

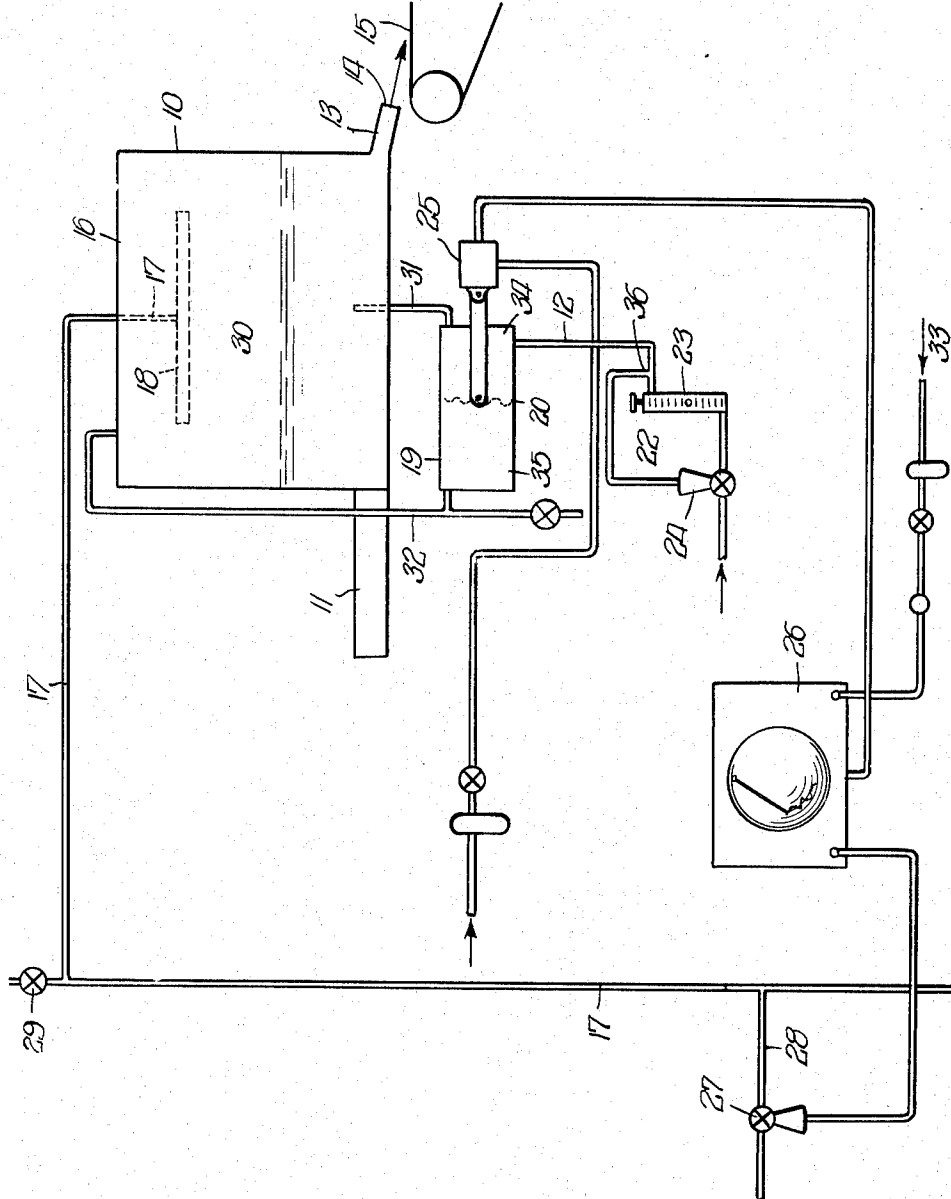
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APPARATUS FOR CONTROLLING STOCK LEVEL IN A PRESSURIZED HEAD BOX

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APPARATUS FOR CONTROLLING STOCK LEVEL IN A PRESSURIZED HEADBOX

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This invention relates to paper making machinery and particularly to the construction and operation of a paper making machine headbox and inlet mechanism wherein the stock is to be maintained at a predetermined level. In this connection the stock as used herein will be understood to refer to the dilute aqueous suspension of paper making fiber with or without additional paper making materials which is delivered as a flowing stream of fluid to the web forming region of a paper making machine by way of the headbox or other stock delivery mechanism.

In the manufacture of a given weight paper on a particular machine it is found that there is an optimum depth for the flowing stream of stock which is maintained within the headbox. It is necessary to supply the stock at the web forming region of the machine at a pressure which is capable of producing an appropriate spouting velocity at the slice. In order to obtain such a pressure by conventional means it is necessary to provide a relatively high liquid level in the headbox.

However, if the liquid level is relatively high, the velocity of the liquid in the headbox is so slow that the fibers begin settling. This gives poor paper formation. These two requirements are inherently conflicting, and it is necessary to devise a compromise means for obtaining optimum results.

In order to avoid some of these difficulties, it has been proposed to use what is called a pressurized headbox. In this construction, part of the liquid head is replaced by a pressurized air pad so as to maintain the required total head. Thus the level of the stock may be reduced, thereby increasing the velocity of the liquid in the headbox so as to prevent settling. However, it is essential that the level of the stock be accurately controlled so that the velocity of the stock through the headbox will remain constant or the paper will be of nonuniform quality. Since the air pad pressure and the stock level are directly interrelated, as will be further explained below, it is possible to control the latter as a function of the former.

Therefore, it is an object of this invention to provide for the accurate control of the stock level in a pressurized headbox of a paper machine. Broadly, the invention consists of a pneumatic control system which relates the air pressure in the headbox to the stock level. By this arrangement the stock level can be accurately controlled at a predetermined optimum level within very narrow limits.

It is also an object of the invention to provide means for controlling the stock level at a predetermined optimum level in a pressurized headbox by relating the air pad pressure to the stock level in the headbox.

A still further object is to provide a stock level control means which rapidly responds to changes in the stock level and makes the necessary adjustments to bring the level back to a predetermined optimum level.

A further object is to provide means for controlling the stock level which is fully automatic and requires little or no operator attention.

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A still further object is to provide a stock level control means which is economical to install and is economical in operation.

Other objects will be apparent upon further development of the specification with reference to the drawing. In the drawing:

The single figure is a diagrammatic view of the stock level control means embodying the invention.

Referring now to the drawing, there is shown a headbox generally denoted by the numeral 10. The headbox is provided with an inlet 11 connected to a source of stock which is forced to the headbox 10 by any suitable pump. Spaced from the inlet is an outlet through which the stock flows onto the web forming wire. A slice 13 is positioned at this outlet 14 to control this flow of the stock onto the web forming wire 15. Extending through the cover 16 into the chamber 30 is an air inlet 17 connected to a pressure source to supply air pressure to the headbox. Secured to the inlet 17 is the air distributing pipe 18 through which the air enters into the chamber 30.

Referring now to the system generally, there is shown a differential pressure transmitter generally denoted by the numeral 19. The transmitter is of the diaphragm type including a chamber partitioned by a diaphragm 20, one side 34 of which is connected to the bottom of the headbox 10 by the duct 31 so as to sense total head pressure therein. The other side 35 of the transmitter 19 is connected by the duct 32 to the top of the headbox 10 to sense the air pressure therein.

It is obvious that the total head pressure (P_T) at the headbox outlet 14 is equal to the liquid pressure P_L plus the air pad pressure (P_A)

$$P_T = P_L + P_A$$

From this relationship it can be seen that the liquid pressure P_L is equal to the total pressure P_T minus the air pad pressure P_A .

$$P_L = P_T - P_A$$

Furthermore, the liquid pressure is equal to the liquid height multiplied by the density of the stock. In other words, the liquid level is directly proportional to the liquid pressure.

Referring back to the differential pressure transmitter, it can be seen that by connecting one side to the chamber 30 to sense air pressure and the other side to the bottom of the headbox 10 to sense total pressure, the differential pressure across the diaphragm 20 is equal to the liquid head pressure which is directly proportional to the liquid level. The diaphragm would be displaced by the differential pressure an amount directly proportional to the liquid level. For example, if the liquid level were to increase due to an increased output from the supply pump and the air pressure were to remain constant, the diaphragm would be displaced to the left by the increased pressure differential. Conversely, if the liquid level decreased and the air pressure increased, the diaphragm would be displaced to the right.

While the diaphragm type differential pressure transmitter described above is the preferred type of liquid level sensing means, the manometer type differential pressure transmitter is also suitable for this purpose. As an illustrative example, the manometer type as applied to this invention would include a U tube, a suitable fluid therein, and means for directing the air pad pressure to one fluid surface and the total pressure to the other fluid surface. The difference in height between the two surfaces would be proportional to the stock depth. The remaining portion of the manometer type device would consist of a float or other mechanical means used to proportionately activate the pneumatic signal generator

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25 as a function of fluid level in either side of the manometer.

A preferred embodiment, although it is not necessary to the practice of the invention, includes means for purging the differential pressure transmitter 19 with clean or white water on the side 34 that senses total pressure. Since this side of the headbox is connected directly to the transmitter 19 by the duct 31, some of the fibrous material may migrate thereto. This material, once reaching the transmitter 19, would probably become trapped and collect therein and cause error to be introduced into the transmitter 19. By using a purge which has an inlet pressure only slightly above the total pressure of the headbox, it has been found that the transmitter 19 will be kept free of the fibrous material and at the same time maintain accurate control of the stock level. It is necessary that the purge supply be maintained at a constant predetermined level only slightly above the total pressure in order not to introduce error into the differential pressure transmitter 19.

Referring now to the drawings, the purge system is generally denoted by the numeral 12. One way of maintaining the purge system constant is by the incorporation of a purge flow controller generally denoted by the numeral 22 into the line. The purge flow controller 22 includes a rotameter 23 and a self controlling valve 24. The rotameter is of the type that may be adjusted to the desired flow rate by means of a needle valve at its top. The needle valve is mechanically linked to an orifice in the rotameter 23 in such a fashion that the area of the orifice may be varied. The self controlling valve 24 is then adjusted to maintain a constant pressure drop across the rotameter, corresponding to the desired flow rate. The self controlling valve 24 continually senses the output pressure of the rotameter by means of a pressure tap 36 and also the input pressure of the rotameter by sensing the pressure of the liquid flowing through it. By means of its internal linkages including a variable orifice and a diaphragm, these pressure signals are used by the self controlling valve to maintain a constant pressure drop across the rotameter. In normal operation the pressure drop is usually maintained at a constant of 2 p.s.i., thereby controlling the flow rate to a predetermined constant, fixed by the position of the rotameter orifice.

Reference is now made to the output signal from the differential pressure transmitter 19. The signals are transmitted by appropriate mechanical linkages interconnecting the diaphragm 20 to a pneumatic signal generator 25 which may be separate or integrated with the differential pressure transmitter 19. The pneumatic signal generator 25 in turn generates a signal directly proportional to the diaphragm position which in turn is directly proportional to the stock level. The signal may vary between 3 and 15 p.s.i. and the signal at any given instant will always be in direct proportion to the stock level at that instant. The output signal from the pneumatic signal generator 25 is communicated to a level recorder controller 26 of any suitable type. One type of controller that is particularly adapted for this use is the reversing type which emits an output signal inversely proportional to the input signal.

It has been found that the pressure signals over the range of stock level which it is desired to exercise control must be magnified from values of less than $\frac{1}{2}$ p.s.i. to proportionate pneumatic signals in the 3 to 15 p.s.i. range. This magnification is necessary to render the controller 26 sensitive to changes in stock level of less than $\frac{1}{8}$ " of water. The controller 26 is designed to receive a signal varying between 3 and 15 p.s.i. which range corresponds with that of the pneumatic signal generator. The controller 26 may be of the recording type to provide a continuous written record of the level of the stock as sensed by the differential pressure transmitter 19. The control section of the controller 26 is supplied by 20 p.s.i. air emitted from a suitable pressure source 33.

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This air is transformed by the control section of the controller 26 into the control signal which is conveyed to the pneumatic control valve 27. As was explained previously, the control signal is inversely proportional to the output signal received from the differential pressure transmitter 19. Thus, if a signal from the pneumatic signal generator 25 of a magnitude of 15 p.s.i. were transmitted to the controller 26, then a control signal of 3 p.s.i. would be communicated to the valve 27, assuming the range of the controller to be 3 p.s.i. to 15 p.s.i.

The type of controller described above is known as a proportional controller. This method of control is adequate in certain operations such as newsprint manufacture where the stock input remains essentially constant during the course of operation. However, in certain types of operations where the grade of the paper is periodically changed and corresponding changes in stock input are necessary, it has been found that a proportional control is not adequate. Due to an inherent characteristic of proportional control, offset, or difference between desired control point and actual control point, is introduced when significant changes in stock input are made.

In view of this it has been found that if the invention is used under varying stock input conditions, the incorporation of a reset feature into the controller is highly desirable. The reset feature is a mechanical means for eliminating offset which tends to occur under varying stock input conditions.

Referring now to the pneumatic control valve 27, it may be of any suitable type. The valve is installed on a bleed line 28 from an air pad supply line so as to bleed controlled amounts of air from the air pad supply pressure. As was explained previously, the stock level is so interrelated with the air pad pressure that it may be controlled by varying the latter. The air pad supply line is equipped with a constant pressure air supply (not shown) and may also be provided with a manual bleed valve 29. By means of the manual bleed valve 29, the air pad pressure may be adjusted to bring the system within the scale on the controller 26.

One type of control valve that is particularly adapted for this use is the air to open. By using the air to open control valve 27 fouling of the air showers is eliminated in the event of failure of the control air. If the control air 33 fails, the control valve is closed and the air pressure will increase in the headbox, thus lowering the stock level so as to give the operator prompt warning of the failure. If an air to close valve were used and the control air were to fail, the headbox would fill with stock which would foul the air showers and other internal piping and fittings before being noticed. While both types of control valves may be used, the air to close type requires more operator attention, so the preferred embodiment of the invention includes the air to open valve rather than an air to close valve.

The operation of the system will now be described. If the stock level were to drop from the predetermined optimum level, the resultant decrease in hydraulic pressure would be transmitted to the differential pressure transmitter 19. Due to the drop in the stock level the diaphragm would be displaced toward the liquid side of the transmitter 19, causing a decreased signal to be emitted by the pneumatic signal generator 25 to the level recorder controller 26. The level recorder controller being a reversing controller communicates an increased control signal to the pneumatic control valve 27. The pneumatic control valve in turn will partially open, thus bleeding air from the air pad supply line. The bleeding will result in lower air pressure in the headbox and allow the stock level to rise to the predetermined optimum level. Conversely, should the level of the stock rise above the optimum level, then the diaphragm would be displaced toward the air side of the transmitter 19, causing an increased signal to be emitted by the pneumatic signal generator 25. The vari-

ous components of the invention may be placed in any desired position with the exception of the differential pressure transmitter. It has been found desirable to place the transmitter at some point below the headbox and thereby allow the bleeding of any air in the transmitter 19 to the headbox. The increased pressure due to the placing of the transmitter 19 below the headbox may be eliminated by the proper adjustment of the differential pressure transmitter.

It is obvious that certain modifications may be made within the scope of the claims without departing from the spirit of the invention.

I claim:

1. A system for controlling the stock level in an air pressurized headbox of a paper making machine comprising means for sensing the difference between the stock pressure at the outlet of said headbox and the air pressure within said headbox, and a valve for varying the air pressure in said headbox, said valve being actuated by said means.

2. A system for controlling the stock level in an air pressurized headbox of a paper making machine comprising a differential pressure transmitter having a flexible diaphragm, one side of said diaphragm acted upon by the stock pressure at the headbox outlet, the other side of said diaphragm being acted upon by air pressure within said headbox, and a valve for varying the air pressure in said headbox, said valve being controlled by said differential pressure transmitter.

3. A system for controlling the stock level in an air pressurized headbox of a paper making machine, comprising a differential pressure transmitter having a flexible diaphragm, one side of said diaphragm being acted upon by the stock pressure at the headbox outlet, the other side of said diaphragm being acted upon by air pressure in said headbox, a pneumatic signal generator actuated by said differential pressure transmitter, and a valve for varying the air pressure in said headbox, said valve being controlled by the pneumatic signal generator.

4. A system for controlling the stock level in an air pressurized headbox of a paper making machine, comprising a differential pressure transmitter having a flexible diaphragm, one side of said diaphragm being acted upon by the stock pressure at the headbox outlet, the other side of said diaphragm being acted upon by the air pressure within said headbox, a valve for varying the air pressure within said headbox, and means for purging said differential pressure transmitter of foreign material.

5. A system for controlling the stock level in an air pressurized headbox of a paper making machine, comprising a differential pressure transmitter having a flexible diaphragm, one side of said diaphragm being acted upon by air pressure within said headbox, the other side of said diaphragm being acted upon by the total pressure in said headbox, means for purging said second side of foreign material, a pneumatic signal generator controlled by the position of said diaphragm, and a valve for varying the air pressure in said headbox, said valve being actuated by the signals from said pneumatic signal generator.

6. A system for controlling the stock level in an air pressurized headbox of a paper making machine, comprising a differential pressure transmitter having a flexible diaphragm, one side of said diaphragm being acted upon by the air pressure within said headbox, the other side of said diaphragm being acted upon by the total pressure within said headbox, means for purging said second side of foreign material, a pneumatic signal generator controlled by the position of said diaphragm, a valve for varying the air pressure within said headbox, and controller means for communicating signals from said pneumatic signal generator to said valve, said valve being controlled by said signals.

7. An air pressurized headbox for delivering stock to the web forming region in a paper making machine, comprising a closed chamber having spaced stock inlet and stock outlet ports positioned below the level of the stock within said chamber, means for maintaining air pressure in said chamber to act upon said stock, a differential pressure transmitter having a flexible diaphragm therein, one side of said diaphragm being acted upon by air pressure within said chamber, the other side of said diaphragm being acted upon by the stock pressure at said outlet port, and a valve for varying the air pressure within said chamber, said valve being controlled by the position of said flexible diaphragm.

8. An air pressurized headbox for delivering stock to the web forming region in a paper making machine, comprising a closed chamber having spaced stock inlet and stock outlet ports positioned below the level of the stock within said chamber, means for maintaining air pressure in said chamber to act upon said stock, a differential pressure transmitter having a flexible diaphragm therein, one side of said diaphragm being acted upon by the air pressure within said chamber, the other side of said diaphragm being acted upon by the stock pressure in said chamber, and a valve for varying the air pressure in said chamber, said valve being controlled by the differential pressure of said diaphragm.

9. A pressurized headbox used for delivering stock to the web forming region in a paper making machine comprising a closed chamber, having spaced stock inlet and stock outlet ports positioned below the level of the stock in the chamber, means for maintaining air pressure in said chamber to act upon said stock, a differential pressure transmitter having a flexible diaphragm therein, one side of said diaphragm being acted upon by the air pressure in said chamber, the other side being acted upon by the combined liquid and air pressures in said chamber, and a valve for varying the air pressure in said chamber, said valve being controlled by the position of said flexible diaphragm.

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