

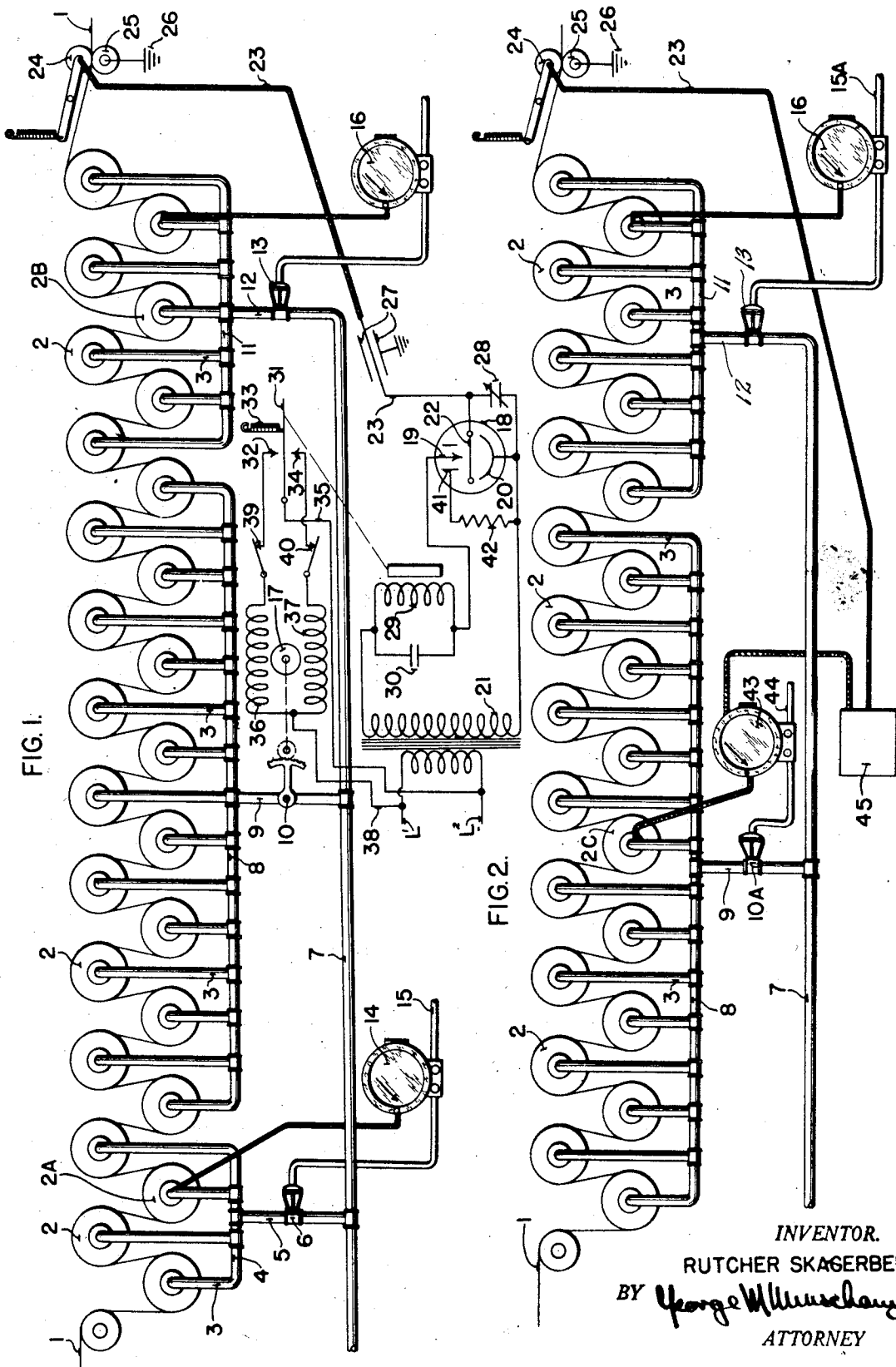
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DRIER CONTROL

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DRIER CONTROL

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The present invention relates to continuous drying machines and, more particularly, to a method of and means for regulating the heat that is supplied to said machines in such a manner that the drying process is carried out more efficiently than heretofore.

During the preparation of the fibers in a paper making process, the fibers are placed in a beater and mixed with water. While the beating is taking place, some of the water combines mechanically with the fibers, and some of it combines chemically, the latter often being referred to as the moisture of hydration. After a web has been formed, a large part of both the mechanically and chemically combined moisture remains in the fibers and has to be removed by a drier before the paper is ready for use.

The mechanically combined moisture exists in much greater quantity and is more easily removed than the chemically combined moisture. The latter results in a gelatinous film on the surface of the fibers which serves as a bonding medium therebetween and is difficult to remove. Because of the difficulty of removing the moisture of hydration, it has been customary to subject the dry end section of the drier to excessive temperatures. This is objectionable because it drives out the moisture of hydration too rapidly, resulting in a breaking down of the bond between the fibers, distorting and weakening the material.

In drying paper and other hygrometric material, it has been customary to vary steam pressure in the drier rolls throughout the entire length of the drier to accommodate the varying drying demands. One objection of maintaining varying temperatures in the dry end section of the drier results when a moisture detecting device is used to control the heat of the drier. Most of the moisture detecting devices are influenced by temperature changes of the web, as well as by its moisture changes. For instance, a device which measures the electrical conductivity of the web will show a greater conductivity with rising web temperature, as well as with rising moisture content of the web. Hence, it is impossible to determine whether a change in reading is due to temperature or moisture. It may be possible to have an increase in temperature and a reduction in moisture which may completely off-set each other and, therefore, result in no correction of the moisture content of the web. Other possible conditions and results are obvious.

two or three sections, as may be desirable, depending upon the type of paper being made, and maintain the steam pressure or temperature constant in the dry end section and allow the steam variations that are necessary to change the drying rate take place in the central section if the drier is divided into three sections, and in the wet end section if the drier is divided into two sections. If the drier is divided into three sections, the wet end section, as well as the dry end section, will be maintained at a constant steam pressure or temperature.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects obtained with its use, reference should be had to the accompanying drawing and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

In the drawing:

Fig. 1 is a view showing the control system for a drier when it is divided into three sections; and Fig. 2 is a view showing the control system for a drier when it is divided into two sections.

Referring first to Fig. 1, there is shown a drier over which a web 1 of paper, or other hygrometric material to be dried, passes. The drier consists of a series of hollow drums or rolls 2 which are individually supplied with steam through pipes 3. As is clearly shown in this figure, the drums 2 are divided into three sections, the pipes 3 of the wet end section being supplied from a secondary header 4 that is connected by a pipe 5, in which is located a valve 6, to a main steam header 7. In a similar manner, the pipes 3 supplying steam to the drums in the center section are supplied from a secondary header 8 by a pipe 9 which has a valve 10 in it and which is connected to the main header 7. The dry end section drums are supplied from a secondary header 11 that is in turn connected to the main steam header 7 by a pipe 12 having a valve 13 in it.

Steam is supplied preferably under a constant pressure to the header 7 from which it goes to the secondary headers 4, 8 and 11 in an amount that is regulated respectively by the valves 6, 10 and 13. These valves could be adjusted by hand, but it is preferred to adjust them in the following manner.

At the wet end of the drier where the material is being heated up from a cool condition to a

I therefore propose to divide the drier into

temperature of evaporation, it is frequently undesirable to subject the material to too high a temperature. For this reason, the temperature of the wet end section that is supplied by the header 4 is adjusted to a predetermined value that will not be excessive, depending upon the condition of the material. The temperature or pressure, as may be desired, since the pressure is an indirect measure of the temperature, of one of the rolls is measured, and the opening of the valve 6 is adjusted in accordance with the value. As is shown in Fig. 1 of the drawing, a temperature or pressure connection from one of the rolls 2A leads to a controller 14 which may be of any suitable type. It is herein shown as being a Brown "Air-O-Line" pressure controller, and pressure variations in the roll 2A are measured by the instrument 14 which in turn adjusts the pressure of air supplied through pipe 15 to the diaphragm of valve 6 proportional thereto, to change the opening of the valve 6 and, in this manner, keep the steam pressure and the temperature of the rolls in this section constant at all times. The pressure at which the instrument controls can be varied as desired for different types of material that are being dried.

In a similar manner, the temperature of the rolls 2 in the dry end section of the drier is kept constant by another pressure controller 16 of the same type which is connected with a roll 2B in this section. The temperature in the dry end section of the drier is generally kept higher than that of the wet end, but it is desirable to also maintain this temperature at a constant value in order that a moisture measuring device, which is used to control the temperature of the center section, may be responsive only to the moisture content of the web and not be effected by temperature variations thereof, and so that these rolls may have a predetermined drying effect.

The center section of the drier, supplied by the header 8, is controlled with respect to its temperature by means of a moisture detector which is subjected to the moisture of the web as it leaves the dry end section. Variations in the moisture content of the web, as detected by a moisture responsive element, will change the opening of the valve 10 as needed to dry the web to a uniform moisture content. The drums in this center section of the drier may be subjected to varying temperatures without injury to the web and without effecting the detecting mechanism of the moisture controller. Also, the material passing over the center section of the drier may be subjected to the rather high temperatures that are necessary to drive out the moisture of hydration without injury to the material.

The form of moisture control device which is shown in connection with this figure consists of an electronic circuit for controlling the motor 17 which regulates the drying rate of this center section of the drier. The moisture responsive means includes a grid glow tube 18 which has its anode 19 connected to one terminal, and its cathode 20 connected to the other terminal of the secondary of a transformer 21, which has its primary winding connected between alternating supply conductors L₁ and L₂, and constitutes the power source for the moisture responsive means. The grid element 22 of the tube 18 is connected by a conductor 23 to a roller 24, which forms a part of the device, and is spring held against a portion of the web above a guide roll 25, the latter having a ground connection 26. To avoid

the effect of stray currents, the conductor 23 is heavily shielded throughout its length, as by shielding means 27. A variable condenser 28 is connected between the cathode 20 and the grid 22.

The connection between the anode 19 and the corresponding terminal of the transformer secondary includes a relay winding 29 shunted by a condenser 30. When the winding 29 is energized by a suitable current flow therethrough, it attracts a pivoted armature 31 and moves the latter out of engagement with a switch contact 32, against the action of a bias spring 33, and into engagement with a switch contact 34. The armature 31 serves as a switch element and is connected by a conductor 35 to the supply conductor L₂. The contacts 32 and 34 are connected by windings 36 and 37, respectively, to one end of a conductor 38 which is connected at its opposite end to supply conductor L₁. The windings 36 and 37 are the energizing windings of the motor 17. The latter may be of any available reversible alternating current motor type adapted to operate in one direction when current flows through the winding 36, and in the opposite direction when current flows through the winding 37. In particular, the motor 17 may be of the type described in the Shivers U. S. Patent No. 1,877,605 and comprising two rotor elements, one in inductive relation with the winding 36, and the other in inductive relation with the winding 37. As shown, the windings 36 and 37 are connected to the contacts 32 and 34 respectively, through limit switches 39 and 40, respectively, whereby the maximum movement of the motor in each direction is limited. As shown, the tube 18 includes an auxiliary cathode 41 in close proximity to the anode 19 and connected to the main cathode 20 by a resistance 42 which serves to prevent the collection of electro-static charges on the glass shield (not shown) of the anode, when current is conducted by the tube.

In the operation of the apparatus shown diagrammatically in Fig. 1, there will be no anode current flow operatively energizing relay winding 29 when the resistance between the grid 22 and the ground connection 26 is high enough to permit the grid to be sufficiently negative to prevent the ionization or break-down of the neon or other gas in the tube 18. With the apparatus properly adjusted, when the moisture content in the web passing between the roller 24 and adjacent grounded guide rolls 25 is lower than is desirable, the conductivity of the web will be correspondingly low, and the potential of the grid 22 relative to the cathode 20 will be sufficiently negative to prevent an energizing current flow through the winding 29. In consequence, the armature switch member 31 will then be held by its bias spring 33 in engagement with the contact 32, the winding 36 will be energized, and the motor 17 will operate in the direction to decrease the steam supply to the drying rolls in the arrangement shown in Fig. 1.

When the moisture content of the web engaged by the roller 24 rises above the desired value, the resultant increase in conductivity of the web will reduce the resistance in the connection between the grid and the ground connection 26, and permit the current flow through that connection to increase to the critical value at which the reduced negative potential of the grid relative to the cathode potential, will permit the tube gas to be ionized, or break-down. The winding 29 will then be energized by the anode current flow, and the armature switch member 31 will be

moved into engagement with the contact 34. This will energize the winding 37, and the motor 17 will then operate to increase the drying effect and suitably reduce the moisture content of the web engaged by the roller 24.

The critical control current flow from the grid 22 through roller 24, the web and the ground connection 26, required to initiate the power current flow between the cathode and anode of the tube 18, need be only a small fraction of a milli-ampere, and very much smaller than the last mentioned current flow. The grid glow tube used as described, thus forms a powerful amplifier, highly effective for the control of the motor 17 by the minute control current flowing from the grid through the ground connection 26. While the anode current flow through the tube 18, created by an increase in the grid control current to its critical value, destroys the control effect of the last-mentioned current, with alternating current energization, the anode current will flow through the tube only during the portion of each alternation period in which the anode potential is positive. In consequence, the control effect of the current flow through the grid to ground connection, is restored during each alternation period as soon as the anode potential reduces to zero, so that for practical purposes, the operation of the motor 17 is at all times subject to the control of the controlling grid current, as the latter rises to and falls below its critical tube ionizing magnitude.

The actual critical magnitude of the control current, and thereby the web moisture content which the apparatus tends to maintain, may be varied by adjustment of the variable condenser 28. While the anode current is pulsating, the condenser 30 in shunt with the winding 29 discharges current through the winding 29 when the anode current reduces to zero, and thus permits the coil 29 to maintain a steady magnetic pull and avoids chattering of the armature switch member 31.

A summary of the operation of this drier control system will now be given. The web from the paper making machine enters the wet end of the drier and is brought up to the temperature of evaporation by the first section of rolls, during the passage over which a portion of the mechanically combined moisture is driven from the web. After passing the first section of rolls, the web goes to the second or center section whose temperature is varied in accordance with the final condition of the web in order that this condition may be held constant. During its passage over the center section of rolls, the remainder of the mechanically combined moisture is driven from the web, as well as a portion of the moisture of hydration. The final section of rolls on the dry end of the machine expels the rest of the moisture of hydration.

By keeping the first and final sections of the drier at a constant temperature that may differ for each section and may be changed to suit the material, it is possible to use these two sections to expel a predetermined amount of moisture from the web. Then by varying the temperature of the center section of the web in response to its final condition, a variable amount of moisture can be driven therefrom to keep the final moisture content constant. Also, by keeping the temperature of the final section constant, the web leaving the machine will be at a constant temperature so that the roll 24 will be subjected only to moisture variations, and will therefore

cause adjustment of valve 10 in response to only the one condition which it is desired to regulate.

It will be understood that the control effected by the moisture responsive device need not directly control valve 10, but the latter may be controlled to maintain a predetermined condition, such as temperature or pressure, in the section of the drier supplied by it, and the predetermined condition will be varied by the moisture responsive device. Such a system is sometimes referred to as an interlock system and may be of the type now to be described in connection with Fig. 2.

The embodiment of the invention disclosed in Fig. 2 has the drier divided into only two sections. The rolls 2 of the first or wet end section are supplied from a secondary header 8 which is in turn supplied from a main header 7 through a pipe 9 which contains the valve 10A. The second or dry end section of the rolls 2 is supplied with steam from a secondary header 11, which is in turn supplied through pipe 12 and valve 13 from the main header 7. The temperature of the rolls in this section is kept constant by a pressure controller 16 which may take the form of a standard Brown "Air-O-Line" pressure controller, and which adjusts the pressure of the air supplied through line 15A to the diaphragm of valve 13.

The interlock system by which the temperature of the rolls 2 of the wet end section are controlled comprises a pressure or temperature controller which is here shown as a standard Brown "Air-O-Line" pressure controller 43. It is responsive to the pressure of the steam in one of the rolls 2C in the wet end section and adjusts the pressure of the air, supplied through line 44, which is impressed upon the diaphragm of the control valve 10A to normally maintain a constant steam pressure in the drier rolls of this section. The control point of the instrument 43, or the pressure which the instrument will maintain in the rolls 2, is adjustable, and, in this case, is adjusted by the moisture controller 45 which may be identical to the one described in detail in connection with Fig. 1.

The operation of this embodiment of the invention is generally similar to that of Fig. 1. The rolls of the dry end section are kept at a constant temperature so that they will drive a predetermined amount of moisture, mainly the moisture of hydration, from the web 1. By keeping the rolls in the second section of the drier at a constant temperature, the moisture responsive roll 24 will not be affected by variations in the temperature of the web, but will be responsive to moisture only. In this manner, the controller 45 will be responsive to the moisture content of the web and will adjust the control point of the pressure controlling instrument 43 up or down, as necessary, to keep the temperature of the drums in the wet end section at that point necessary to drive out the mechanically combined moisture and a portion of the moisture of hydration.

It will be seen from the above that I have invented a control system for a continuous drier in which the drier is divided into sections, each of which has a specific function in the drying operation. Namely, one or more sections is to drive a predetermined amount of moisture from the web, while another section is to drive a variable amount of moisture from the web. The manner in which the various sections of the drier are controlled with respect to the travel of the

web being dried is such that a most efficient operation is performed. The various control instruments can perform their control functions quickly and accurately. The control system avoids any confusion of the measurement of temperature and moisture, and prevents destruction of the web as a result of too rapid removal of the moisture of hydration.

By recognizing that there are two types of moisture in the web and setting up the machine so that each will be handled in the most effective manner, the final moisture content of the web can be adjusted within very narrow limits.

Although I have described my invention as being used for the drying of a paper web, it will be obvious to those skilled in the art that it may be used in the drying of any type of web.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a drying machine comprising a plurality of drying rolls divided into sections and including a dry end section, means to supply steam to each section individually, means to regulate the steam supplied to the dry end section solely in response to a physical condition of the steam supplied to the rolls in that section to maintain the rolls in said section at a constant temperature, means to measure the moisture content of the material being dried after it leaves the rolls of said dry end section, and means to adjust the amount of steam supplied to the section of drier over which the material being dried passes prior to reaching the dry end section in response to a measurement made by said measuring means.

2. In a drying machine comprising a plurality of rolls over which a web is adapted to run, said rolls being divided into sections comprising a wet end section, a center section and a dry end section over which the web passes in the order named, means to individually supply steam to said sections, means to adjust a condition of the steam supply to the wet end section to a constant value, means to adjust a condition of the steam supply to the dry end section to a constant value which is responsive solely to a physical condition of the steam supplied to the rolls in that section and which is different from the value of the supply to the wet end section, and means to adjust the steam supply to the center section to a variable value, said means being responsive to the moisture content of the web after it leaves the dry end section.

3. In a drying machine comprising a plurality of rolls over which a web of material to be dried is adapted to pass, a first header to supply steam to a plurality of rolls on the dry end of the machine, a second header to supply steam to a plurality of rolls on the wet end of the machine, a supply of steam for said headers, means to adjust a condition of the supply of steam to said first header to a constant value that is responsive solely to a physical condition of the steam in rolls of that section, means to measure the moisture content of the web after leaving the rolls on the

dry end of the machine, and means to adjust the supply of steam to said second header in response to a measurement made by said measuring means.

4. The method of controlling the drying process in a continuous drier which consists of dividing the drier into a plurality of sections and individually controlling the temperature of each section, by maintaining a physical condition of a drying medium in the dry end section at a predetermined constant value and adjusting the flow of said drying medium to the section just prior to the dry end section in response to the moisture content of the material being dried as determined immediately after it has left the drier.

5. The method of controlling the drying process in a continuous drier which comprises dividing the drier into a plurality of sections and maintaining a physical condition of a drying medium in the dry end section constant, whereby the material being dried will leave the machine at a constant temperature, and adjusting the quantity of said drying medium supplied to the section of the drier prior to the dry end section in response to the moisture content of the material as determined immediately after leaving the drier.

6. In a drying machine comprising a plurality of drying rolls divided into a plurality of sections including a dry end section and one or more sections preceding said dry end section over which the material to be dried first passes, adjustable means to individually supply steam to each section of drying rolls, means to maintain the value of the steam drying qualities in the dry end section constant, means to measure the moisture content of the material being dried after it has passed the dry end section, and means responsive to a measurement made by said measuring means to adjust the steam supply means to one of said other sections in accordance therewith.

7. In a drying machine containing a plurality of drying rolls, means to supply a temperature changing medium to said rolls and means to control the supply of said medium to some of said rolls separately from the supply to others of said rolls, said last named means comprising mechanism solely responsive to a physical condition of the drying medium within one of the rolls in a group forming the last rolls over which the material to be dried passes to control the supply of the temperature changing medium to those rolls and means to measure the moisture content of the material after it has passed the last named group of rolls and control the drying effect of a group of rolls prior to the last group of rolls.

8. In a drying machine containing a plurality of drying rolls means to vary the drying effect of said rolls comprising means to individually vary the drying effect of various groups of said rolls, said means comprising mechanism solely responsive to a physical condition of the drying medium within one of the rolls of a group of rolls over which the material to be dried last passes to vary the drying effect of that group of rolls and mechanism responsive to the moisture content of the material after it has passed said last mentioned group of rolls to control the drying effect of a group of rolls prior to the last group of rolls over which the material to be dried passes.

9. In a continuous drying machine having a plurality of drying rolls divided into a plurality of sections, means to supply steam to each of said sections individually to heat the drums in each section the same amount, means responsive

solely to a physical quality of the steam supplied to one of the drums in the last section over which the material being dried passes to maintain the temperature of said drums at a predetermined constant value, second means responsive to a physical quality of the steam supplied to one of the drums in a section of drums prior to the last section over which the material being dried passes to maintain the temperature of the drums

of that section at a predetermined value, means to measure the moisture content of the material being dried shortly after it passes the last drum in the last section, and mechanism operated in response to a measurement made by said last named means to vary the predetermined temperature at which said second responsive means will keep the rolls in the section that it controls.

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