# United States Patent

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**Beloit, Wis.**


[54] **PRESIZE MOISTURE CONTROL SYSTEM FOR A PAPERMAKING MACHINE**
**5 Claims, 1 Drawing Fig.**


[52] **U.S. Cl.** ..... **162/253,** 34/54, 162/263, 235/151.35
[51] **Int. Cl.** ..... **D21f 5/04,** G01m 23/16
[50] **Field of Search** ..... 162/198, 252, 253, 263; 34/54; 73/73; 235/151.33, 151.35



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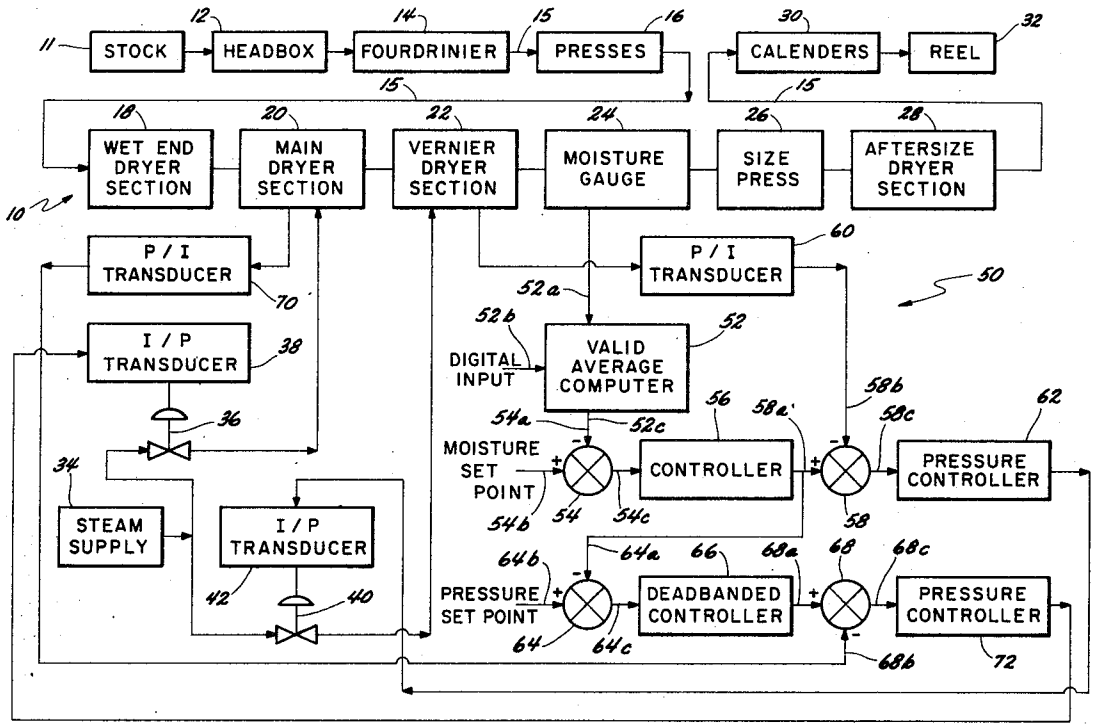
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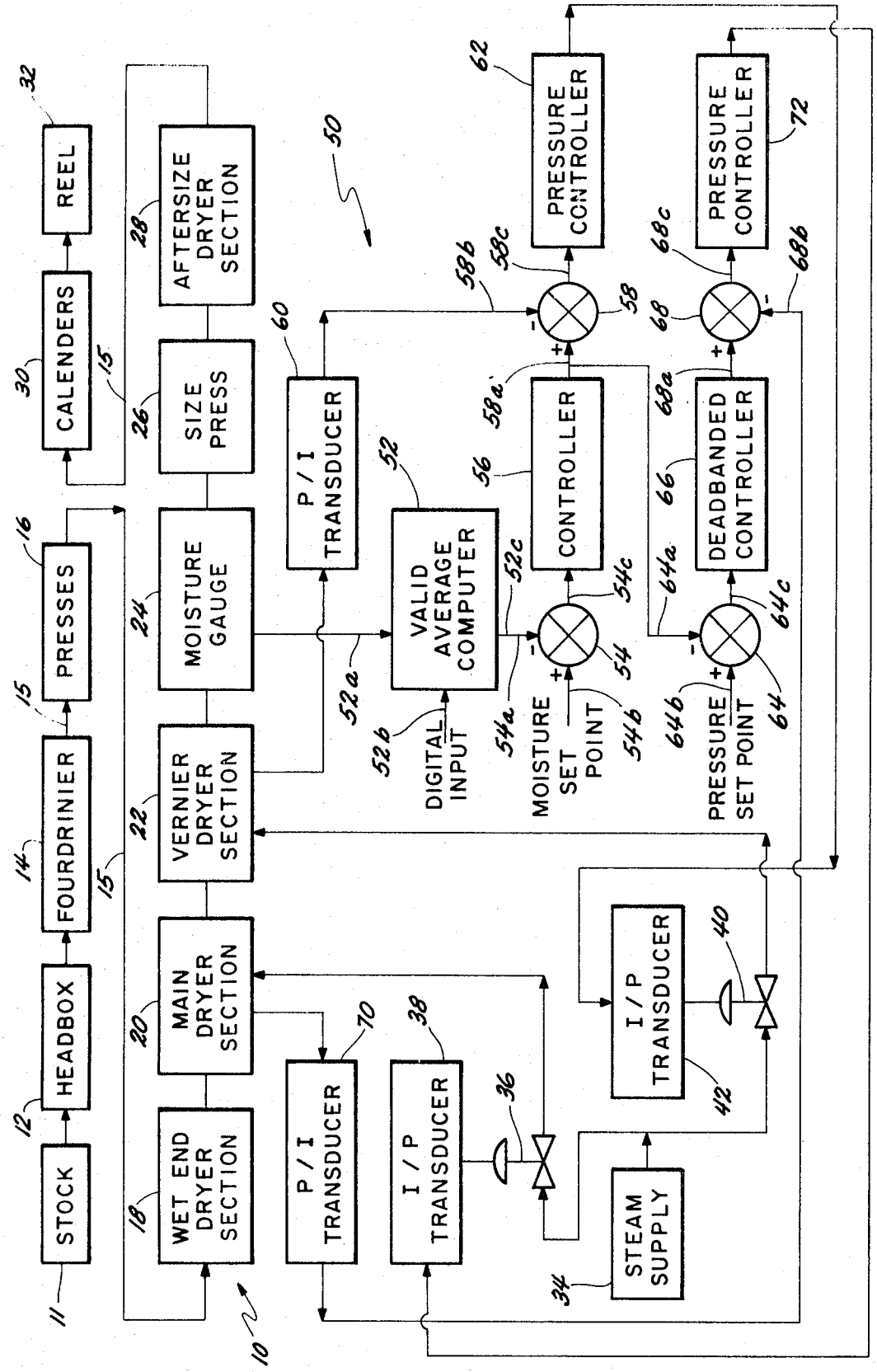


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**ABSTRACT:** A vernier dryer section normally provides sufficient heat so as to maintain the moisture content of the paper web within a relatively narrow range as it enters the size press. When the vernier dryer section fails, or starts to fail, to maintain the prescribed moisture limits, another dryer section of larger capacity is thermally adjusted so that the moisture content of the web is closely controlled and in this way held within the specified limits.


STOCK
HEADBOX
FOURDRINIER
PRESSES
CALENDERS
REEL
WET END DRYER SECTION
MAIN DRYER SECTION
VERNIER DRYER SECTION
AFTERSIZE DRYER SECTION
SIZE PRESS
MOISTURE GAUGE
P / I TRANSDUCER
VALID AVERAGE COMPUTER
DIGITAL INPUT
MOISTURE SET POINT
CONTROLLER
PRESSURE CONTROLLER
DEADBANDED CONTROLLER
PRESSURE SET POINT
I / P TRANSDUCER
STEAM SUPPLY
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# PRESIZE MOISTURE CONTROL SYSTEM FOR A PAPERMAKING MACHINE

## BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to the control of moisture in a papermaking machine, and pertains more particularly to the accurate control of moisture just before the size press.

2. Description of the Prior Art

Having the correct amount of moisture in the paper web as it enters the size press is extremely important. It has been the practice to run virtually bone dry, that is 1-percent moisture or less. The reason for doing this is that the sizing agents that are added accentuate cross machine profile variations. Obviously, where there is little moisture present, variations are quite minimal.

However, where the web is too dry, the surface resistance to size penetration is high and the additive or sizing agent will not go into the web properly because the web has been literally burned. Not only does the web become less pervious to the sizing agent, but its physical characteristics, such as tensile strength, are adversely affected because overdrying breaks down the fiber bonding within the web.

Furthermore, excessive drying is expensive as many thousands of dollars can be wasted each year because of the additional cost of the extra steam that is used.

## SUMMARY OF THE INVENTION

One object of the present invention is to provide a surface-sized paper of improved quality. More specifically, the invention has for an aim the accurate control of moisture contained in the paper web as it passes into the size press. Also, it is within the purview of the invention to provide a moisture content that is relatively uniform in a cross machine direction, thereby minimizing the number of sizing streaks that will otherwise occur due to the irregular picking up of the sizing agent.

A more detailed object of the invention is to provide a dual control. In this regard, the invention has for an aim the control of a vernier dryer section that is normally utilized to effect an optimum amount of drying, but if the vernier dryer section cannot maintain the correct moisture content and still remain within predetermined pressure limits, then an additional drying section in advance of the vernier drying section is utilized so that the limit that has been exceeded will be more rapidly reduced to a value within the prescribed range.

Another object of the invention is to provide a highly efficient control system that results in a monetary saving by avoiding the overdrying that has occurred with prior art arrangements.

## BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE presented for exemplifying the invention includes a typical papermaking machine with our moisture control system incorporated therein.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

An exemplary papermaking machine is set forth in block form in the drawing, being designated in its entirety by the reference numeral **10**. Typically, the machine **10** includes a stock supply **11**, the stock being delivered to a headbox **12** and from there directed onto a Fourdrinier wire **14**. After passing from the Fourdrinier wire **14** the web labeled **15** proceeds through wet presses **16**.

The thermal drying begins with a wet end dryer section **18**. Actually, the number of drying sections will vary depending upon the particular design of machine and its production rate. However, in the illustrated instance, what will be termed a main dryer section **20** is included directly after the wet end dryer section **18**, the main dryer section **20** sometimes being referred to as an intermediate dryer section. It is from the main dryer section **20** that the web **15** is forwarded to a control or vernier dryer section **22** that provides the necessary heat for optimal maintenance of the web moisture; the main dryer section adjustments are made only when the prescribed limits of the vernier section are inadequate to maintain moisture at the desired level.



Directly after the vernier dryer section **22** is a moisture gauge **24** that traverses the web **15** in a lateral direction, that is from front to back or edge to edge, and provides a signal indicative of the moisture that it senses as it passes over the web. It will be observed that the moisture gauge **24** is interposed between the vernier dryer section **22** and a size press labeled **26**. It is of course at the size press **26** that the sizing agents, such as rosin, glue, gelatin, starch and the like, are added. As already mentioned, it is important to have the surface of the web **15** presented to the size press **26** with the proper amount of moisture contained therein. After the sizing has been added at the press **26**, further drying is achieved via an aftersize dryer section **28** and then the web **15** is directed to calenders **30** and from the calenders **30** the finished paper product is wound upon a reel **32**.

The various dryer sections identified by the reference numerals **18**, **20**, **22** and **28** are all heated by steam. However, the two dryer sections with which the present invention is concerned are what have been called the main dryer section **20** and the vernier dryer section **22**. These dryer sections **20** and **22** receive their steam from a steam supply **34**. The main dryer section **20** has a valve **36** through which steam is passed to this dryer section. The actuating means for the valve **36** is identified as a transducer **38**, the transducer **38** converting a current signal into a pressure signal the magnitude of which determines the position of valve **36**. Similarly, a valve **40** passes steam to the dryer section **22**. In this instance, a similar current-to-pressure transducer **42** is employed for assuring proper delivery of the position signal to the valve **40**.

The moisture control system for supplying the appropriate signals to the transducers **38** and **42** has been denoted generally by the reference numeral **50**. Since the moisture gauge **24** scans the width or trim of the paper web, it is necessary to provide an integrating action so that a signal is derived which is representative of the average moisture, this normally being referred to as "valid average"; the scan average is used to minimize probability of controlling based on a very atypical point of the web. Hence, a computer **52** may be employed having a first input line **52***a* connected to the gauge **24** so that information or data pertaining to the amount of moisture in the web **15** between the dryer section **22** and the press **26** will be fed to the computer **52**. The computer **52** has a second input line **52***b* for making certain that the calculated average signal is made available only after the gauge **24** has reached either the front or back side of the web. In other words, the input line **52***b* provides a digital signal that assures that an output signal at the output line **52***c* of the computer will not be forwarded until a scan has been completed and that a valid average has been calculated from data sensed by the gauge **24** during its traverse. Gauges are available, though, which will calculate the valid average; then only a relay contact need be closed after a scan so as to indicate that a valid average is available.

A summing junction or comparator circuit **54** has a pair of input terminals **54***a* and **54***b* and an output terminal **54***c*. The input terminal **54***a* is connected directly to the output line **52***c* of the valid average computer **52**. In this way, the output signal from the valid average computer **52**, which is the moisture input signal in this instance, is transmitted via the line **52***c* to the input terminal **54***a* of the summing junction **54**. At the summing junction **54**, the moisture signal is differenced with the moisture set point applied to the terminal **54***b* of the summing junction **54**. The resulting error signal appearing at the output terminal **54***c* is forwarded to a moisture controller **56**.

The output from the moisture controller **56** is dependent upon the time function of error and is transmitted to a summing junction or comparator circuit **58**, more specifically

one of its input terminals labeled 58*a*, where it is differenced with a signal supplied from a pressure-to-current transducer 60, the transducer 60 receiving its pressure signal from the vernier dryer section 22 and delivering its current signal to a second input terminal 58*b* belonging to the summing junction 58. The resulting error signal in this instance is then fed to a pressure controller 62. The output from the pressure controller 62 is a function of the error on a time basis. The output signal provided by the controller 62 proceeds to the previously mentioned current-to-pressure transducer 42 which adjusts the valve 40. The valve 40 in turn adjusts the steam flow rate to the vernier dryer section 22.

The output of the controller 56, this being the same output signal going to the terminal 58*a* of the summing junction 58, is also transmitted to a summing junction or comparator circuit 64, more specifically its input terminal 64*a*. In this way, the signal from the controller 56 constitutes one of the inputs to the summing junction 64. The pressure set point, which represents the desired pressure of the vernier dryer section 22, constitutes the other input, being applied to terminal 64*b*. The two signals impressed on the terminals 64*a* and 64*b* of the summing junction 64 are differenced and the resulting error signal appears as an output on terminal 64*c*. The error signal then proceeds to a deadbanded controller 66 having upper and lower limits which prescribe the upper and lower limits of the vernier dryer section 22. In other words, the alluded-to upper and lower limits represent pressure limits within which the vernier dryer section 22 should operate.

The controller 66 has its output side connected to a terminal 68*a* of another summing junction or comparator circuit 68. Of course, the normal or steady state output of the deadbanded controller 66 is only affected or changed when the value of the error signal exceeds the upper limit or decreases below the lower limit. When operating within the limits of the deadband, the output from the controller 66, which is the signal applied to the terminal 68*a*, maintains its present value and no corrective action is taken.

The output signal from the controller 66 is applied to the input terminal 68*a* of the summing junction 68 and is differenced with a signal applied to a second input terminal 68*b*, the last-mentioned signal coming from a pressure-to-current transducer 70, the transducer 70 supplying a current signal having a value in accordance with the steam pressure existing at the main dryer section 20.

The summing junction 68 has an output terminal 68*c* and any difference between the signals applied to its input terminals 68*a* and 68*b* appears as an error signal at the terminal 68*c* which signal is then transmitted to a pressure controller 72 whose output goes to the current-to-pressure transducer 38. It is the transducer 38 which produces an adjustment of the valve 36 which in turn adjusts the rate of steam flowing to the main dryer section 20.

Should the operation be such that the upper limit of the deadbanded controller 66 be exceeded, that is more pressure is demanded at the vernier dryer section 22 than is desired, the controller 66 will produce an output of increased value. This will automatically cause the magnitude of the error signal appearing at the output terminal 68*c* to increase. Since the pressure controller 72 now receives a signal reflecting the need for more drying heat, it will in turn cause the current-to-pressure transducer 38 to adjust the valve 36 in a direction to increase the rate of steam flow to the main dryer section 20. Hence, the drying rate derived from the main dryer section 20 will be increased. In other words, the main dryer section 20, which is ahead of the vernier dryer section 22, will dry at a faster rate than before the adjustment is made.

Since more drying is being achieved with the main dryer section 20, the amount of drying demanded at the vernier dryer section will be decreased to maintain the same moisture level in the web 15. Under these circumstances, the vernier dryer section 22 will be returned automatically to an operating range within the pressure limits prescribed therefor, because a sufficient portion of the drying load has been shifted from the vernier section 22 to the main section 20. It is the error or difference signal that appears at the terminal 58*c*, as hereinbefore pointed out, that is fed to the controller 62 which forwards a control signal to the transducer 42, thereby causing the valve 40 under these conditions to reduce the amount of steam being supplied to the vernier dryer section 22 with a concomitant reduction in the pressure sensed by the transducer 60. Such action, inasmuch as the output from the transducer serves as an input to the summing junction 58, progressively reduces the value of the error signal functioning as the input to the controller 62.

Conversely, should the moisture gauge 24 determine that too much drying of the web 15 is taking place, then the comparison made at the summing junction 54 between the inputs applied to the terminals 54*a* and 54*b* will result in an algebraically different error signal at the terminal 54*c* with the consequence that the moisture controller 56 outputs a signal to the terminal 64*a* which is compared with the pressure set point applied to terminal 64*b* so that the summing junction 64 produces a signal at its output terminal 64*c* below the lower limit of the selected dead band for the controller 66. The output from the controller 66, when compared at the summing junction 68 with the signal derived from the transducer 70, causes an error signal to appear at the terminal 68*c* that in turn causes the transducer 38 to reposition the valve 36 in a direction to reduce the rate of steam flow to the main dryer section 20.

Hence, the vernier dryer section is operated within a given pressure range and whatever upper and lower limits that are selected are maintained. As a result, the moisture content of the web 15 is efficiently and effectively held within established limits.

We claim:

1. In a machine for making a continuous web of paper having first and second dryer sections followed by a size section, a presize moisture control system comprising first valve means for supplying heat to said first dryer section, second valve means for supplying heat to said second dryer section, first control means responsive to the actual moisture content of said web as determined between said second dryer section and said size section for controlling said second valve means, and second control means controlled by said first control means for controlling said first valve means when said actual moisture content has increased to a predetermined value, said second control means including a controller having a dead band representative of upper and lower pressure limits for said second dryer section to position said first valve means in a direction to increase the flow of heat to said dryer means when said upper pressure limit is reached and to position said first valve means in a direction to decrease the flow of heat to said first dryer section when said lower limit is reached.

2. In a machine for making a continuous web of paper having drying means, valve means for supplying steam to said drying means, a size press, a presize moisture control system comprising means providing a signal indicative of the actual moisture content of said web at a location between said drying means and said size press, first comparator means for comparing said actual moisture signal with a moisture set point signal to produce an error signal representative of any difference therebetween, second comparator means for comparing said error signal with a set point signal representative of a desired pressure of steam for said drying means to produce a second error signal representative of any difference therebetween, and means for adjusting said valve means in a direction to change the flow of steam to said drying means so as to reduce any difference between said actual moisture signal and said moisture set point signal, said drying means including a main dryer section and a vernier dryer section, said vernier dryer section being located between said main dryer section and said size press, and said valve means including a first valve for supplying steam to said main dryer section and a second valve for supplying steam to said vernier dryer section, said system additionally including third comparator means for comparing

said first error signal with a signal representative of the steam pressure at said vernier dryer section to produce a third error signal for controlling the position of said first valve, and fourth comparator means for comparing said second error signal when above or below prescribed limits with a signal representative of the steam pressure at said main dryer section to produce a fourth error signal for controlling the position of said second valve.

3. In a machine for making a continuous web of paper having a size press, a main dryer section, a vernier dryer section between said main dryer section and said size press a first valve for supplying steam to said main dryer section and a second valve for supplying steam to said vernier dryer section, a presize moisture control system comprising means providing a signal indicative of the actual moisture contained in said web at a location between said vernier dryer section and said size press, first comparator means for comparing said actual moisture signal with a moisture set point signal to provide a first error signal representative of any difference between said moisture signals, second comparator means for comparing the value of said first error signal with a signal indicative of a desired steam pressure for said vernier dryer section to provide a second error signal representative of any difference therebetween, means responsive to the value of said second error signal for positioning said second valve in accordance with the value of said second error signal, third comparator means for comparing the value of said first error signal with a pressure set point signal to provide a third error signal representative of any difference therebetween, a deadbanded controller responsive to upper and lower limits of said third error signal for providing an output signal representative of values above and below said levels, and fourth comparator means for comparing the value of said output signal with a signal indicative of the steam pressure at said main dryer section to provide a fourth error signal in accordance with any difference therebetween for positioning said first valve in accordance with the value of said fourth error signal, whereby said vernier dryer section will operate between pressure limits determined by the dead band of said controller.

4. In a machine for making a continuous web of paper, a moisture control system comprising first means for supplying heat to a first portion of said web, first control means responsive to the actual moisture content of said web at a given location therealong for controlling said first heat-supplying means, second control means controlled by said first control means for controlling said second heat-supplying means when said actual moisture content has increased to a predetermined value, said second control means including a controller having a dead band representative of upper and lower limits for said first heat-supplying means to increase the flow of heat supplied by said second means when said upper limit is reached and to decrease the flow of heat when said lower limit is reached.

5. In a machine for making a continuous web of paper having a first dryer section and a second dryer section, first means for supplying heat to said first dryer section and second means for supplying heat to said second dryer section, a moisture control system comprising means providing a signal indicative of the actual moisture content of said web after said web has passed through said first and second dryer sections, first comparator means for comparing said actual moisture signal with a moisture set point signal to produce an error signal representative of any difference therebetween, second comparator means for comparing said error signal with a set point signal representative of a desired amount of heat to be supplied by said first dryer section to produce a second error signal representative of any difference therebetween, means for adjusting said second heat-supplying means to change the amount of heat supplied to said second dryer section so as to reduce any difference between said actual moisture signal and said moisture set point signal, third comparator means for comparing said first error signal with a signal representative of the heat supplied by said second dryer section to produce a third error signal for controlling the first heat-supplying means, and fourth comparator means for comparing said second error signal when above or below prescribed limits with a signal representative of the heat supplied by said first dryer section to produce a fourth error signal for controlling said second heat-supplying means.

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# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 3,625,812 Dated December 7, 1971

Inventor(s) John A. Gudaz and Marion A. Keyes, IV

**It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:**

Column 6, line 2, after "web" insert --second means for supplying heat to a second portion of said web,--.

**Signed and sealed this 13th day of June 1972.**

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents