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SLOWNESS TESTER FOR PAPER STOCK

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Fig. 1.

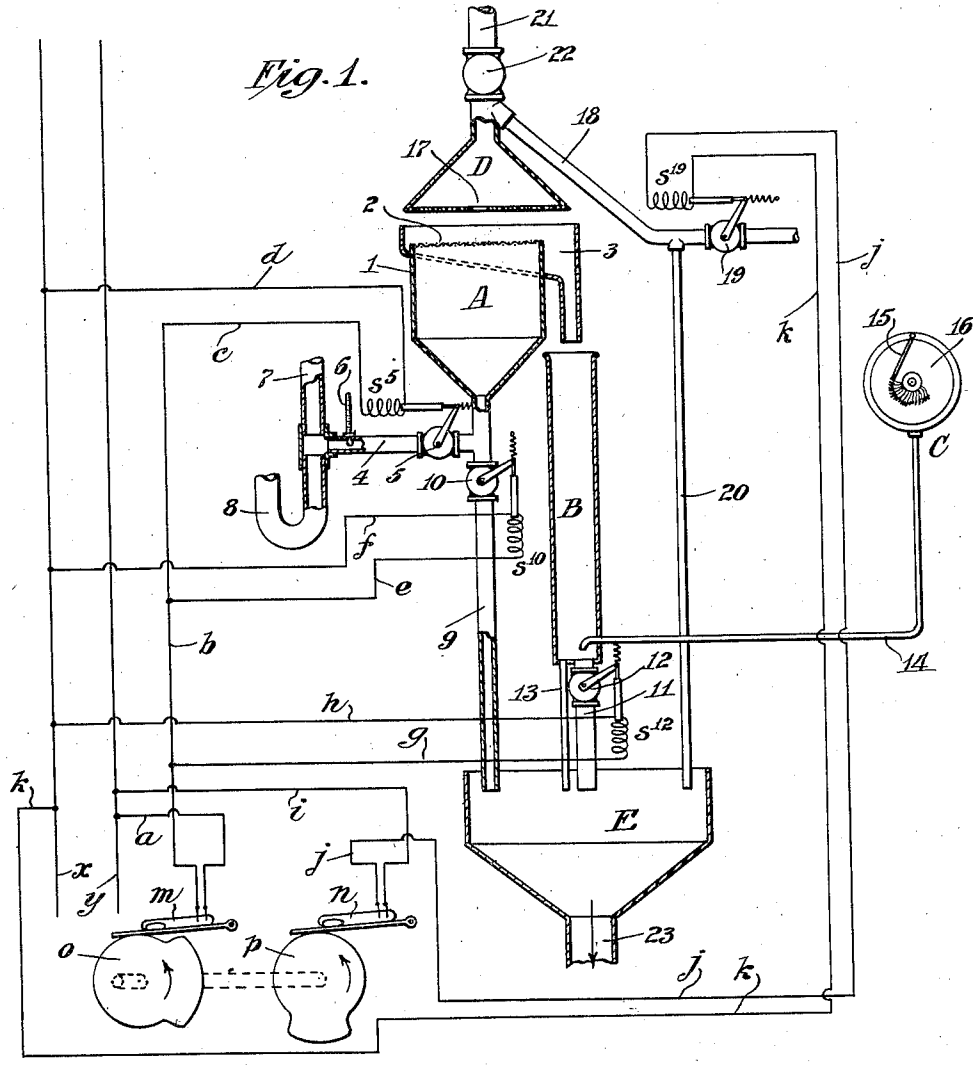
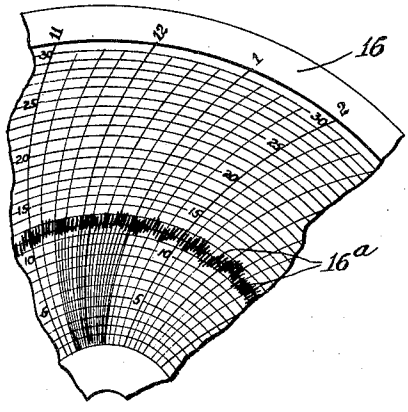


Fig. 2.



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SLOWNESS TESTER FOR PAPER STOCK

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This invention relates to apparatus for testing the slowness of the paper stock which is fed to a paper machine, and the object thereof is to provide a simple, efficient, and reliable apparatus for automatically determining and recording such slowness at regular intervals.

In the manufacture of paper, the stock is prepared for the paper machine and for the kind of paper to be made chiefly in beaters, of one type or another, by which its fibers are beaten out and hydrated. As hydration proceeds, the stock tends to give up its water less and less freely, as on the drainage wire of the paper machine for instance. Hence, a stock which has been hydrated to a comparatively low degree and so gives up its water more or less freely is known as free, while a stock in which hydration has been developed to a high degree is known as slow.

The slowness of the paper stock is of prime importance, since on it largely depend not only the physical properties of the paper made therefrom but also the speed at which the paper machine can properly be run. For example, other things being equal, the slower the stock the greater will be the bursting strength and the smoother will be the finish of the paper; and if the stock is too slow on the wire of the machine it will necessarily go very wet to the presses, with the result that the paper may crush, cockle, or be too dense, too low in strength, or too tinny or brittle. In any event, uniformity in the quality of the finished paper cannot be obtained without uniformity in the slowness of the stock.

The present standard practice in testing the slowness of paper stock is substantially as follows: A sample of the stock is obtained and, as the results from the apparatus employed are very much affected by consistency, is first subjected to a preliminary consistency test—ordinarily by weighing a small portion of the sample, bone-drying it, weighing the dry residue, and then adding to the main part of the sample water sufficient to give it a standard thin consistency of say 0.3 per cent., i. e., 0.3 per cent. of fiber to 99.7 per cent. of water. A measured portion of the sample thus prepared, usually a liter, is then placed in a container having a bottom of wire mesh which is mounted over a funnel-shaped receptacle provided with a small orifice in its bottom and a larger orifice in one side somewhat above the bottom. The water in the sample drains through the strainer bottom of the container while the fibers therein are deposited and form a mat thereon, the rate of drainage, dependent on the slowness of the stock, being comparatively rapid at first but decreasing as the head of the stock in the container lowers and the thickness of the mat of deposited fibers increases. As the water drains from the container into the funnel below, it cannot all flow through the restricted orifice in the bottom of the latter during the initial rapid drainage but backs up therein and runs out through the side orifice, whence it is conducted into a graduated measuring glass, but as the drainage slows up the bottom orifice shortly becomes sufficient therefor and the water in the funnel then sinks below and ceases to flow through the side orifice. The amount of the overflow water collected in the measuring glass thus measures the slowness of the stock. For example, with a very free stock such as an unbeaten sulphite pulp, the measuring glass will receive about 700 of the 1000 cubic centimeters of the sample used in the test, and as the hydration of the stock is developed lower and lower readings will be obtained therein until, carried to an extreme as in the case of stock for glassine paper, the measuring tube will receive only 20 to 30 cubic centimeters of the overflow water. The slowness test is usually run twice from the prepared dilute sample, between and after which the apparatus has to be thoroughly washed and rinsed. A slowness test as outlined usually takes from twenty to twenty-five minutes, including the determination of consistency.

By my present invention I have provided an apparatus which, while certain of its parts may be manipulated to make tests whenever and as often as desired, in its entirety is automatic in its operation and will accurately make and record slowness tests in a continuous series and at regular short intervals, say every three minutes.

One practical embodiment of the invention is shown, by way of illustration and not of limitation, in the accompanying drawings, in which—

Figure 1 is a more or less diagrammatic view showing the apparatus partly in elevation and partly in vertical section and the mechanism and electric circuits by which its valves are automatically controlled; Fig. 2 is the face view of a portion of a chart on which a series of slowness tests has been recorded.

Paper stock, usually of a fairly thick consistency—in the neighborhood, say, of 2 to 3 per cent.—is ordinarily fed to the paper machine through a stuff gate into a stream of white water, which is the drainage water recirculated from the paper machine, and the resultant stock, thus thinned to a consistency, usually, of 0.3 to 0.8 per cent. generally depending upon the kind of paper to be made, passes through rifflers and thence by gravity to the screens, in many mills located from three to four feet below the rifflers, and from the screens flows directly to the paper machine.

The apparatus, which as shown comprises as its principal parts a wire-head A, stand-pipe B, recording pressure-gauge C, shower-head D, and catch-bowl E, will usually be installed in a convenient position generally adjacent to the rifflers and screens and connected therewith, to receive a flow of the diluted stock from the bottom of the rifflers, since I have found that the apparatus, unlike the old testers described, is not very sensitive to consistency variation and that the accuracy of the slowness tests as made and recorded thereby is not seriously affected by any ordinary variations in the consistency of the stock in the rifflers.

The wire-head A consists of a chamber 1, with a strainer-head or top 2 of wire mesh, which may be strengthened, if found desirable, by a backing of heavier and coarser wire mesh (not shown) preferably so applied to the upper side of the head that no fibers will be caught between the two sets of wire mesh. The upper end of the wire-head is surrounded by a collecting cup 3, which discharges at one side into the open head of the stand-pipe B; and at its lower funnel-shaped end is connected by a pipe 4, controlled by an inlet-valve 5 and preferably equipped with a thermometer 6 to register the temperature of the stock therein, to a T-connection the upper end 7 of which is connected to the bottom of the rifflers and the lower end 8 to the screens, and is also connected by a pipe 9, controlled by a drainage-valve 10, with the catch-bowl E. Thus, when the mill is in operation, a steady stream of diluted paper stock will flow from the rifflers through the T-connection and thence either to the screens or, when the inlet-valve 5 is open, in part at least to the wire-head which, it is to be understood, is located at a level sufficiently below that of the screens to provide the desired pressure of the stock within the wire-head. The connections shown provide a constant circulation of the stock, which it is well to have, and avoids the necessity for a pump with which to pump the stock from the lower branch of the T-connection back, say, into the riffler box.

The stand-pipe B has at its lower end an outlet-pipe 11, which is controlled by a drainage-valve 12 and discharges into the catch-bowl below, and, preferably also as shown, a pipe 13 of small diameter which provides a restricted drainage outlet.

The pressure recorder C, which is or may be a liquid-level gauge of standard type, comprises as usual a pressure-pipe 14 the mouth of which is here located within the stand-pipe adjacent its lower end, and a pivoted arm 15 carrying a pen adapted to bear on the face of a rotating paper chart 16. For some paper stocks, the mouth of the pressure tube may be equipped with a standard diaphragm box (not shown) provided with a fine rubber diaphragm, to prevent any possible clogging of the pipe by fine fibers which may pass through the wire-head and into the stand-pipe.

The shower-head D, here provided with an additional enlarged spray opening 17 directly over the center of the wire-head A, has a water supply-pipe 18 which is controlled by an inlet-valve 19 and, preferably, is also equipped with a drip-pipe 20 so located as to drain into the catch-bowl the upwardly inclined end of the supply-pipe and any water which may leak through the valve when closed. And to provide for the rapid drainage of the shower-head when the water is shut off at the valve, it is equipped at the top with an air inlet-pipe 21 controlled by a check-valve 22.

The catch-bowl E has an outlet-pipe 23 in its funnel-shaped bottom which discharges to the sewer or, if desired, to some recovery system.

The control valves 5, 10, 12, and 19, preferably of a quick-acting type, are electromagnetically actuated. The normally closed inlet-valve 5 is opened by a solenoid s^5 against the action of a closing spring, while the drainage-valves 10 and 12, which are normally open, are closed by the solenoids s^{10} and s^{12}, respectively, against the action of opening springs, or the action of the solenoids and the springs may be reversed if desired; and, when these three valves are to be actuated simultaneously, the coils of their actuating solenoids are connected across suitable feed-wires x and y either in series or, preferably as shown, in parallel by the common circuit wires a and b, controlled by a switch m, a mercury switch as shown, and thence, respectively, by the wires c and d, e and f, and g and h. The water inlet-valve 19, normally

closed, is opened by a solenoid s^{19}, against the action of a closing spring, a separate circuit for which is provided by the wires j and k controlled by a second mercury switch n. The two control switches are in turn controlled by a timing device comprising the two cams o and p which are mounted to rotate together at slow speed, as upon a shaft driven by a motor through reducing gears or from some suitable part of the paper machine. These cams are so shaped and relatively positioned that, on each revolution, the active face of the cam o will first tilt the switch m, to close the actuating circuits of the valves 5, 10 and 12, hold it in closed position for a time, and then, its active face passing from engagement therewith, allow the switch to drop to and remain in open position, and, at a short interval after the switch m has dropped to open position, the active face of the cam p will similarly engage and tilt the switch n, to close the actuating circuit of the valve 19, hold it in closed position for a time, and then pass by and allow the switch to drop to and remain in open position.

The operation of the apparatus is as follows: Starting with the control cams o and p in the positions shown in the drawings, the switches m and n are open, the actuating solenoids of all the valves are de-energized, and the two inlet-valves 5 and 19 are closed while the two drainage-valves 10 and 12 are open. As the cams rotate, the switch m is first engaged and tilted to closed position, closing and so energizing the circuits of the solenoids s^5 s^{10} s^{12} which respectively open the inlet-valve 5 and close the drainage-valves 10 and 12 and hold them in such position so long as the solenoid actuating circuits remain closed by the switch m. Thereupon, the stream of thin paper stock in the pipe 7 flows therefrom through the pipe 4 and thence, the valve 10 being closed, upwardly into the wire-head, and, the chamber quickly filling, is forced under a constant and considerable pressure against the wire mesh strainer. The fibers of the stock collect and form a mat on the lower surface of the strainer, while the water passes through into the collecting cup and thence runs down into the stand-pipe, comparatively rapidly at first and more and more slowly as the fiber mat increases in thickness. The water thus discharged into the stand-pipe drains off through the restricted outlet provided by the pipe 13; but, as this outlet is too small to carry it all off during the initial rush, the water will first rise in the stand-pipe to a maximum level which, dependent upon the rate of drainage in turn dependent upon the slowness of the stock as hereinabove explained, through the pressure created thereby in the tube 14 will be recorded on the paper chart by the outward swing of the arm 15, and then, as the discharge slows up and falls below the drainage capacity of the pipe 13, the level of the water in the stand-pipe drops and so reduces the pressure in the pipe of the recorder until, usually on the opening of the drainage-valve 12, it sinks below the level of the mouth of the pressure tube and so removes all pressure therein. The heavy outer ends of the lines 16^a recorded on the chart (see Fig. 2) mark the drop in pressure due to the lowering of the level of the water in the stand-pipe from its maximum to the level from which the stand-pipe is rapidly drained by the opening of the valve 12. The drainage-pipe 13 may, however, be omitted, and if so the level of the water discharged into the stand-pipe will continue to rise therein, and be recorded on the chart, so long as the discharge from the wire-head continues and the valve 12 remains closed, but will fall rapidly when this valve is opened to drain the stand-pipe. After a period determined by the timing device, the circuits of the valve-actuating solenoids are broken at the switch m and thereupon the inlet-valve 5 is closed and the two drainage-valves 10 and 12 are opened by their springs, thus shutting off the flow of the stock to the apparatus and draining both the wire-head and the stand-pipe. Then, after a brief interval, the cam p tilts up the switch n to close the actuating circuit of and so energize the solenoid of the water inlet-valve 19, which is thereupon opened and remains open until its actuating circuit is broken at the switch n. While the valve 19 is open water flows through the supply pipe into the shower-head and, closing the check-valve 22, is projected downwardly, through the opening 17 in a heavy stream which will break the fiber mat formed on the under side of the screen of the wire-head centrally, and through the surrounding spray-holes in finer jets which will complete the breaking up of the fiber mat and will thoroughly wash out the wire-head, the collecting-cup, and the stand-pipe; and, when the water is shut off on the closure of the valve 19, the check-valve 22 will open to admit air to the shower-head and so enable it to drain quickly, while the drip-pipe 20 will drain the upwardly inclined end of the water supply-pipe and any water which may leak through the valve. Thereafter, the two inlet-valves remain closed and the two drainage-valves remain open for a period, allowing the apparatus to drain thoroughly, and then the above-described cycle of operations is repeated.

The apparatus may be adapted for measuring and recording stock of a wide range of slowness in various ways—for instance, by raising or lowering the elevation of the wire-head, thus varying the pressure on the screen of the stock flowing thereto, by making the wire-heads of different diameters, and using the larger heads with the greater drainage area for slow stocks, by increasing or diminishing the diameter of the stand-pipe and

varying the diameter of the discharge outlet through the pipe 13, etc. I have found, however, that for stock of average slowness a wire-head six inches in diameter and a stand-pipe some two feet in height and two and one-half inches in diameter, with a discharge outlet of one-eighth inch diameter in the pipe 13, give good results. In case the pipe 13 is omitted, the stand-pipe should be of somewhat larger diameter so as to give it a capacity to take all the water discharged from the wire-head without unduly raising the pressure on the pressure recorder. It is essential, however, that the amount of wash water discharged through the shower-head be so adjusted with reference to the capacity of the stand-pipe that the rise thereof in the stand-pipe shall not appreciably affect the pressure recorder, as otherwise the recording pen might be swung out further than during the slowness tests and so destroy the readings for such tests. Also, while the timing of the control for the valves may be widely varied, I have found that very satisfactory results can be obtained by driving the control cams at a speed of one revolution per three minutes, giving the active faces of these cams arcs of 90° and 60°, respectively, and so positioning the cam *p* with respect to the cam *o* that its active face will engage and close the switch *n* at an interval of from one to five seconds after the active face of the cam *o* has passed from the switch *m* and allowed that switch to open. Thus, a slowness test of the paper stock will be recorded on the chart every three minutes, that is to say, twenty tests per hour; and, during each three minute period, the actuating solenoids of the valves 5, 10 and 12 will be energized for forty-five seconds, the actuating solenoid of the valve 19 will, after a very brief interval, be energized for thirty seconds, and then the actuating solenoids of all four valves will be deenergized for the remainder of the period, or about one hundred seconds.

In certain cases, as for use in mills where the screens are at a comparatively low elevation, it may be desirable to place the flow of the paper stock to the wire-head under full riffler pressure, which can readily be done by inserting in the pipe 8 a normally open valve similar to the valves 10 and 12 and connecting the coil of its actuating solenoid in parallel with the solenoids of these valves and the valve 5. Also, on certain highly hydrated stocks, such as glassine, where the fibers tend to cling quite tenaciously to the strainer of the wire-head, the shower-head may be connected with its water supply-pipe by a short length of rubber hose and mounted to oscillate slightly, or to rotate back and forth through a short arc, to more surely break off and wash out all the matted fibers.

While I have shown and described a complete automatic slowiness recording apparatus in what I now consider to be the best embodiment of the several parts thereof, it is to be understood that hand-operated valves may be substituted if automatic operation is not desired, and that the parts of the apparatus may be further modified in their details, or certain of the parts omitted entirely, within the scope of the appended claims, without departing from the spirit or sacrificing the advantages of the invention.

What I claim as new, and desire to obtain by Letters Patent, is—

1. Apparatus of the type described comprising a wire-head, means for supplying during a predetermined time interval a stream of dilute paper stock to the under side of the strainer of the wire-head under constant pressure, and means for measuring the discharge from the wire-head during such time interval.

2. Apparatus of the type described comprising a wire-head, means for supplying during a predetermined time interval a stream of dilute paper stock to the under side of the strainer of the wire-head under constant pressure, and means for measuring the discharge from the wire-head during such time interval in excess of the capacity of a restricted drainage outlet.

3. Apparatus of the type described comprising a wire-head, means for supplying to the under side of the strainer of the wire-head during a predetermined time interval and under a constant head a dilute paper stock from a stream thereof flowing from the rifflers of a paper mill, and means for measuring the discharge from the wire-head during such time interval.

4. Apparatus of the type described comprising a wire-head, means for supplying to the under side of the strainer of the wire-head during a predetermined time interval and under a constant head a dilute paper stock from a stream thereof flowing from the rifflers of a paper mill, and means for measuring the discharge from the wire-head during such time interval in excess of the capacity of a restricted drainage outlet.

5. Apparatus of the type described comprising a wire-head, means for supplying for a predetermined time interval a stream of dilute paper stock to the under side of the strainer of the wire-head under constant pressure, means for measuring the discharge from the wire-head during such time interval, means for draining the wire-head, and means for supplying a shower of water to break off the fiber mat formed on the under side of the screen of and to wash out the wire-head.

6. Apparatus of the type described comprising a wire-head, means for supplying for a predetermined time interval a stream of dilute paper stock to the under side of the

strainer of the wire-head under constant pressure, means for measuring the discharge from the wire-head during such time interval in excess of the capacity of a restricted drainage outlet, means for draining the wire-head, and means for supplying a shower of water to break off the fiber mat formed on the under side of the screen of and to wash out the wire-head.

7. Apparatus of the type described comprising a wire-head, means for supplying during a predetermined time interval a stream of dilute paper stock to the wire-head under constant pressure, a receiving vessel adapted to receive the discharge from the wire-head, and means for measuring the level to which the discharge from the wire-head rises in the receiving vessel during such interval.

8. Apparatus of the type described comprising a wire-head, means for supplying during a predetermined time interval a stream of dilute paper stock to the wire-head under constant pressure, a receiving vessel adapted to receive the discharge from the wire-head and having in its bottom a restricted drainage outlet, and means for measuring the level to which the discharge from the wire-head rises in the receiving vessel during such interval.

9. Apparatus of the type described, comprising a wire-head, means for supplying during a predetermined time interval a stream of dilute paper stock to the wire-head under constant pressure, a receiving vessel adapted to receive the discharge from the wire-head, and associated with the receiving vessel a pressure gauge adapted to record the level to which the discharge from the wire-head rises in the receiving vessel during such interval.

10. Apparatus of the type described comprising a wire-head, valve-controlled means for introducing into the wire-head under constant pressure a stream of dilute paper stock flowing from the rifflers of the paper mill, a receiving vessel adapted to receive the discharge from the wire-head, a pressure recorder associated with the receiving vessel adapted to record the maximum level to which the discharge from the wire-head rises in the receiving vessel, means for draining both the wire-head and the receiving vessel, and a shower-head for supplying a shower of water to break off the fiber mat formed within the wire-head and to wash out both the wire-head and the receiving vessel.

11. Apparatus of the type described comprising, in combination, a wire-head having valve-controlled inlet and drainage orifices, means for supplying a stream of dilute paper stock under constant pressure to the inlet orifice of the wire-head, a stand-pipe located adjoining and adapted to receive the discharge from the wire-head and having a valve-controlled drainage orifice, a recording pressure-gauge operatively associated with the stand-pipe to record the maximum level to which the discharge from the wire-head rises in the stand-pipe during a predetermined time interval, and a shower-head having a valve-controlled water supply-pipe mounted over and adapted to direct a shower of water down upon the wire-head.

12. Apparatus of the type described comprising a wire-head having valve-controlled inlet and drainage orifices, means for supplying a stream of dilute paper stock under constant pressure to the inlet orifice of the wire-head, a collecting cup surrounding the upper end of the wire-head, a stand-pipe having a valve-controlled drainage orifice located adjoining the drain-pipe to receive from the collecting cup the discharge from the wire-head, a recording pressure gauge operatively associated with the stand-pipe, and a shower-head having a valve-controlled water supply-pipe mounted directly over the wire-head and collecting cup.

13. Apparatus of the type described comprising, in combination, a wire-head having a valve-controlled inlet-pipe adapted to be connected with a pipe through which a stream of dilute paper stock constantly flows from the rifflers of a paper mill, whereby such paper stock may be admitted to the wire-head under pressure when the valve is open, and also having a valve-controlled drainage-pipe, a stand-pipe located to one side of and somewhat below the wire-head and having a valve-controlled drainage-pipe, a collecting-cup surrounding the wire-head adapted to receive the discharge therefrom and conduct it into the stand-pipe, a pressure-gauge operatively associated with the stand-pipe, and a shower-head with valve-controlled water inlet-controlled water inlet-pipe located over the wire-head and collecting-cup and having in addition to the usual spray-holes therein a larger opening substantially over the center of the wire-head.

14. Apparatus of the type described comprising, in combination, a wire-head having inlet and drainage orifices, a stand-pipe adapted to receive the discharge from the wire-head and having a drainage orifice, a pressure recorder operatively associated with the stand-pipe, a shower-head adapted to wash out the wire-head and stand-pipe and having a water inlet orifice, automatically actuated valves controlling said orifices of the wire-head, stand-pipe and shower-head, and timing means for controlling the actuation of said valves whereby during successive predetermined time intervals the valve controlling the inlet orifice of the wire-head will be open and the valves controlling the drainage orifices of the wire-head and stand-pipe will be closed for a substantial fraction of each time interval and will be closed and open

respectively during the remainder thereof and shortly after the closure of the said inlet valve and opening of the said drainage valves the valve controlling the water inlet orifice of the shower-head will be open for another substantial fraction of such time interval and will be closed during the remainder thereof.

15. Apparatus of the type described comprising, in combination, a wire-head having inlet and drainage orifices controlled respectively by electromagnetically-actuated valves, means for supplying to said inlet orifice under pressure a stream of dilute paper stock flowing from the riffilers of a paper mill, a stand-pipe located to one side of and somewhat below the wire-head to receive the discharge therefrom and having a drainage orifice controlled by an electromagnetically-actuated valve, a pressure recorder operatively associated with the stand-pipe, a shower-head located over the wire-head and having a water inlet orifice controlled by an electromagnetically-actuated valve, electric circuits for said electromagnetically-actuated valves, and control means for the electric circuits including timing mechanism operative during successive predetermined time intervals to close and for a fraction of each time interval to maintain open the actuating circuits of the valves controlling the inlet orifice of the wire-head and the drainage orifices of the wire-head and stand-pipe and then to open and maintain open said circuits during the remainder of the time interval and shortly after the opening of said circuits to close and maintain closed for another fraction of each time interval the actuating circuit of the valve controlling the water inlet orifice of the shower-head and then to open and maintain open said circuit during the remainder of the time interval.

16. In apparatus of the type described, the combination, with a wire-head having inlet and drainage orifices controlled respectively by normally closed and normally open electromagnetically-actuated valves, a stand-pipe to receive the discharge from the wire-head having a drainage orifice controlled by a normally open electromagnetically-actuated valve, and a shower-head for washing out the wire-head and stand-pipe having a water inlet orifice controlled by a normally closed electromagnetically-actuated valve, of a switch-controlled electric circuit for simultaneously energizing the magnet coils of the valves controlling the inlet and drainage orifices of the wire-head and the drainage orifice of the stand-pipe, a second switch-controlled electric circuit for energizing the magnet coil of the valve controlling the water inlet orifice of the shower-head, and a timing device for controlling the switches of the said two electric circuits comprising two cams mounted to rotate together at slow speed and having each an active cam face extending through a substantial arc of a circle and operative the active face of one cam to actuate the switch controlling the electric circuit of the magnets of the valves of the wire-head and stand-pipe and the active face of the second cam set slightly behind that of the first cam, to actuate the switch controlling the electric circuit of the magnet of the valve of the shower-head.

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