April 18, 1944. E. W. SAMSON ET AL 2,346,945

PULP CONSISTENCY TESTING APPARATUS

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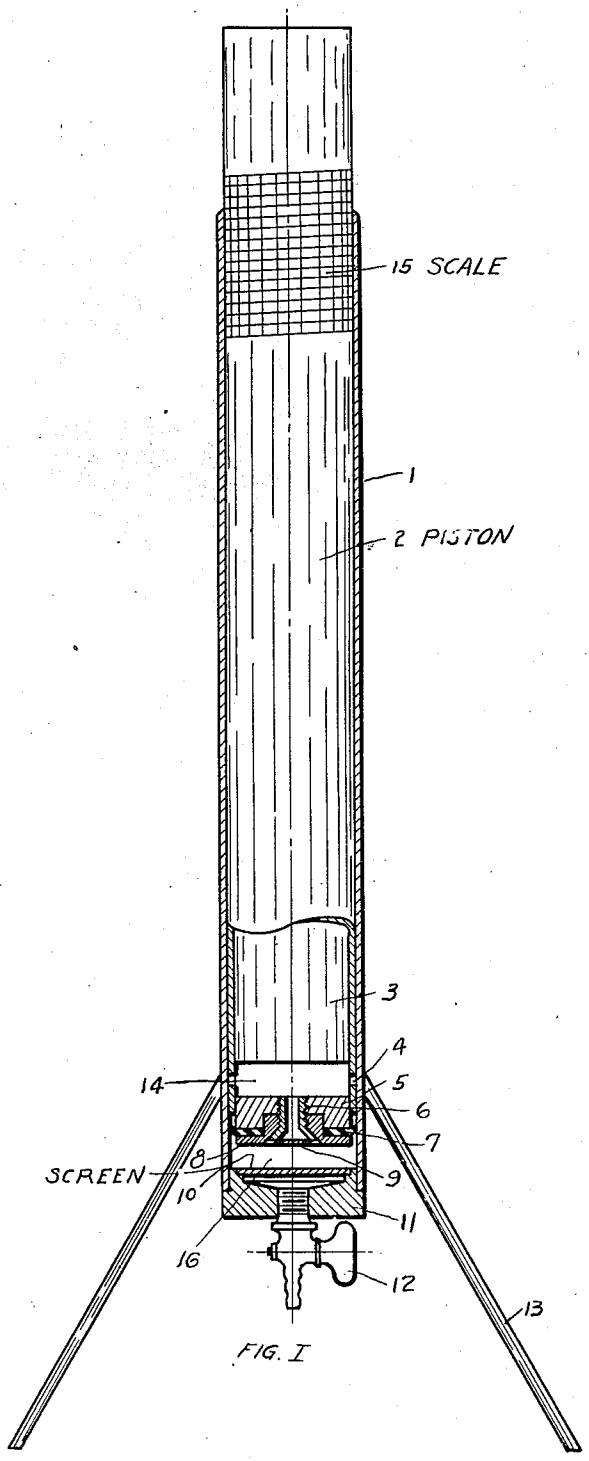


FIG. I

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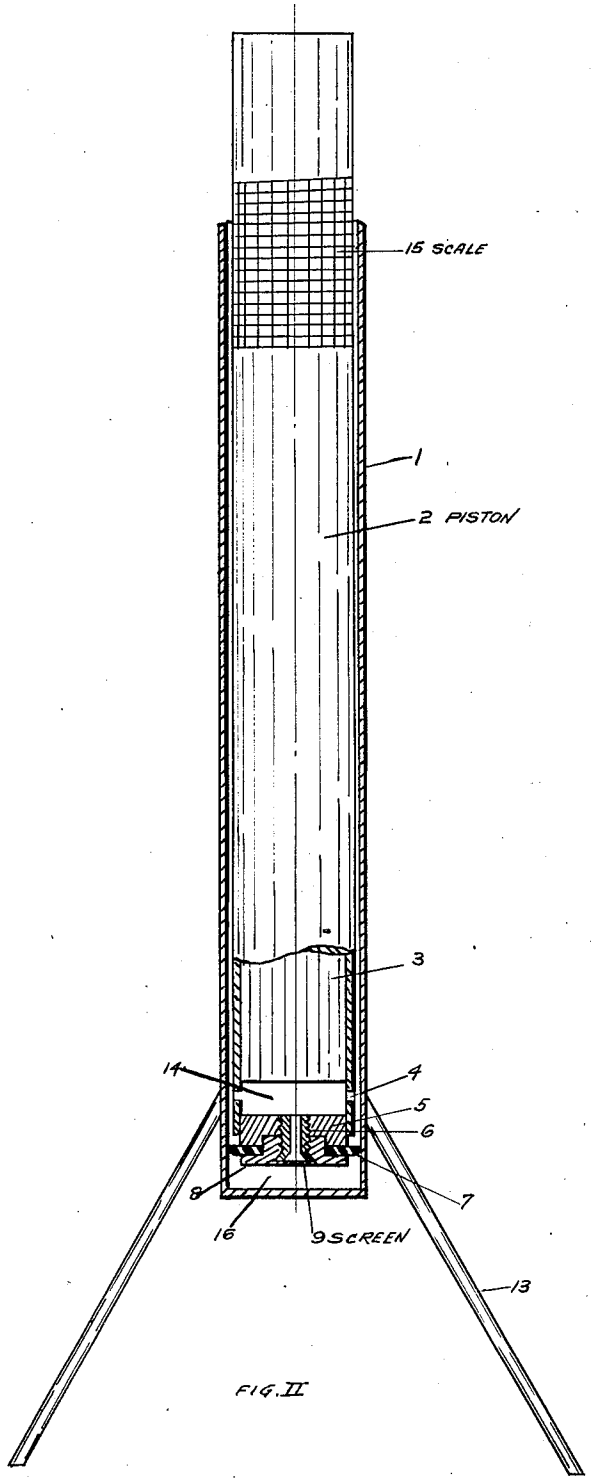


FIG. II

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PULP CONSISTENCY TESTING APPARATUS

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Application September 16, 1941, Serial No. 411,056

1 Claim. (Cl. 73—51)

This invention relates to apparatus for measuring the consistency of a pulp suspension in a liquid medium.

The common practice heretofore in the art of determining the consistency, that is, the oven-dry weight of fiber per unit weight of pulp suspension, in the investigation and control of pulp suspensions in pulp and paper mill operations, has been to dry and weigh the fibers from a measured sample of the pulp suspension, and calculate the consistency. In detail the procedure has been to measure, by weight or volume, a suitable quantity of the pulp suspension, to remove excess water by drainage on a screen or filter, to remove more water by pressing between blotters or by centrifuging, to dry the pulp thoroughly at approximately the boiling temperature of the liquid in an oven or on a hot plate, to determine its weight on a balance, either in an oven or in an airtight container, and then calculate the consistency. This procedure, called the dry test method, of measuring the consistency of a pulp suspension, not only requires a considerable amount of equipment but also is time-consuming, laborious, and frequently too slow for control work. A method and an apparatus are desirable by which the mass of fiber in a measured volume of pulp suspension may be determined quickly and with the required degree of accuracy.

By our invention the measurements of the consistency of a pulp suspension may be made with rapidity and with considerable accuracy. The basic idea underlying our invention is to obtain the volume of a pulp fiber pad, out of which most of the water or other liquid has been squeezed through a screen by the application of a definite constant pressure. Through experiment we have discovered that suspensions in water of similar pulps when subjected to such pressure and drainage in appropriate apparatus are compressed to a volume that depends only on the mass of fibers, no matter what the original consistency of the pulp suspension. The relation of the mass of fibers to the volume occupied may differ for different types of pulps or differently treated pulps, and will vary with the amount of squeezing pressure employed. This property of similar pulps in suspension subjected to constant pressure and to drainage is used as the basis of our new method and apparatus for measuring rapidly, accurately and conveniently the consistency of a pulp suspension.

Our new method of measuring the consistency of a pulp suspension, in a liquid medium comprises squeezing the liquid gradually out of a measured quantity of the pulp suspension under a definite constant squeezing pressure until a final constant volume is reached, measuring the said volume, and comparing this measured volume with calibration data showing the relationship that exists between the said final volume, the said measured quantity, and the consistency of the original pulp suspension, for pulps similar in type to that measured.

One form of apparatus for applying the method, which embodies certain special features, is described in detail below. From this description further objects and advantages will be more apparent.

Figure 1 represents a vertical, elevational view of the measuring apparatus partly in section.

Figure 2 represents another form of the same type of measuring apparatus.

In this device a hollow cylinder 1 open at the top is held in a vertical position by tripod legs 13. It is evident that many other means instead of tripod legs may be used to support vertically the cylinder. The bottom end of cylinder 1 is fitted with a plug 11 which is shaped to hold the attached perforated screen plate 10 and the pet cock 12 below. The screen plate 10 is perforated with holes of a size and number to prevent appreciable escape of fibers through it, while allowing free drainage of liquid.

A long piston 2 may be freely inserted into or withdrawn from cylinder 1 at will. Appropriate clearance is provided between the walls of the cylinder and piston to allow the piston to slide in the cylinder essentially without wall friction. To the bottom end of the piston 2 is secured a plug 5 which is shaped for a hollow screw 6 provided with a small screen plate 9 similar to screen plate 10. A plate 8 for holding a flexible elastic sealing ring 7 is fastened against plug 5 by the hollow screw 6. The piston 2 is loaded with a suitable material to an appropriate weight, in such a way as to leave the chamber 14 between the top of plug 5 and the bottom of the loading material. Holes 4 are drilled through the wall of the piston into the chamber 14 to provide air vents via the hollow screw 6 and the screen plate 9 for any air under the piston, and the air escapes to the atmosphere up through the clearance provided between the walls of the cylinder and piston.

In operation a sample of the pulp suspension in the cylinder 1 is compressed under the weight of the piston 2, squeezing water out, mainly through the screen 10, forming the pulp fibers into a pad in the space 16. A numbered scale 15 for measuring the thickness of the pulp pad, is

based on a pair of spirals each of a certain number of lines per inch and equally spaced apart vertically, engraved completely around the piston. A number of vertical straight lines are engraved across this spiral a certain number of degrees apart. The scale is so designed and placed on the piston that the top of cylinder 1 which has a bevel serves as the reading indicator edge, reading zero when the piston is inserted in the empty cylinder. In reading the scale the point is observed where the spiral line passes the edge of the cylinder, reading vertical divisions down to this spiral and then reading horizontal divisions to the vertical line nearest this point. It is evident that other types of scales may be used to give the thickness of the pad of pulp.

All of the various parts of the above described apparatus are constructed of suitably corrosion resistant and wear resistant materials.

To make a measurement or test, the pet cock 12 is closed and the empty cylinder 1 with the piston 2 removed is quickly filled with the pulp suspension, freshly stirred, of a consistency which for best accuracy should be between about one-tenth per cent and one per cent. For accurate filling it is advisable to allow some of the pulp suspension to overflow the cylinder. The pet cock 12 is then opened, allowing the water or liquid medium to start draining and the piston 2 is inserted in the cylinder 1 as soon as possible to avoid dropping the piston with an impact. The fall of the piston occurs in two stages; the first stage is rather rapid while the bulk of the water is draining off, and the second is rather slow compressing the fibers gradually into a pad under the constant pressure of the weight of the piston. To wait for the "ultimate" settling point would be inconvenient in ordinary measurements or tests for consistency. We have standardized therefore on a time of three minutes for unbeaten pulps and fifteen minutes for beaten pulps at which the scale reading should be made. A variance of plus 30% or minus 15% may be allowed from these times without appreciable errors. When the piston is removed from the cylinder a suction is created between the piston and the pad of pulp causing the pad to follow the piston to the top of the cylinder, where it is easily removable.

For a consistency measurement or test the consistency corresponding to the scale reading is then read from a calibration curve or table.

For calibration, however, tests hereafter called calibration tests are made, in each of which a dry test consistency of the original is also obtained from the pad of pulp. The scale readings from the apparatus and the corresponding dry test consistencies from a series of calibration tests over a range of consistencies on a number of samples of the type of pulp in question are plotted and a smooth calibration curve is drawn, after which the consistency corresponding to any scale reading may be read from the calibration curve or from a table prepared therefrom.

From the calibration data the probable errors of consistency measurements or tests as made with the apparatus may be calculated. In a series of experiments with the described apparatus the probable error was 1.4% of the consistency measured for unbleached spruce pulp and 1.7% of the consistency measured for bleached spruce pulp, made by the sulphite process.

For stock below 0.1% consistency, accuracy is better attained by measuring a larger volume in a graduate cylinder, pouring it all into the tester before inserting the piston, to obtain a readily measurable pad, and multiplying the consistency read from the curve by the dilution factor. For stock above 1% consistency, accurate sampling requires a larger measured volume of sample because considerable clotting of the fibers occurs. The sample is diluted in a definite ratio to bring it to below 1% consistency. The consistency of the diluted sample is measured in the ordinary way and the result is multiplied by the dilution factor.

To assure reasonable accuracy in consistency tests, a given calibration curve should be used only on pulp samples that have received precisely similar treatment within the limits of mill precision, and preferably, on a single tester. Variations from this procedure should be made with caution. A calibration should always be made with a number of different samples of the pulp for which it is to be used. These precautions are simple in routine practice because repeated tests are made on similar pulp from the same place in the mill.

In the operation of this apparatus the air under the piston must be vented, because otherwise the trapped air would cause a sudden drop of the piston when the water or liquid seal drained away, with the destruction of the constant pressure condition required for accurate results, and undue compression of the pad of pulp. Thus the air vents become an important requirement of the form of the apparatus described hereinabove.

A workable device for the same purpose of measuring or testing the consistency of a pulp suspension can also be constructed, as shown in Fig. 2, with the bottom of the cylinder closed and unperforated by placing a screen in the bottom of the piston and having proper channels to allow the escape of both air and water. Although in this form the air is automatically vented we prefer the other form as being more convenient in operation. The only change in procedure with this form of device would be a greater lapse of time before reading the scale.

The sealing member 7 represents our preferred solution of several serious problems which occurred in the development of the illustrated form of apparatus. It should be made of a flexible, elastic material such as rubber, in the form of a relatively thin projecting fin placed horizontally around the bottom of the piston 2, as shown in the drawing. When unflexed, as it is when the piston is removed from the cylinder it is flat, has a diameter slightly larger than the cylinder, and has sufficient clearance to allow adequate flexing in an upward direction when the piston is inserted into the cylinder, and during a measurement. The elastic fin then exerts a pressure against the cylinder wall, which seals against the escape of fibers from the space 16 throughout the downward motion of the piston. Now with this sealing member the frictional resistance to motion, which for accurate measurement must be very constant throughout the motion of the piston, is maintained constant in spite of the normal variations in size and shape along a cylinder made by ordinary methods, and in spite of the inevitable lodging of some small fibers between the sealing member and the cylinder wall, by virtue of the fact that the sealing member can correspondingly alter its shape with only an insignificant change of its pressure against the cylinder wall. Other types of seal have been tried out and have been inadequate for lack of this property.

An adequate seal, at least for some types of

pulp can also be made, but with considerable difficulty, by using a cylinder machined with extreme accuracy, and making a short section at the bottom of the piston to fit the cylinder so as to have a very small clearance and yet slide freely.

The apparatus herein described is essentially a device for accurately measuring the volume of the pulp under a definite, constant squeezing pressure, which is required to apply the method herein described of measuring consistencies. This method of determining the consistency of a pulp suspension is based on a definite property of similar pulps, not heretofore clearly recognized. The apparatus is not limited to making consistency measurements on pulps. It may be used, with obvious variations of procedure, to determine the amount of suspension necessary to contain a predetermined amount of fiber, to obtain a predetermined amount of fiber in the pad itself, or to simply determine the amount of fiber in the pad, all of which are common technical measurements. It may be used in connection with a dry test consistency measurement on the pulp and the appropriate calculation, to measure a new and useful pulp quality index discovered by the use of the instrument and characterizing different pulps by the degree of packing of the pad. The apparatus is not only an instrument for routine and control work but is also an instrument for research and investigation of certain pulp qualities.

The terms and expressions which we have employed are used as terms of description and not of limitation, and we 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.

What we claim is:

An apparatus for quickly and accurately measuring the consistency of a sample of pulp introduced therein, which comprises a cylinder open at the top, a perforated closure member across the bottom of the cylinder, a weighted piston that fits loosely into the cylinder, having at its lower end a sealing member in the form of a flexible, elastic, relatively thin projecting disc-like membrane attached in a horizontal plane around the bottom of the piston, with outside diameter slightly larger than that of the cylinder, and enough free space surrounding it to allow it considerable flexibility in the region between its attachment to the piston and its contact with the cylinder, when inserted therein, thereby sealing against the escape of fibers while still maintaining uniform friction against the cylinder wall throughout the motion of the piston, and having also at the lower end of the piston a perforated plate or screen so disposed and connected to egress channels in the piston as to facilitate the early escape of air from under the piston up through the clearance provided between the walls of the cylinder and the piston.

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