The instant invention relates to improved control in the operation of paper machine suction boxes, and more particularly, to an improved control of the vacuum applied at such suction boxes so as to obtain a more uniform paper product and to minimize wear of the wire.

In the Fourdrinier type paper machine, stock is fed onto the traveling forming wire at one end of the top run of the looped wire and the stock is dewatered to form a web on the wire. The wire travels initially over table rolls which support the same and permit the free flow of water through the wire. Next, the wire passes over suction boxes or the so-called "flat boxes" which present a firm, smooth top surface that engages the bottom side of the wire and a vacuum maintained within the suction box withdraws water from the web through the forming wire and top of the box. There are a substantial number of suction boxes thus mounted in succession and after the last suction box the wire passes over a couch roll and the wire has then been removed from the wire and taken on through the press section and dryers. Heretofore, the general idea was to maintain maximum vacuum in the suction boxes so as to obtain the maximum dewatering of the web as it passes thereover. This was done mainly by manual control of the vacuum applied. Usually the several groups of suction boxes mounted in succession with a vacuum header connected to each group and the vacuum thereat would be controlled manually.

Unfortunately, however, the manual control of such suction boxes was not adequate to control the water contents in the stock so that the pressures across the wire varied randomly. In addition, excessive wear on the wire resulted from the use of unnecessarily great pressure differentials across the wire at the suction boxes. One of the main causes of wear of the wire is involved in moving the wire over the top of the suction boxes; and in vacuum operations the vacuum would be maintained so high in the suction boxes that the necessary dewatering of the web would be accomplished before the web had passed over all of the suction boxes, so that an unnecessary amount of wear on the wire resulted.

The instant invention is based in part upon an appreciation of the undesirable results obtained by the aforementioned random control of suction boxes in the operation of a paper machine; and the instant invention is also based upon the discovery of means for obtaining effective control of the suction boxes so as to minimize wear of the wire and to obtain more uniform moisture control across the finished sheet (since the suction boxes tend to remove more water where the sheet is more "free" or the stock is thinner).

In the instant invention the water content of the web is measured at a point in its travel over the suction boxes and/or couch roll and the vacuum in the suction boxes is controlled in response to this water content. Preferably, this measurement is taken by measuring the amount of water drawn off at the last suction box or at the couch roll, since it is important to the obtaining of an appreciable amount of dewatering at these points. If no dewatering takes place at these points, then the vacuum applied earlier in the travel of the wire and web is reduced so that less complete dewatering takes place in the early stages of the travel over the suction boxes. In this way there is assurance that at least some dewatering takes place at all of the suction boxes and too much pressure has not been applied in urging the wire against the tops of the suction boxes early in the travel thereof so as to cause excessive wear and tear.

It is, therefore, an important object of the instant invention to provide an improved control for the operation of suction boxes in a paper machine, and more particularly, to provide an improved method and apparatus for effecting such control.

It is another object of the instant invention to provide an improved method of dewatering a wet web which comprises conveying the wet web on a moving foraminous surface through a series of stations, creating a pressure differential across the web and surface at each of such stations to withdraw water from the web and through the surface, measuring the water withdrawn at one of the stations and controlling such pressure differential in response to the water content of the web at a predetermined point in the travel thereof.

Still another object of the instant invention is to provide an improved suction box control on a paper machine, which comprises a travelling forming wire carrying a wet web thereon, a plurality of suction boxes mounted in succession beneath said wire withdrawing water from the web, control means maintaining a vacuum in said suction boxes and measuring means actuating said control means in response to water content of the web at a predetermined point in the travel thereof on said wire.

Other and further objects, features and advantages of the present invention will become apparent to those skilled in the art from the following detailed disclosure thereof and the drawings attached hereto and made a part hereof.

In the drawing the reference numeral 10 indicates generally a paper machine forming wire arrangement, which is shown diagrammatically. In the instant machine 10, a looped forming wire 11 is trained over a breast roll 12, a plurality of table rolls 13, 15, etc., a plurality of suction boxes 14a, 14b, 14c, and 14d, a couch roll 15, and return rolls 16a, 16b, 16c. As will be appreciated, substantially more suction boxes than the four here shown may be used and usually are, but for the purposes of simplicity additional suction boxes have been eliminated here.

Referring to the suction box 14a, it will be seen that this device comprises a long narrow brass box 17 provided with a wooden cover 17a which is perforated and which engages the bottom of the wire 11. The box 17 and cover 17a extend the full width of the wire 11 and, as here shown on the back side of the wire 11, a suction manifold 18 is connected to the interior of the box 17 for drawing a vacuum therein and the manifold 18 is equipped with a drop leg 19 which extends downwardly below the level L of water in a white water pond P maintained below the level of the wire 11. Substantially identical structures are shown for the other suction boxes 14b, 14c, and 14d. It will be noted, however, that in the instant embodiment a vacuum line 20 connects directly to the vacuum manifolds 18, 18 of three of the suction box assemblies 14a, 14b, and 14c, so that the vacuum therein is maintained substantially the same. The vacuum line 20 is connected through a valve 21 to a main vacuum header 22 to which is connected vacuum supplying means such as a pump 23 (indicated diagrammatically). The vacuum manifold 18d of the suction box assembly 14d is, however, connected to the main vacuum header 22 through a separate valve 24, which permits independent control of the vacuum within the suction box assembly 14d. A gauge 25 may be used to measure the vacuum in the vacuum line 20 and a gauge 26 may be used to measure the vacuum in the vacuum manifold 18d.

It will also be noted that the drop leg 19d for the
3 suction box assembly 14d is equipped with a measuring device, such as a standard flow meter 27 (shown diagrammatically) to measure the flow of water down the drop leg 19d. If no water is flowing down the drop leg 19d then the earlier suction boxes 14a, 14b and 14c have been operating at an excessive vacuum so as to effect too much dewatering. If, on the other hand, a very substantial amount of water is flowing through the drop leg 19d, it may be that an insufficient amount of dewatering has been done by the suction boxes 14a, 14b and 14c. The amount of water actually measured by the meter 27, thus an indication as to the uniform operation of the machine 10 and the amount of water thus measured is signalled to a control box 28 through a signal line 29 (indicated in dotted lines) which in turn signals through a signal line 30 (in dotted lines) to a control box 31 for the valve 21. In this control arrangement, if too much water is registered by the flow meter 27, the valve 21 is opened wider so as to create greater suction in the suction boxes 14a, 14b and 14c; and if too little water is signalled by the flow meter 27, the controls 28 and 31 will close the valve 21 to the desired extent to reduce the suction somewhat in the suction boxes 14a, 14b and 14c.

As will be appreciated, control valves such as the system 31-21, flow measuring devices such as the flow meter 27 and control boxes 28 with associated signal lines 30 are all well known in the art and need not be described in further detail herein (U.S. Patents Nos. 1,897,135, 2,360,889, and 2,585,347). The control lines 30 and 29 may transmit electrical signals or they can be compressed air lines transmitting different air pressure signals, all as well understood in the art. In the arrangement just indicated a substantially constant desired suction is maintained in the suction box 14d; and this is preferred so as to have one “constant” in the system and to permit variations in the flow measured by the flow meter 27 to be the “variable” which controls the operation of the system. It will be appreciated that, using a constant suction in the suction box 14d, the flow meter 27 actually measures the water content of the web W travelling across the suction box 14d. The amount of water passing through the flow meter under such circumstances can readily be translated into the actual weight of water in the web passing over the suction box 14d, so that the actual weight of water in the web W passing over the suction box 14d controls the amount of vacuum which flow meter 27 measures. The criticality of this will be appreciated, since a certain dryness in the web is desired at the time it finishes passing over the suction boxes. It will also be appreciated that, if the valve 21 is held in another suction box, such a predetermined dryness in the web at such other location could also be established for the desired operating condition. Preferably, however, the measurement of the water content of the web is taken near the end of its travel on the wire 11. In this respect, other measuring means may be employed to control the valve 21.

For example, it will be noted that the couch roll 15 is provided with a suction gland 15a which is connected to a suction manifold 32 having a drop leg 33 with a flow meter 34 (such as the flow meter 27) mounted thereto. The drop leg 33 extends in the usual manner to below the level L of another water pond P so that water may be drained off therethrough without losing the vacuum in the manifold 32. The manifold 32 is connected through a valve 35 to the main suction header 22 and a control valve 36. The main suction gland 15a can be controlled. Here again, it is desired that a certain amount of water be drawn off from the web W through the wire 11 into the suction gland 15b. As will be seen, the flow meter 34 measures this amount of water and thus indicates the water content of the web W as it passes over the suction gland 15a. As will be seen, the flow meter 34 transmits signals to the control box 28 through a signal line 36 (in dotted lines). This signal system is thus comparable to the signal system for the flow meter 27 and it will, of course, be appreciated that its control box 28 can be similar to the other signal box 28 depending upon which signal is to be employed in the control of the instant device 30. Instead of either of the signals just mentioned from the flow meters 27 and 34, still another signal may be transmitted to a signal line 37 for actuation of the control box 28. The signal line 37 is connected to a beta-ray counter 38 which receives beta radiation from a suitable generator 39 positioned on the opposite side of the web W and wire 11. This device is commercially known as a “Beta-ray” gauge, which measures the presence of water in the web by the loss of beta radiation (Furnier Industries, November 1956, pages 769-76; Tappi, vol 39, No. 7, July 1956, pages 480-483). In other words, at a given beta radiation rate from the transmitter 39, increases in the water content in the web W will result in lower measurements by the beta-ray counter 38, which in turn sends the appropriate signal to the control box 28.

In the operation of the instant device 10 about a vacuum of 10 inches mercury is the maximum that should be maintained in the suction boxes 14a, 14b, etc. A fixed vacuum below this maximum is maintained in the suction box 14d and in a specific example the flow meter 27 measures the amount of water in the web by the suction box 14d. At a machine rate of 2500 feet per minute (wire speed) the amount of water per foot of web width should be about 22.5 pounds per minute as measured by the flow meter 27 using 7.5 inches of mercury in the manifold 18d. Under the same conditions using a vacuum of 20 inches mercury in the suction gland 15a, the flow of water through the flow meter 34 should be 45 pounds per minute per foot of web width.

It will be understood that modifications and variations may be effectuated without departing from the spirit and scope of the novel concepts of the present invention. I claim as my invention:

1. A paper machine, a travelling forming wire carrying a wet web thereon, a plurality of suction boxes mounted in succession beneath said wire withdrawing water from the web, control means for controlling a vacuum in said suction boxes, means actuating said control means in response to water content of the web at a predetermined point in the travel thereof on said wire downstream of said suction boxes.

2. In a paper machine, a travelling forming wire carrying a wet web thereon, a plurality of suction boxes mounted in succession beneath said wire withdrawing water from the web, first means maintaining a predetermined vacuum on one suction box, second means maintaining a variable vacuum on others of said suction boxes upstream of said one suction box, and means responsive to the water content of the web passing over said one suction box in control of the degree of vacuum in said second means.

3. In a paper machine, a travelling forming wire carrying a wet web thereon, a plurality of suction boxes mounted in succession beneath said wire withdrawing water from the web, first means maintaining a predetermined vacuum on the last suction box in succession, second means maintaining a variable vacuum on others of said suction boxes, and means responsive to the water content of the web passing over said last suction box in control of the degree of vacuum in said second means.
5 box in control of the degree of vacuum in said second means.

5. In a paper machine, a suction couch roll, a travelling forming wire looped over the couch roll carrying a wet web thereon, a plurality of suction boxes mounted in succession beneath said wire withdrawing water from the web, control means for controlling a vacuum in said suction boxes and measuring means actuating said control means in response to measurement of water content of the web between the suction boxes and the couch roll.

6. In a paper machine, a suction couch roll, a travelling forming wire looped over the couch roll carrying a wet web thereon, a plurality of suction boxes mounted in succession beneath said wire withdrawing water from the web, control means for controlling a vacuum in said suction boxes, dewatering means maintaining a vacuum in said couch roll to withdraw water from said web and measuring means actuating said control means in response to measurement of water withdrawn by said dewatering means.

7. In a paper machine, a travelling forming wire carrying a wet web thereon, a plurality of suction boxes mounted in succession beneath said wire withdrawing water from the web, control means for controlling a vacuum in said suction boxes, a beta-ray generator on one side of the web downstream from said suction boxes, a beta-ray counter opposed to said generator on the other side of the web measuring the water content thereof, and means responsive to said water content measured by said beta-ray counter actuating said control means.

8. In a paper machine, a travelling forming wire carrying a wet web thereon, a plurality of suction areas mounted in succession beneath said wire withdrawing water from the web, first means maintaining a predetermined vacuum on one suction area, second means maintaining a variable vacuum on others of said suction areas upstream from said one suction area; and means responsive to the water content of the web passing over said one suction area in control of the degree of vacuum in said second means.

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