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3,293,120

PAPER MACHINE PRESSURIZED HEADBOX CONTROL OF STOCK FLOW

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This invention relates to a control system for a paper machine and more particularly to a control system for a pressurized headbox supplying stock to a web forming traveling screen.

It has been established that preferably the spouting velocity, that is the rate of discharge of stock from the headbox, should be properly correlated with the velocity of the traveling screen in order to produce a satisfactory web. If the spouting velocity deviates substantially from that of the screen poor paper formation may result or a web having undesirable variations in thickness may be formed. As the velocity of the screen is adjusted from time to time, in response to observations and measurements made on the web or finished paper, and further as the velocity of the screen will vary with changes in voltage, frequency and the like of the drive motors for the screen it follows that corresponding and immediate changes should be made in the headbox spouting velocity.

Heretofore as taught by Eastwood in United States Patent 3,077,924 and by De Mers in United States Patent 1,936,049 correlation between screen velocity and spouting velocity may be obtained by varying the level of stock in the headbox. The advent of the pressurized headbox, however, that is a headbox wherein a pad of compressed air is maintained above the level of stock, while permitting higher spouting velocities and hence higher machine speeds, has presented a new control problem.

Accordingly, it is an object of this invention to provide a control for a paper machine headbox of the pressurized type.

It is a further object to provide a pressurized headbox control wherein the spouting velocity of the stock immediately and in proper proportion follows variations in speed of the traveling screen.

It is another object of this invention to provide a pressurized headbox control wherein the level of stock in the headbox is maintained at a predetermined desired value, hence assisting in the maintenance of a spouting stock of uniform mixture and quality.

Still another object is to provide a pressurized headbox control which while reacting instantaneously to changes in machine speed is stable in operation, produces the desired results without cycling, causing neither fluctuations in the quality of the spouting stock, nor undesired fluctuations in the rate of stock fed to the headbox.

These and other objects will be apparent from the description to follow and from the drawings in which:

FIG. 1 is a cycle diagram of a typical pressurized headbox and traveling screen of a paper making machine to which our control may be applied.

FIG. 2 is a diagrammatic illustration of a control embodying our invention arranged for application to the cycle shown in FIG. 1.

FIG. 3 illustrates a modified form of our invention.

Referring now to FIG. 1 we therein show a pressurized headbox 1 having an adjustable orifice 2, or slice as it is commonly called, for spouting stock on a traveling screen 3. The screen 3 is provided with the usual breast roll 4 and a couch roll 5 located at opposite ends of the screen, the latter being driven by any suitable means such as an electric motor or the like (not shown).

Below the screen 3 is a pit 6 for receiving the water drained from the stock (white water) which is recycled through a conduit 7 to the stock supply system. Feedstock is supplied the headbox 1 by means of a fan pump 8 through a conduit 9. Makeup stock is introduced into the stock supply system through a conduit 10. We have shown in conduits 7 and 10 valves 11 and 12 respectively as representative of any conventional means, manual or automatic, for maintaining a desired ratio between recycled white water and makeup stock.

Compressed air from any suitable source (not shown) is introduced into the headbox through a conduit 13 to pressurize the headbox and maintain an air pad above the level of stock. The velocity of the stock spouting from the orifice 2 may be varied by varying the differential pressure across the orifice. This differential pressure is equal to the total head within the headbox, that is the head produced by the weight of stock above the orifice plus the pressure of the air pad. Conveniently, therefore, the spouting velocity can be varied by varying the pressure of the air pad and to accomplish this we show in conduit 13 valves 14 and 15, the valve 14 controlling the supply of compressed air to the headbox and the valve 15 controlling the air wasted therefrom to the atmosphere. Any desired air pressure may be maintained by proper adjustment of valves 14 and 15.

It is evident that as the spouting velocity of stock through the orifice tube varies so must the supply of stock to the headbox vary to maintain a desired level of stock within the headbox. We accordingly show as representative of a suitable control means for the stock input a valve 16 disposed in the conduit 9. As evident flow control of the feedstock could also be obtained, if desired, by varying the speed of pump 8 solely or in combination with adjustment of valve 16.

As this description is addressed to those skilled in the art we have purposely, in FIG. 1, shown the headbox and related equipment in skeleton form, omitting features which while necessary and while known in the art are not essential to an understanding of our invention.

In FIG. 2 is illustrated diagrammatically a control system embodying our invention arranged for application to the pressurized headbox shown in FIG. 1. Measuring instruments and final control elements shown in FIG. 2 have been referenced into FIG. 1. While in FIG. 2 we have illustrated a control system of the so-called pneumatically operated type it is apparent that our invention may equally as well be incorporated in electric or hydraulic instrumentalities.

Referring now to FIG. 2 there is illustrated a control system for a pressurized headbox which maintains the spouting velocity of the stock in desired relation to screen speed and further maintains the level of stock in the headbox at a predetermined or desired value. Therein we show a transmitter 17 responsive to the differential across the orifice 2, or in other words, responsive to the total head within the headbox 1, which establishes a pneumatic loading pressure proportional to the differential. This loading pressure is transmitted through relays 21 and 18 to valves 14 and 15 arranged to operate in opposite directions. Thus as the pressure established by transmitter 17 increases indicating an increase in total head, the output pressure of relay 18 will decrease proportionally causing valve 14 to move in a closing direction and valve 15 to move in an opening direction to thereby decrease the pressure of the air pad.

The relay 18 may be of the type described in Panich United States Patent 2,805,678 and is preferably of the so-called proportional plus reset type incorporating a proportional band adjustment and having automatic adjustable reset. The set point of relay 18, which determines

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the differential pressure maintained by the control, is automatically maintained proportional to screen velocity. Thus, as shown, the loading pressure established by a screen speed transmitter 20 is introduced into relay 18 through conduit 23. The transmitter 20 is driven, as shown in FIG. 1, by the couch roll 5 through any suitable means such as a belt 30.

As the loading pressure established by the transmitter 20 varies directly with the velocity of the traveling screen whereas the spouting velocity of the stock through the orifice 2 varies as the square root of the total head, a relay 21 is interposed between transmitter 17 and relay 18 to extract the square root of the loading pressure established by transmitter 17. Hence changes in machine speed effecting proportional changes in the loading pressure established by transmitter 20 will effect directly proportional changes in the velocity of the stock spouting through the orifice 2. The relay 21 may take anyone of several well known forms and if desired can be incorporated in the transmitter 17 as taught by Jack F. Shannon in United States Patent 2,986,151. Conversely, a relay may be provided to generate a loading pressure proportional to square of the output pressure of speed transmitter 20 and inserted in conduit 23. In essence with the control so far described the transmitter 20 establishes a demand signal calling for a precise differential pressure, which differential pressure is then maintained by the constant differential pressure control.

The speed transmitter 20 also establishes the demand for stock flow to the headbox so that the rate of stock fed to the headbox 1 is maintained equal to the output therefrom. As shown there is provided in conduit 9 a flow transmitter 22 generating a loading pressure proportional to the square of the rate of flow of stock to the headbox 1. This loading pressure through relays 28 and 25 operates valve 16 to maintain the stock feed at the set point value established in relay 25 which, as shown, is responsive to the loading pressure generated by the speed transmitter 20 through an algebraic summing relay 24.

Thus the set point of the constant flow control is adjusted in proportion to changes in screen speed.

To compensate for instrument and control component inaccuracies and to maintain a predetermined level of stock within the headbox, the loading pressure generated by speed transmitter 20 is modified in algebraic summing relay 24 in accordance with changes in level of stock. We show a level transmitter 26 which establishes a loading pressure proportional to level, which through a proportional plus reset relay 27 is effective in relay 24 for modifying the loading pressure generated by speed transmitter 20.

The relay 28 similar to the relay 21 is provided to extract the square root of the loading pressure generated by the transmitter 22. This relay, as discussed with reference to relay 21, may be made integral with the transmitter 22 so that a loading pressure varying in direct proportion to stock flow may be generated.

In the embodiment of our invention shown in FIG. 2 the rate of flow of feedstock to the headbox 1 is maintained proportional to screen speed and inferentially maintained equal to the rate of flow of stock spouting from orifice 2. It is evident, however, if the rate of flow of feedstock to the headbox 1, established by the demand signal from speed transmitter 20, is not equal to the rate of flow of stock spouting from orifice 2, the level of stock in the headbox will tend to vary which will operate through the constant level control to modify the set point of the constant flow control as established by the demand signal as required to restore the desired level and proportionality between stock flow to and from the headbox.

In FIG. 3 we show a modification wherein the rate of flow of stock fed to the headbox is ratioed directly with the flow through the orifice 2. Therein the set

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point of the constant flow control of stock feed is adjusted from the loading pressure generated by relay 21 and hence adjusted in accordance with the square root of the loading pressure established by the total head transmitter 17. Otherwise the control shown in FIG. 3 operates as explained with reference to FIG. 2.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In a control system for a papermaking machine having a traveling web forming screen and a pressurized headbox containing a pool of stock and having an orifice for spouting stock on said screen, a first conduit for supplying stock to the headbox, a second conduit for supplying compressed air to the headbox above the level of stock to pressurize the headbox, means producing a signal corresponding to the velocity of the traveling screen, a first valve in said first conduit under the control of said signal maintaining the rate of flow of stock to the headbox proportional to the velocity of the traveling screen, a supply and waste valve means in said second conduit under the control of said first signal maintaining the total head in said headbox proportional to the velocity of the traveling screen, means producing a second signal proportional to the level of stock in the headbox and means modifying the control of said first valve by said second signal in accordance with changes in the level of stock in the headbox.

2. In a control system for a papermaking machine having a traveling web forming screen and a pressurized headbox containing a pool of stock and having an orifice for spouting stock on said screen, comprising in combination, means producing a first signal corresponding to the velocity of the screen, means producing a second signal corresponding to the level of stock in the headbox, means producing a third signal corresponding to the flow of stock to the headbox, and means under the joint control of all of said signals regulating the flow of stock to said headbox.

3. In a control system for a papermaking machine having a traveling web forming screen and a pressurized headbox containing a pool of stock and having an orifice for spouting stock on the screen, comprising in combination, first means regulating the pressure in the headbox to maintain a constant differential pressure across the orifice, second means responsive to the velocity of the traveling screen adjusting the constant differential pressure maintained by said first means in accordance with changes in the velocity of the screen, constant flow control means of the stock to the headbox, a third means responsive to the level of stock in the headbox, and means under the control of said second and third means adjusting the rate of flow of stock maintained by said constant flow control means to establish a flow of stock proportional to the velocity of the screen modified by changes in the level of stock in the headbox.

4. In a control system for a papermaking machine having a traveling web forming screen and a headbox containing a pool of stock and an orifice for spouting stock on the screen, comprising in combination, constant flow control means having an adjustable setpoint of the stock supplied to the headbox, means producing a first control signal corresponding to the velocity of the traveling screen, means producing a second control signal corresponding to the level of stock in the headbox and means adjusting the setpoint of the constant flow control means responsive to said first and second control signals to maintain the rate of flow of stock to the headbox in proportion to the velocity of the traveling screen modified in accordance with changes in level of stock in the headbox.

5. In a control system for a papermaking machine having a traveling web forming screen and a pressurized headbox containing a pool of stock and an orifice for spouting stock on the screen, comprising in combination, constant flow control means having an adjustable setpoint of the stock supplied the headbox, means having an adjustable

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setpoint for regulating the pressure in the headbox to maintain a constant differential across the orifice, means producing a control signal corresponding to the velocity of the traveling screen, means under the control of said signal adjusting the setpoint of said constant differential pressure control means to maintain the velocity of the stock through said orifice in proportion to the velocity of the traveling screen, means under the control of said signal adjusting the setpoint of said constant flow control means to maintain the flow of stock to the headbox proportional to the velocity of the traveling screen, means producing a control signal corresponding to changes in the level of the pool of stock in the headbox and means responsive to said last named control signal modifying the adjustment of the setpoint of said constant flow control means in accordance with changes in the level of the pool of stock in said headbox.

6. In a control system for a papermaking machine having a traveling web forming screen and a pressurized headbox containing a pool of stock and an orifice for spouting stock on the screen, comprising in combination, constant flow control means having an adjustable setpoint

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of the stock supplied the headbox, means producing a control signal corresponding to the differential pressure across said orifice, means under the control of said signal for regulating the pressure in the headbox, means under the control of said signal adjusting the setpoint of said constant flow control means to maintain the flow of stock to the headbox proportional to the velocity of the screen, means producing a control signal corresponding to changes in level of the pool of stock in the headbox and means responsive to said last named control signal modifying the adjustment of the setpoint of said constant flow control means in accordance with changes in level of stock in said headbox.

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