April 18, 1944. A. B. GREEN 2,346,746

CONTINUOUS FREENESS RECORDING METHOD AND MEANS

Filed March 3, 1941

Fig. 1

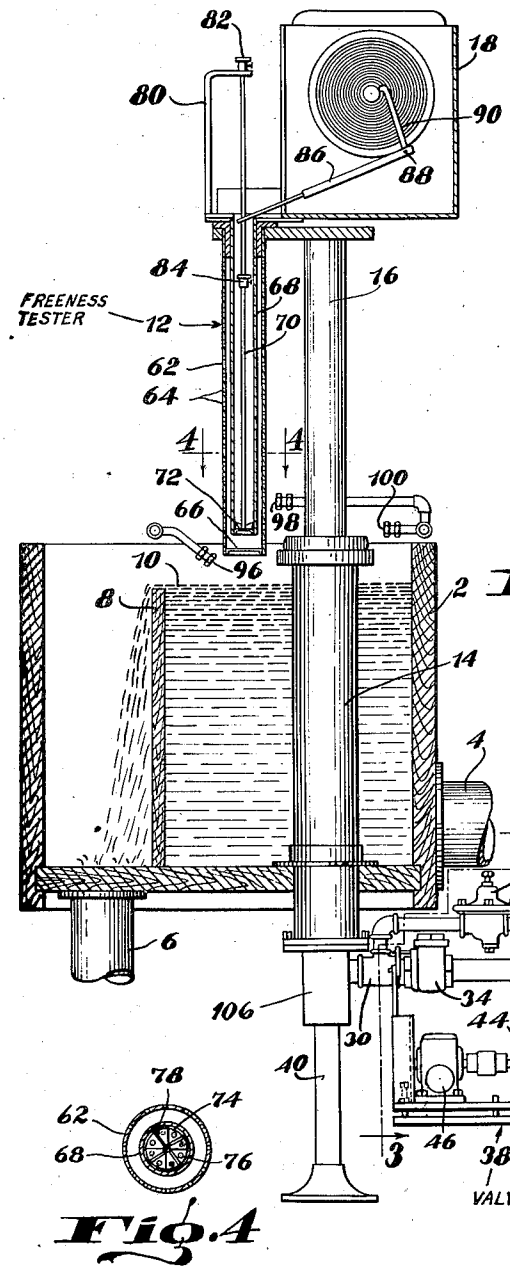


Fig. 2

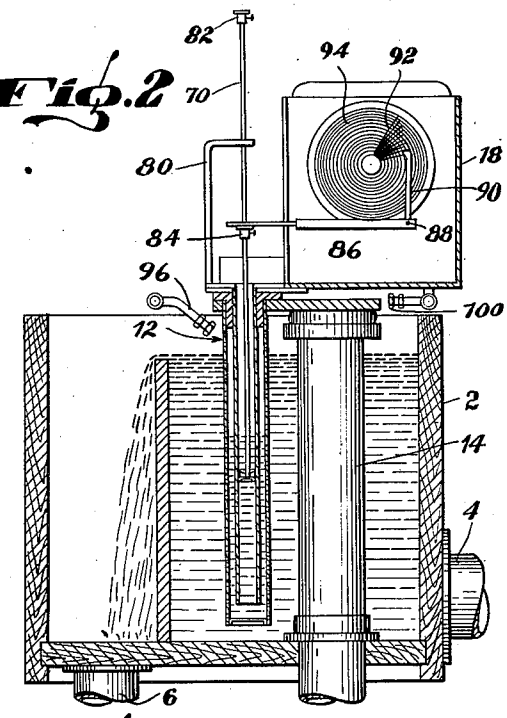


Fig. 5

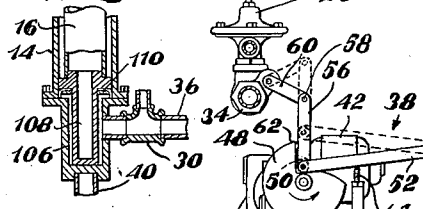


Fig. 3

Fig. 4

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CONTINUOUS FREENESS RECORDING METHOD AND MEANS

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15 Claims. (Cl. 73—51)

This invention relates to the measurement of the rate of release of a liquid from its mixture with solid particles and the recording of such measurement. The invention is particularly related to the manufacture of paper and paper board, for determining the condition of the paper stock prior to its delivery to the forming machines.

When the body of paper stock is in such condition that water will be released rapidly from the solid material, the stock is said to be free. If, on the other hand, the release of water therefrom takes a relatively long time, then the stock is said to be slow. Accordingly, devices for testing such conditions of paper stock are known as freeness or slowness testers. In connection with this application, the invention will be referred to as a freeness tester, although it is to be understood that the device also indicates slowness, the two terms being in effect the reverse of each other.

As paper making stock is prepared, prior to passing to the web-forming machine, it passes through two types of machines, either of which can be used without the other, but both of which are commonly used together. The first type is known as a beater, and operates as a batch process. The second type is known as a refiner, and operates as a continuous process. If the batch beater is employed, either singly or in multiple, the successive batches, when the beater preparation has been completed, discharge to a chest, provided with a mixer or agitator, which serves as a reservoir. It is from such a chest that stock is then drawn continuously for the next paper making process, whether this be continuous refining or continuous web-forming as on the paper or paperboard machine.

Where batch beaters and continuous refiners are both employed, the total work of preparing the stock is shared between them, the batch beaters being the vessels in which the furnish, or composition, of the final product is determined, and the engines in which the preparation of the stock by mechanical treatment is begun. When the stock leaves the batch beaters, in this case, and passes through a reservoir chest to continuous refiners, it usually suffices for practical purposes if the refiners deliver the stock continuously at a specified freeness, during the making of a single grade of product. If continuous refiners perform the entire stock preparation, it is essential that they deliver the stock continuously at a specified freeness during the making of one grade of product.

Owing to the variable paper making properties of untreated fibrous pulps, which arise from the random growth of woods and other plant sources of fibre, it is not possible to deliver a specified freeness uniformly by maintaining a uniform adjustment of the refining equipment. On the contrary, the adjustments of the refining equipment must be changed constantly in such way as to compensate for the unavoidable variables in the paper making properties of incoming pulps, and for the further variables in the response, or yield, of fibrous pulps to the mechanical stock preparation treatments. In order to effect such compensations, it is essential that the operator in charge be able to see what freeness of stock is being delivered, so that he may observe any variations from a specified freeness immediately, and readjust the refining equipment to make proper and accurate corrections.

Heretofore it has been customary to remove from the stock periodically for testing purposes samples which then pass to a laboratory or to a manual tester; or to introduce into the stock a freeness tester of the type disclosed in the patent to Arthur B. Green, No. 1,985,321, periodically and to make a freeness reading therefrom. However, such methods have proven unsatisfactory, as such readings do not keep the operator of the refining equipment continuously informed, and they further require extra labor. In consequence, departures from a specified freeness may occur and pass undetected, and the quality of the product may be correspondingly impaired, and the productivity of the web-forming machine may be correspondingly limited; also a special labor cost is incurred, increasing the total cost of production.

According to the present invention, the freeness testing device is combined with a mechanism which produces a series of tests at predetermined intervals and records the result of each test in a permanent record for continuing inspection by the operator. Thus, by employing time intervals between tests sufficiently short, the operator is informed immediately of variations from a specified freeness and is able to make immediate corrections by readjustment of the refining equipment, and maintain correctly that freeness which will produce the desired product.

A further object of the invention is the provision of a freeness tester with means for introducing it into the stock uniformly and periodically while the stock is undergoing treatment, combined with means for recording the results of each test. Thus, by the elimination of the variables

that have inevitably appeared in tests made according to methods heretofore used, the resulting running record made by this invention will give a reliable report of the freeness at the time of each test. As previously stated, however, control of the stock density and temperature is assumed as indicated freeness varies with changing density and temperature.

These and other objects of the invention will appear more fully as the description and explanation of the invention proceed, with the aid of the accompanying drawing, in which;

Fig. 1 is a side elevation of the invention, part being in section, showing the freeness tester in the position it normally assumes between the periodically made tests.

Fig. 2 is a side elevation of the invention, also partly in section, with the freeness testing mechanism immersed in the paper stock.

Fig. 3 is an end elevation on the line 3—3 of Fig. 1.

Fig. 4 is a section on the line 4—4 of Fig. 1.

Fig. 5 is a detail of cushioning means used to check the descent of the piston.

Referring to Fig. 1, a flow box 2 is connected to carry stock by intake pipe 4 and outlet pipe 6. A dam 8 provides for the maintenance of a constant level of stock as at 10. The stock, as it flows in through pipe 4 and out through pipe 6, is representative of the stock under treatment. Thus, any tests made on the stock within the flow box will be representative of tests of all stock moving toward the web-forming machine. It will be understood that the stock is flowing into flow box 2 continuously through intake pipe 4 and likewise is flowing continuously over the dam 8. As a result, the stock in the flow box is in continuous movement and is being continuously replaced by the new stock being added from intake pipe 4. There is never any dead or stationary stock in the flow box so that any tests that may be made thereon will always be made on the newly arriving and continuously changing incoming stock.

An immersion freeness tester 12 is mounted on means designed to provide for periodic immersion of the tester into the stock of the flow box. A construction that has been found convenient is shown in the drawing and consists of a cylinder 14, a piston 16 carrying tester 12 and vertically movable within the cylinder, an automatic recording mechanism 18 and control means, referred to generally at 20, for automatic lowering and raising of piston 16 and immersion and removal of the freeness tester 12.

Through the operation of control means 20, the freeness tester 12 is periodically introduced into the stock in the flow box 2, a recording of the degree of freeness at that time is made on the recording mechanism 18, all followed by subsequent removal of the freeness tester until such time as the operation is repeated. Thus, as the freeness of the stock in the flow box changes, such change will be noted and recorded through the periodic immersion of the tester.

While one form of tester of the immersion type is disclosed, it is to be understood that any other suitable type of tester capable of giving a recordable reading may be used, and likewise the means for introducing the tester into the stock may be varied.

The control mechanism for raising and lowering piston 16 operates as follows. Connected in order to a water supply pipe 22 are shut-off valve 24, strainer 26, pressure regulator 28, T 30 and fitting 106, the latter of which connects with the bottom of cylinder 14. The other outlet of T 30 connects with quick acting valve 34, which in turn is connected to discharge pipe 36. Quick acting valve 34 is controlled by a suitable mechanism generally referred to at 38 and shown in Figs. 1 and 3.

For purposes of rigidity and general support, an extension 40 placed beneath the fitting 106 supports the piping and cylinder structure. This, however, is but illustrative and any other type of suitable support may be used with equal effect.

Water entering pipe 22 under suitable pressure exerts an upward force against the end of piston 16 to drive the latter upwardly to the limiting position shown in Fig. 1. Valve 34 at this time is closed, and with the piston in upward position, no further flow of water through pipe 22 takes place. If, however, quick acting valve 34 is opened so that not only the incoming water may escape through discharge pipe 36, but also the water within cylinder 14 under the influence of the downward pressure of piston 16 and its associated structure, it is apparent that piston 16 will move downwardly at a rate determined by the dimensions of the various parts and the water pressure as controlled by valve 24 and pressure regulator 28.

As the load on piston 16 is constant, it is obvious that the rate of descent of the piston upon the opening of valve 34 will be the same on each occurrence, except as it may be affected by resistance of the stock to entrance of the freeness tester 12. For all practical purposes, however, the time of the descent of the freeness tester 12 into the stock is substantially the same on each test. This being so, it is apparent that a mechanism has been provided which is capable of immersing the tester repeatedly into the stock at the same rate and within the same time interval.

The means for controlling the operation of valve 34, which in turn controls the movement of piston 16, is shown in Figs. 1 and 3 and referred to generally as at 38. This mechanism comprises an electric motor 42 which through reduction gearing 44 and 46 rotates cam 48 counter-clockwise, as indicated in Fig. 3. The gearing may be adjusted to give the cam any desired speed of rotation, it being contemplated, however, that for each revolution of the cam, there will be one complete reciprocation of piston 16.

Resting on cam 48 is a cam follower 50 which is supported in position by lever 52, pivoted at 54. As cam 48 rotates, follower 50 will move up and down and will carry with it lever 56, which in turn is pivoted at 58 to arm 60 of valve 34. Upward movement of arm 60 closes valve 34; downward movement opens it. In the position shown in Fig. 3, valve 34 has just been opened.

An adjustable stop 61, positioned to engage lever 52, serves to limit the downward movement of arm 60. Thus, by suitable adjustment of stop 61, the extent of opening of valve 34 may be controlled, and in this way the desired rate of descent of piston 16 may be achieved.

With the automatic immersion mechanism in operation and with cam follower 50 on the large circumference or dwell portion of cam 48, arm 60 will be in the dotted line position (Fig. 3) and valve 34 closed, and piston 16 and freeness tester 12 will be in the position shown in Fig. 1. As cam 48 rotates, follower 50 will finally drop off the high part of the cam at the terminating edge 62 to assume the position shown in Fig. 3. This immediately opens quick acting valve 34 so that descent of piston 16 commences. This continues until such time as the piston and associated parts

reach the position shown in Fig. 2. In the meanwhile, rotation of cam 48 has proceeded and valve 34 is gradually closed. Closure, however, is timed to take place only after the immersion tester 12 has been in the stock a sufficient period to give the desired indication and recording. Finally, however, valve 34 closes so that water can no longer escape through discharge pipe 36, and as a result, piston 16 is driven upwardly to resume the position of Fig. 1. This action is repeated again and again and at uniform intervals as determined by the cam rotation speed.

The freeness tester 12 is substantially the same as that disclosed in the Green Patent No. 1,985,321, previously referred to, and consists of a cylindrical body 62 having therethrough a plurality of suitably sized perforations 64. Body 62 could if desired be composed of screening or any other material that would permit suitable infiltration of water when immersed in the pulp stock. The lower end of body 62 is closed by end member 66. Within and positioned coaxially therewith is an imperforate tube 68 open at its lower end. Inside of tube 68 is a movable rod 70 having on its lower end a resistance element 72 so designed as to permit controlled passage of liquid thereby. A suitable form of resistance element is shown in Figs. 1 and 4, in which there is a bottom disk 74 perforated at 76 and carrying thereabove a plurality of angularly set blades 78. Water passing upwardly through perforations 76 will impinge on the blades 78 to cause rotation thereof.

The upper end of rod 70 is guided by bracket 80 and a stop 82 limits the downward motion of rod 70 and element 72 within tube 68. Another stop 84 on rod 70 acts as a means for making engagement with a lever arm 86 of the recording mechanism 18. The recording mechanism 18 is shown diagrammatically as the particular construction thereof does not constitute part of this invention. However, it will be seen that if lever 86 is swung upwardly about its pivot at 88, arm 90 will be swung to the right to make a permanent record of its movement as at 92 on the rotating paper disk 94.

In Fig. 5 is shown a detail of the construction of the lower end of the piston, which includes special cushioning means for eliminating any shock to the recording apparatus that would otherwise occur at the completion of its descent.

The lower end of cylinder 14 terminates in a tubular portion which forms what may be called a cushioning cylinder, as at 106. It is at this reduced section that the T 30 is connected, with a portion of the cushioning cylinder extending therebelow. The piston 16 has extending from its lower end a secondary piston 108 shaped to fit relatively closely within the confines of the cushioning cylinder 106. Primary piston 16 also has at its lower end a cup packing 110 which seals the piston 16 and cylinder 14 against leakage.

As piston 16 descends following the opening of valve 34, secondary piston 108 will finally reach the entrance to the cushioning cylinder 106, when the recording apparatus is close to the bottom of its movement. As soon as secondary piston 108 enters cushioning cylinder 106, which may be considered that part below the connection to T 30, and in turn discharge pipe 36, the downward travel of piston 16 and associated parts will be slowed, due to the fact that the fluid imprisoned in the bottom of cushioning cylinder 106 can escape upwardly past secondary piston 108 to pass into discharge pipe 36 but slowly. This results in a gentle easing of piston 16 to its final position of rest and insures that there will be no jarring of the recording apparatus at the termination of its downward movement. As a result, the recordings made thereon will be accurate and in accordance with the exact movement of rod 70.

Operation of tester

As the tester is immersed in the stock, water from the stock will immediately begin to filter through perforations 64. The water will flow to the bottom of the cylinder body 62 and then upwardly into tube 68. Since the resistance element 72 resists the upward movement of water in the tube, it and rod 70 will be carried upwardly along with the water, lagging somewhat behind as water passes through perforations 76 of the resistance element. This, of course, moves stop 84 into engagement with lever 86 and recording arm 90 commences its swing to the right.

At the outset, the inflow of water through perforations 64 is rapid, but as the stock accumulates on the outside of the cylinder body 62 to gradually block perforations 64, passage of water to the interior becomes slower so that the rate of rise in tube 68 decreases.

It will be apparent, therefore, that a point will finally be reached at which the rate of descent of resistance element 72 and rod 70 through the water in tube 68 will exactly equal the rate of rise of the water column. At this point, the upward movement of rod 70 ceases and arm 90 will have moved its maximum distance to the right to complete the recording on that test. Thereafter, as rod 70 descends, further rise of the water column within tube 68 is immaterial and valve 34 may be closed to cause withdrawal of the tester from the stock to its original position as in Fig. 1.

As the tester is withdrawn from the stock, the water which has collected within body 62 and tube 68 reverses its direction and flows outwardly through the perforations 64, causing the fiber mat on the outside to leave the screen and to fall back into the stock along with the flushing water, thus bringing the tester to condition for the next test.

In addition, the mat removal, that normally takes place as the tester is withdrawn from the stock, as just described, may be assisted by spray nozzles 96 and 98 which are provided to give sufficient additional washing effect as the tester is withdrawn to drive any residue therefrom. Nozzle 100, directed at piston 16, cleans the latter to insure uniform performance. These nozzles receive their water supply from any convenient source and may be brought into operation by any convenient means upon the commencement of upward movement of piston 16 to be shut off when the upper limit of travel is reached.

Summary of operation

The complete operation of the invention is as follows. Paper stock flows continuously into flow box 2 and is maintained at a constant level therein by dam 8. Cam 48, which controls the fall and rise of piston 16, rotates at a constant speed and valve 34 is opened and closed at equal intervals. Upon opening of valve 34 as cam follower 50 drops off edge 62 of cam 48, the freeness tester 12 is immersed in the paper stock, rod 70 rises to a maximum point determined by the rate of rise of water in tube 68, which rate of rise is dependent upon the freeness of the stock at that instant. Arm 90 is swung to the right and makes a per-

manent record of the maximum rise of rod 70. Thereafter the tester is removed from the stock as further rotation of cam 48 brings the cam follower to a position where valve 34 is closed and the entire unit is at that time reset for the next test.

As the treatment and flow of stock continue, the stock within flow box 2 may become slower or freer and on the next test the water entering body 62 through perforations 64 will do so at a slower or faster rate, due to the change of character of the stock that accumulates over the perforations. As a result, the rate of rise of the water within tube 68 will be less or more and the corresponding movement of arm 90 to the right will be less or greater. Successive tests therefore give a running record of the variations in freeness of the stock, the point of reading on the recording mechanism being the outer end of the mark. Through suitable calibration of the tester, the recordings will indicate directly the freeness, so that the operator in charge of stock treatment will know immediately by mere reading of the recorder when the stock is at the desired freeness to go to the machines.

While a preferred construction has been illustrated and described, it is recognized that other means may be used for controlling the immersion and withdrawal of the tester from the stock. For example, air instead of water could be used to control the piston operation.

However, whatever the particular means for controlling the immersion of the tester is, it is to be understood that it is to be immersed at determined intervals of time and at the same rate, whereby any change in reading on the recorder will be an indication of a corresponding change in freeness. Likewise, it is to be understood that the particular construction of the immersion tester itself may be varied so long as the requisites of operation are the immersion of the tester into the stock on each test at the same rate and to a fixed depth. Furthermore, it is understood that the invention is to be limited only by the appended claims.

I claim:

1. Means for testing and recording the freeness of paper stock, comprising a constant level flow box containing paper stock to be tested, an immersion type freeness tester, means for recording the result of each test made by said freshness tester on said paper stock, and means for periodically and uniformly immersing said freeness tester into said paper stock and then withdrawing it from said stock after each test has been recorded.

2. Means for testing and recording the freeness of paper stock, comprising a constant level flow box containing paper stock to be tested, an immersion type freeness tester, means for recording the result of each test made by said freeness tester on said paper stock, and means operated by fluid under pressure for automatically conducting a series of uniform tests at predetermined intervals, each test comprising the movement of said tester into and out of said stock.

3. Means for testing and recording the freeness of paper stock, comprising a constant level flow box containing paper stock to be tested, an immersion type freeness tester, means for recording the result of each test made by said freeness tester on said paper stock, means for automatically conducting a series of uniform tests by immersing said tester to a fixed depth at a determined rate at predetermined intervals, said uniform test means including means for cleaning said freeness tester of paper stock after each test, whereby the conditions at the commencement of each test will be identical.

4. Means for testing and recording the freeness of paper stock, comprising a constant level flow box containing paper stock to be tested, an immersion type freeness tester, means for recording the result of each test made by said freeness tester on said paper stock, means for lowering said freeness tester into said paper stock tc a fixed depth and at a determined rate at predetermined intervals, and means for subsequently withdrawing said freeness tester from said paper stock prior to the time of making the next test.

5. Means for testing and recording the freeness of paper stock, comprising a receptacle containing paper stock to be tested, means for maintaining a uniform level of said paper stock, an immersion type freeness tester, means for recording the result of each test made by said freeness tester on said paper stock, means for immersing and withdrawing said freeness tester into and from said paper stock at predetermined times, said immersing and withdrawing means comprising a fluid operated piston, a valve controlling the pressure of fluid against said piston, and means for opening and closing said valve at predetermined time intervals.

6. Means for testing and recording the freeness of paper stock, comprising a receptacle containing paper stock to be tested, means for maintaining the level of said paper stock in said receptacle at a constant point at the time of each test, an immersion type freeness tester comprising a perforated element, a tube within said element for receiving liquid that may pass through said perforated element, a resistance element movable vertically within said tube, means for recording the result of each test made by said freeness tester on said paper stock in accordance with the vertical movement of said resistance element under the influence of a rising column of liquid within said tube, and means for automatically conducting a series of uniform tests at predetermined intervals by the introduction of said tester into said paper stock to a predetermined depth and at a predetermined rate, said last means comprising a fluid operated piston, a valve controlling the pressure of fluid against said piston, and means for opening and closing said valve at predetermined time intervals.

7. Means for testing and recording the freeness of paper stock, comprising a receptacle containing paper stock to be tested, an immersion type freeness tester, means for recording the result of each test made by said freeness tester on said paper stock, means including a piston and cylinder for repeatedly lowering said freeness tester into said paper stock to a fixed depth in a substantially uniform time at predetermined intervals, and means for decreasing the rate of descent of said freeness tester as it approaches the bottom of its travel, said last named means comprising an extension at the end of said cylinder of reduced cross sectional area and a projecting portion on the end of said piston adapted to enter said cylinder extension as the piston approaches the end of its travel.

8. Means for testing and recording the freeness of paper stock, comprising a receptacle containing paper stock to be tested, a freeness tester, means for lowering said freeness tester into said stock in a substantially uniform time to a fixed

depth during each test, and means for slowing the rate of descent of said tester into said stock as it approaches the bottom of its travel to prevent detrimental jarring of said tester.

9. The method of determining the freeness of paper stock, comprising the steps of continuously supplying paper stock to be tested to a receptacle and maintaining it therein at a constant level and in continuous motion, immersing a freeness tester into said stock to a predetermined depth and at a predetermined rate, allowing said tester to remain in said stock until the result of said test has become known and recorded, then withdrawing said tester from said paper stock and thereafter repeating the aforesaid steps at predetermined time intervals.

10. The method of determining the freeness of paper stock, comprising the steps of continuously supplying paper stock to a receptacle and maintaining it therein at a constant level and in continuous motion, immersing a freeness tester into said paper stock at predetermined time intervals and to a fixed depth and at a predetermined rate, allowing said freeness tester to remain in said paper stock until the test is completed, recording the result of said test, and finally emoving said tester from said paper stock.

11. The method of determining the freeness of paper stock, comprising the steps of continuously supplying paper stock to a receptacle and maintaining it therein at a constant level, immersing a freeness tester into said paper stock at predetermined time intervals and to a fixed depth and at a predetermined rate, allowing said freeness tester to remain in said paper stock until the test is completed, recording the result of said test, and finally removing said freeness tester from said paper stock and at the same time cleaning it of paper stock which may have accumulated thereon during the making of the test.

12. Means for testing and recording the freeness of paper stock, comprising a receptacle containing paper stock to be tested, means for maintaining the level of said paper stock in said receptacle at a constant point at the time of each test, an immersion type freeness tester comprising a perforated element, a tube within said element for receiving liquid that may pass through said perforated element, a resistance element movable vertically within said tube, means for recording the result of each test made by said freeness tester on said paper stock in accordance with the vertical movement of said resistance element under the influence of a rising column of liquid within said tube, and means for automatically conducting a series of uniform tests at predetermined intervals by the introduction of said tester into said paper stock to a predetermined depth and at a predetermined rate.

13. Means for testing and recording the freeness of paper stock, comprising a constant level flow box containing continuously moving stock, means for progressively forming a single vertically disposed mat within said stock, means for maintaining said mat in a fixed position within said stock for a time long enough to complete a test, said mat forming means being in the form of a screen through which water may pass, means for measuring and recording the relative rates of flow of water through successively formed individual mats while said mats are held stationary in said stock, and means for returning the material of each mat and the water whose flow has been measured to said flow box.

14. In combination with a flow box through which paper stock to be tested is flowing, a freeness tester and recorder movable as a unit with respect to said flow box, fluid-operated means for raising and lowering said unit into and out of said flow box, timing means for setting said fluid-operated means in operation at uniform intervals, means for forming a mat of paper stock on said tester when immersed in said stock, means for holding said tester stationary in said stock after immersion therein, means for measuring the rate of flow of water through said mat without removing any water from said flow box, and means for causing operation of said recorder for recording the rate of flow through each individual mat so formed.

15. In combination with a constant level flow box through which paper stock to be tested is flowing, mat forming means, means for immersing said mat forming means in said stock thereby to cause the automatic progressive formation thereon of an individual mat of paper stock of determined area, means for measuring and recording the rate of flow of water through the paper stock as it is progressively developing as a mat on said mat forming means, said mat forming means so constructed that removal from said paper stock will cause the return of said mat and the water whose flow has been measured through the reversal of water flow, to said flow box, and means for causing the periodic immersion and removal of said mat forming means into and out of said paper stock to be tested.

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