the height of water

in said receiving means for determining the rate of drainage of water from said stock.

GEORGE S. WITHAM.

#### REFERENCES CITED

The following references are of record in the file of this patent:

#### UNITED STATES PATENTS

| Number    | Name     | Date          |
|-----------|----------|---------------|
| 1,161,168 | Trimbey  | Nov. 23, 1915 |
| 1,653,125 | Schur    | Dec. 20, 1927 |
| 1,945,988 | Witham   | Feb. 6, 1934  |
| 2,027,660 | Wells    | Jan. 14, 1936 |
| 2,203,925 | Poirier  | June 11, 1940 |
| 2,252,014 | Lupfer   | Aug. 12, 1941 |
| 2,272,970 | Frymoyer | Feb. 10, 1942 |
| 2,379,835 | Sisler   | July 3, 1945  |

#### FOREIGN PATENTS

| Number  | Country       | Date         |
|---------|---------------|--------------|
| 492,982 | Germany       | Mar. 3, 1930 |
| 458,978 | Great Britain | 1936         |