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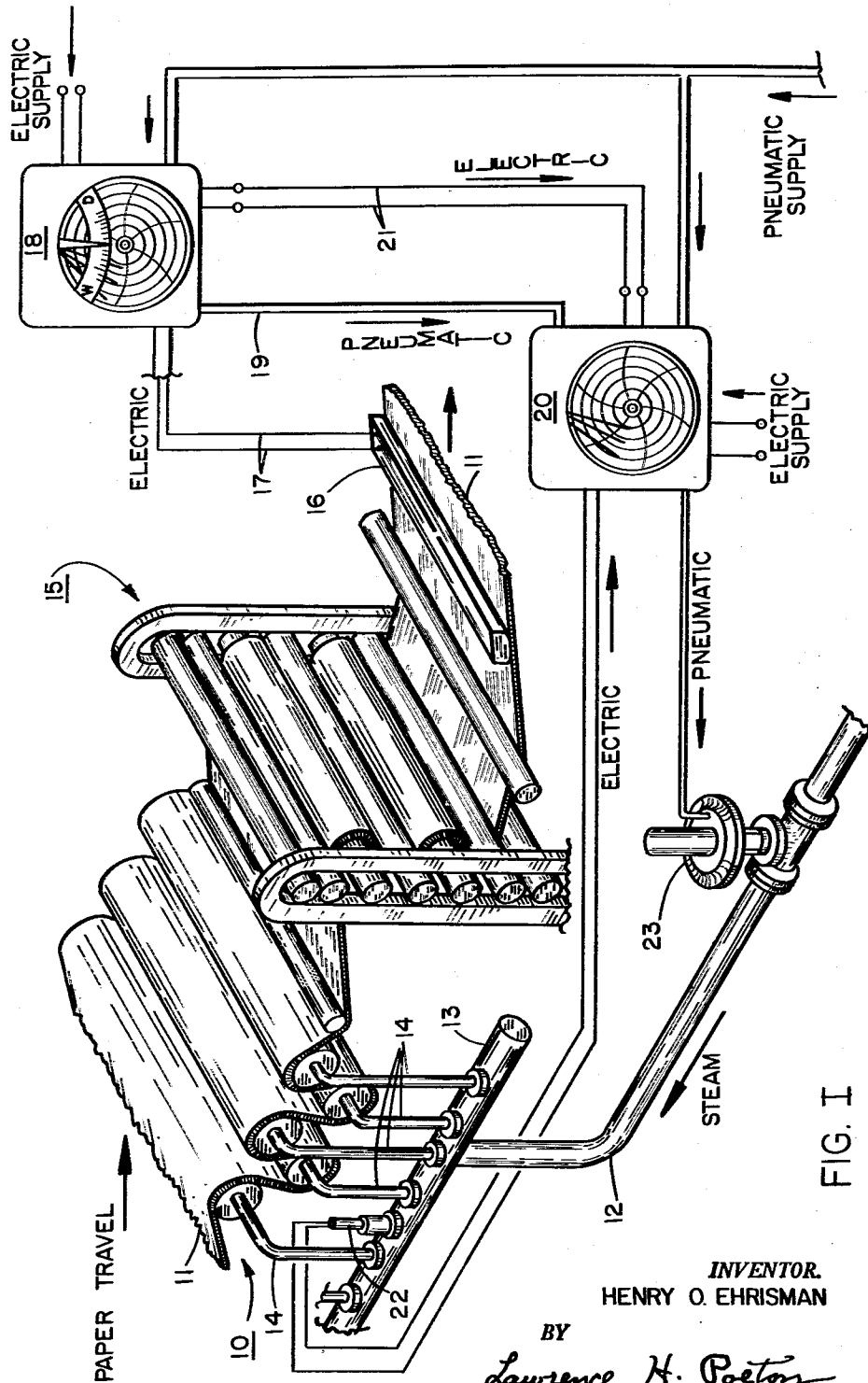
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2,724,903

MOISTURE CONTROL APPARATUS

Filed Aug. 31, 1954

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

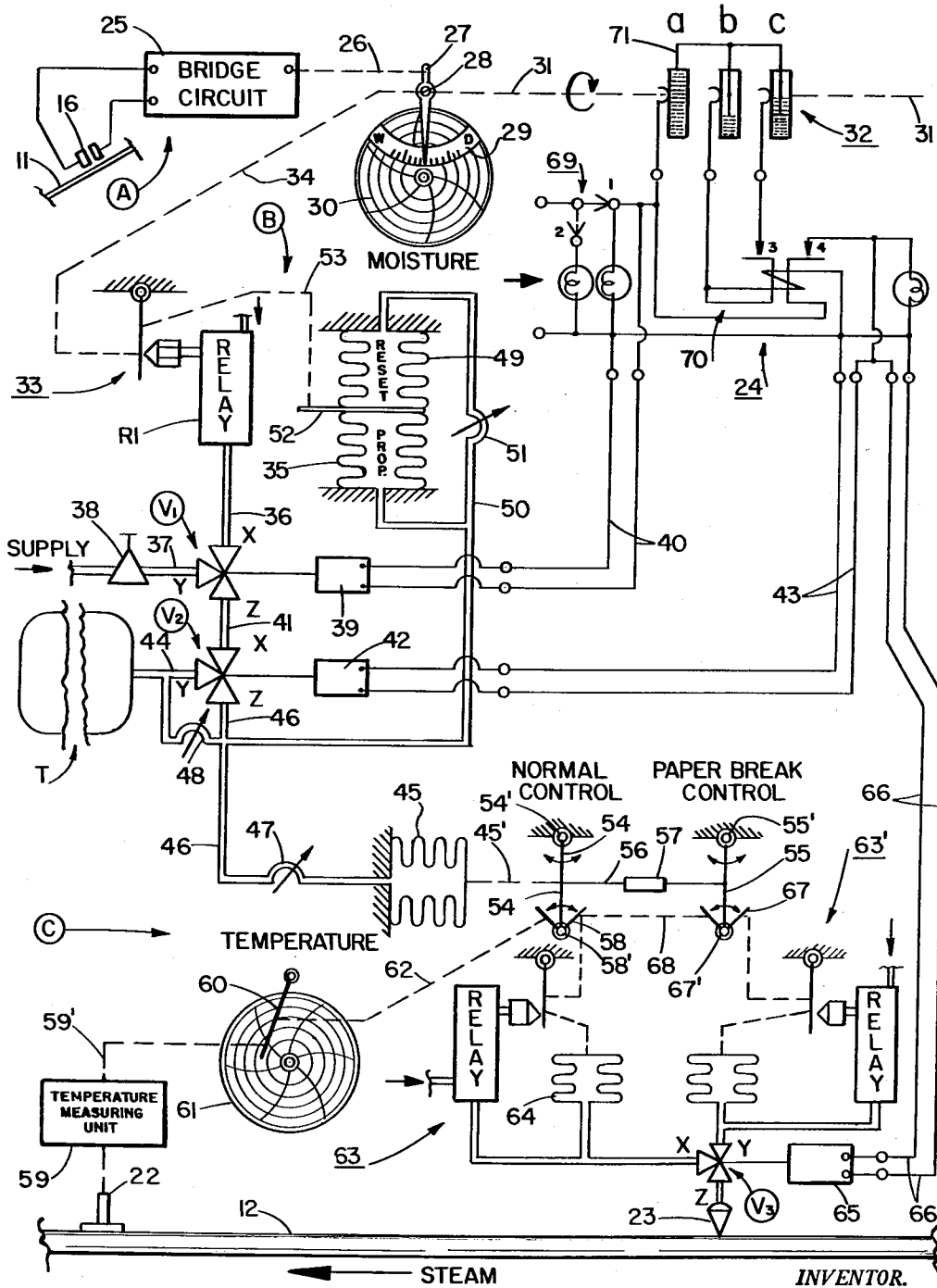


FIG. II

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3 Sheets-Sheet 3

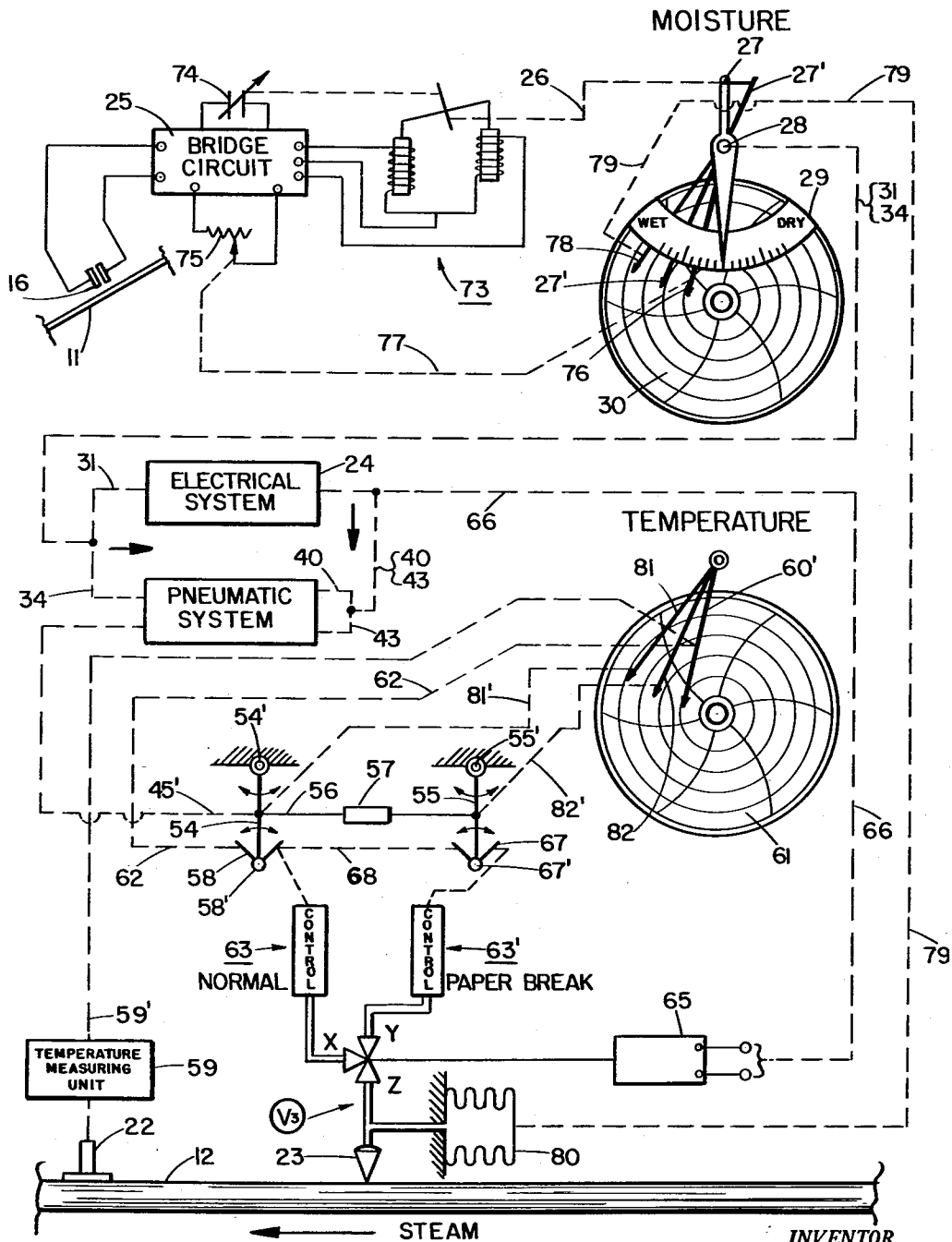


FIG. III

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2,724,903

MOISTURE CONTROL APPARATUS

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Application August 31, 1954, Serial No. 453,176

3 Claims. (Cl. 34—49)

This invention relates to moisture control by means of control of a drying medium. As an example, an embodiment of this invention may be used to control the moisture content of paper in paper making machinery by controlling the temperature of steam which is used as a heating medium to reduce the moisture content of the paper.

One of the last steps often used in the manufacture of paper is a drying step in which the paper is passed over heated rolls. In the embodiment mentioned above, a steam pipe feeds steam to the rolls, and a temperature control instrument is used to control the temperature of the steam. Further, a moisture control instrument is used to measure the moisture changes in the paper with a moisture sensing element in firm contact with the paper at a point following the heated rolls, and the output of the moisture control instrument is used to adjust the control set point of the temperature controller.

In the course of its manufacture, the paper web is purposely broken from time to time so that the machinery may be cleaned, and under some conditions the paper may accidentally break. It is important in such cases, especially if the break condition lasts more than a few minutes, to establish the conditions of manufacture in such a way as to facilitate a restart and continuance of the paper production. When the paper breaks in any manner, the moisture sensing element usually no longer engages the paper. The controllers then react as if confronted with very dry paper. In prior art arrangements, the result of such action has been a substantial waste of paper when the paper is rethreaded.

This waste occurs because the rethreaded paper comes off the machine at first either too wet or too dry, depending on the prior art arrangements. In certain of such arrangements, after a paper break, the dryer rolls are allowed to cool down too far and the rethreaded paper comes over too wet. In other such arrangements the surface temperature of the dryer rolls becomes too hot and the paper comes over badly overdried, hence brittle, causing additional paper breaks and spoilage.

The control device of this invention provides means for overcoming the disadvantages set forth above. When a control device according to one embodiment of this invention is used a break in the paper results in (1) a lockup of the steam control system, and (2) with this lockup at a point which results in a steam temperature which is an appropriate predetermined amount below that called for immediately preceding the break. Thus the dryer rolls are neither allowed to cool down too far nor become too hot. Further, the temperature of the dryer rolls when the paper is rethreaded, is easily and rapidly changed the comparatively small amount necessary to reach the conditions for correct drying, with a minimum of waste. Certain controller pneumatic system lockup arrangements are provided, so that the controllers are in condition for quickly and easily reaching normal control condition after the paper is rethreaded.

In a pneumatic system combination which is provided in accordance with an embodiment of this invention, the

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output of a moisture controller is a pneumatic pressure which is used to adjust the set point of a duplex temperature controller. When the paper breaks, the control is shifted automatically from one part of the duplex unit to another, and the temperature control set point is thereby automatically changed to a point which is a predetermined amount below its value immediately preceding the break.

In the embodiment described herein, the steam admission controller is a temperature controller. However, for some applications a pressure controller is equally suitable.

It is, accordingly, an object of this invention to provide improved moisture control apparatus.

It is a further object of this invention to provide improved apparatus for controlling the moisture content of paper in the process of manufacture, in the drying area of a paper making machine.

Other objects and advantages of this invention will be in part apparent and in part pointed out hereinafter.

In the drawings:

Figure I is a general illustration of an embodiment of this invention, with a moisture and temperature controller combination shown in association with a dryer section of a paper machine;

Figure II is a schematic illustration of a control arrangement for the embodiment of this invention as shown in Figure I; and

Figure III is another showing of the control arrangement of Figure II, with illustrations of associated indicating and recording devices and connections therefor.

Cited herein: (1) Copending application by W. H. Howe, Serial No. 309,046, filed September 11, 1952, and entitled "Means for Measurement by Electrical Condenser of Characteristics and Conditions of Material;" (2) Patent No. 2,476,104, issued July 12, 1949, to C. E. Mason, and entitled "Method and Apparatus for Control;" (3) Patent No. 2,175,085, issued October 3, 1939, to C. L. Lothrop, and entitled "Control Mechanism."

In Figure I, a set of paper machine dryer rolls 10 is shown with a sheet of wet paper 11 being partially dried by being passed over and under the rolls 10 according to their locations. The paper has excess moisture therein as a result of previous steps in the paper making process, and steam is provided through a supply pipe 12 to heat the rolls as a means of reducing the moisture content of the paper. The steam supply pipe 12 leads the steam to a header pipe 13 and steam is fed to each of the rolls 10 through one of a group of steam supply pipes 14 each of which is connected from the header pipe 13 to the interior of its respective dryer roll.

After leaving the last roll in the set of dryer rolls, the paper 11 is passed through a calender stack 15 and thereafter has a moisture sensing element 16 associated therewith, with the element 16 in firm contact with the paper 11. The sensing element 16 is an electrical condenser with the paper 11 passing through the edge spray field thereof, and with electrical leads 17 to a moisture controller 18. This form of sensing element and its association with a controller are shown in the above-cited Howe patent application, Serial No. 309,046. By very generally considering the structure of the Howe application as combined with the proportional control structure of the above-cited Mason Patent No. 2,476,104, a general idea may be obtained of the type of structure which is provided in the moisture controller 18.

The output of the moisture controller 18 is in the form of a pneumatic pressure applied through a pneumatic connection pipe 19 to adjust the set point of a temperature controller 20. This temperature controller embodies the type of proportional control disclosed by the above-cited Mason Patent No. 2,476,104. An electrical con-

nection 21 is shown between the moisture controller 18 and the temperature controller 20. This connection 21 is part of an auxiliary electrical switching circuit which is operated when, due to a break, the paper loses contact with the moisture measuring element. This arrangement will be detailed hereinafter.

The temperature controller 20 controls the temperature of the steam in the steam header 13. A temperature sensing element 22 for the temperature controller 20 is located in a chamber off the steam header 13 and a steam supply control valve 23, which is operated by the temperature controller 20, is located in the steam supply pipe 12.

Figure II presents a more detailed showing of the control structure of Figure I as related to one embodiment of this invention. In order to consider this illustrative embodiment of this invention in detail, reference is made to the general showing of Figure I; to the fact that the moisture controller of Figure I generally embodies a combination of structures such as those shown in the above-cited Howe patent application, Serial No. 309,046, and in the above-cited Mason Patent No. 2,476,104; and to the fact that an electrical switching arrangement 24 of Figure II is used with the moisture controller 18, Figure I. The electrical switching circuitry of this arrangement is generally disclosed in the above-cited Lothrop Patent 2,175,085.

In Figure II, section A is an electrical circuit in representation of the circuit in the above-cited Howe patent application. Section B is a pneumatic control arrangement (moisture) which has general similarities with respect to the pneumatic proportional and reset control disclosure in the above-cited Mason patent. Section C is a pneumatic control arrangement (temperature) which has general similarities with respect to the pneumatic proportional control disclosure in the above-cited Mason patent. With reference to Figure I, the Figure II sections A and B are associated with the moisture controller 18, and the Figure III section C is associated with the temperature controller 20.

In Figure II at the top left, a section of the paper 11 is shown as passing through the edge spray field of the moisture sensing element, that is, the electrical condenser 16.

The electrical condenser moisture sensing element 16 is arranged with both plates thereof on one side of the paper 11 and is connected to an electrical bridge circuit 25 which produces a mechanical movement which is indicated at 26 and is used to rebalance the electrical bridge circuit 25 and as an output movement thereof.

Referring further to Figure II, the output movement of the bridge circuit 25 is applied to a moisture indicator arm 27. The indicator arm 27 is thus movable about a pivot 23 and along an indicator scale 29 which transversely overlies a rotatable moisture controller chart 30. The indicator arm 27 is positioned at the mid-point of the scale 29 in representation of a null balance condition of the bridge circuit 25. Thus the measurement through the bridge circuit 25 is one of deviation from a predetermined set point. The pivotal movement of the indicator arm 27 is applied, through a mechanical connection 31, to actuate an electrical contact unit 32 in the electrical switching circuit 24 in a manner and for purposes which will be detailed hereinafter. The bridge balancing movement (26) of section A is also applied to a pneumatic nozzle-baffle unit 33 in section B as indicated by a mechanical connection line 34 from the controller indicator arm 27 to the baffle of the nozzle-baffle unit 33. The nozzle of this unit 33 is connected to a pneumatic relay R1 in a conventional pneumatic system arrangement wherein the back pressure in the nozzle is varied as the baffle is moved toward and away from the nozzle. Accordingly, the output of the pneumatic relay R1 is a pneumatic pressure which varies in predetermined relation to moisture content changes in the paper 11 as the paper is processed on the dryer rollers 10.

A pneumatic system combination is shown in Figure II. Elements which are directly involved in the combination include the moisture controller pneumatic relay R1; a two-way, triple ported valve V1 to which the output of the relay R1 is directed through a pipe 36, with the valve V1 provided with a side port Y, a pipe 37 connected to the side port Y from a manual supply regulator valve 38, an electrical solenoid unit 39 for operating the valve V1, and electrical connections 40 to the electrical switching circuit 24; a two-way, triple ported valve V2 connected to the valve V1 by a pipe 41, with the valve V2 provided with an electrical solenoid unit 42 for operating valve V2, and electrical connections 43 to the electrical switching circuit 24; a pneumatic capacity "memory" tank T with a pneumatic pipe connection 44 to the valve V2, with the tank T shown as broken to indicate large capacity with respect to the other portions of the pneumatic systems; an output pressure bellows 45 pneumatically connected to the valve V2 through a pipe 46 and through a damping restrictor 47; a pneumatic bleed restrictor 48 in a by-pass around the valve V2, pneumatically connecting the pneumatic capacity tank T to the bellows 45 at all times; and a proportioning (35) and reset (49) bellows assembly pneumatically connected to the output of valve V2 through a pipe 50, with the portion of the pipe 50 which leads to the reset bellows 49 containing a reset restrictor 51. The reset bellows 49 is mounted on the proportioning bellows 35 with a dividing wall 52 therebetween which is movable to represent the difference in the pressures in the proportional and reset bellows. The movement of the dividing wall 52 is applied to the baffle of the nozzle-baffle unit 33 through a mechanical connection 53 in a balancing action which is usual in this type of controller. Note that the valve V2 may be operated to pneumatically isolate the reset bellows 49 with respect to the relay R1.

This pneumatic system may be considered to comprise two pneumatic systems with the valve V2 established as the juncture of the systems. It may be noted that the moisture and temperature controllers 18 and 20, Figure I, and the pneumatic systems of this present combination do not necessarily have the same point of separation. If desired, the control units may be located in their respective controller housings, with a panel unit therebetween for the valve arrangements etc.

In the normal control joint operation of the moisture and temperature controllers, two pneumatic systems are joined through the valve V2, that is, pipes 41 and 46 are pneumatically connected. In this condition the pneumatic capacity memory tank T is closed off from both systems by the valve V2, except for its pneumatic bleed connection through the by-pass pipe restrictor 48 to the bellows 45. As will be discussed hereinafter, when a particular upset occurs, for example, when the paper breaks in the paper machine, the valve V2 is automatically operated to close off pipe 41 and to directly connect the tank T to pipe 46, through the valve V2.

When manual control is desired, the valve V1 is operated to disconnect pipes 36 and 41 and to connect pipes 37 and 41, and the hand valve 38 is thereafter operated as desired.

During the normal control operation of the controller combination the valve V1 connects the relay R1 and the valve V2 completes the connection from the relay R1 to the output bellows 45. The tank T is closed off by the valve V2 but the pneumatic pressure in the output bellows (45) system is established in the tank T by pneumatic bleed action through the by-pass restrictor 48. When the paper breaks, these connections remain the same for a short period, while the moisture control indicator 27 is moving towards "dry" indication, to the point of actuation of the switching circuit 24. The pneumatic pressure throughout the proportioning, reset and output bellows systems is reduced during this period as the moisture controller reacts to shut off the

steam supply because the moisture controller senses a relatively very dry condition in the absence of the paper. The switching circuit 24 is actuated before this pressure reduction has gone very far in the output bellows 45, the reset bellows 49, and the tank T; and the valve V2 is thereupon automatically operated to lock the remaining pressure in the proportioning, reset and output bellows systems and to add to this remaining pressure the pressure in the pneumatic capacity memory tank T. The calculated end result is that the proportioning, reset and output bellows and the tank T are locked up in a single pneumatic system at a pressure which approximates the pressure in the output bellows 45 immediately preceding the paper break, and the normal temperature controller set point is thus maintained. However, as will be seen hereinafter, an auxiliary temperature control set point is brought into action at the same time that the valve V2 is thus actuated, and the temperature controller is operated at this auxiliary set point, which has been established to be an appropriate predetermined amount below the normal set point as it is immediately preceding the paper break. Thereafter, when the paper is again in process and in contact with the moisture sensing condenser 16, normal operating pressure is re-established in the output of the relay R1, and the valve V2 is again automatically operated, this time to reconnect the relay R1 and the output bellows 45, the normal temperature control point is re-established in an associated action detailed hereinafter, and the valve V2 again blocks off the pipe 44 to the tank T. As the process thereafter continues, the pressures in the output bellows 45 and the tank T again tend to be equalized by pneumatic bleed through the pneumatic restrictor 48.

The temperature control arrangement in section C, Figure II, is provided with a schematically illustrated duplex control system. First, a pair of pivoted set point index arms 54 and 55 are provided, on fixed pivots 54' and 55' respectively, with a connector bar 56 therebetween having a micrometer adjustment unit 57 for changing the pivoted positions of the set point index arms with respect to each other. The movement of the previously mentioned output bellows 45 is applied to the set point arm 54 through a mechanical connection 45' and the moisture measurement is thus translated into simultaneous adjustment of both of the set point arms, but with the paper break set point always having a predetermined difference with respect to the normal set point, according to the setting of the micrometer adjustment unit 57 between the set point arms 54 and 55.

With reference to the normal control structure and operation, the normal set point arm 54 has, pivoted thereon, an angle arm 58 with the pivot 58' at the angle apex. It may be noted that as the normal set point arm 54 is adjusted about its pivot 54', the location of the normal angle arm pivot 58' is correspondingly changed. The angle arm 58 is moved about its pivot 58' in accordance with the temperature measurement, from the temperature sensing element 22 in the steam supply pipe 12 through a temperature measuring unit 59 and an operating connection 59' to a pivoted temperature indicator arm 60 overlying a temperature chart 61, and an operating connection 62 from the temperature indicator arm 60 to the angle arm 58. Movement of the angle arm 58, about its own pivot 58', is applied to a nozzle-baffle-relay normal control unit 63, which is provided in the conventional manner with proportioning bellows 64 and connections therefor. The pneumatic output of the normal control unit 63 is applied to the steam control valve 23 in the steam supply pipe 12 through a third two-way, three-ported valve V3. The valve V3 is operated by a solenoid unit 65 which has electrical connections 66 to the electrical switching circuit 24 mentioned hereinbefore and to be detailed hereinafter.

Thus, in the normal control operation of the temperature controller, the temperature measurement is ap-

plied to the normal control unit 63 under the combined effect of the temperature measurement from the measuring element 22 and the position of the normal set point arm 54, with the result that the steam control valve 23 is operated to maintain the steam temperature at the normal control set point. Actuation of the steam control valve 23 may thus result from steam temperature variations with respect to an unchanged normal set point, from a changed normal set point, or from a combination of steam temperature and normal set point changes.

The paper break, auxiliary temperature control arrangement is indicated at 63' and essentially duplicates the normal temperature control arrangement. This auxiliary arrangement includes the auxiliary set point arm 55 as pivoted at 55'. As previously mentioned, the normal and paper break set point arms 54 and 55 are connected by an adjustable length bar 56, so that adjustment of the normal set point arm 54 by the bellows 45 results in a tracking adjustment of the auxiliary set point arm 55, with a pivotal location difference always maintained between the set point arms 54 and 55 in accordance with the adjustment of the micrometer unit 57.

The auxiliary set point arm 55 has a temperature measurement pivot 67' thereon with an angle arm 67 mounted on this pivot. The normal and auxiliary control angle arms 58 and 67 are mechanically connected as indicated by the connection line 68. With this arrangement, any movement of the normal control angle arm 58 about its pivot 58' is duplicated in the auxiliary control angle arm 67 about its pivot 67'. Movement of the auxiliary angle arm 67 is applied to the auxiliary control unit 63' in duplication of the operation of the normal control unit 63 except for the effect produced by the difference in set points as established by the adjustment of the micrometer unit 57 between the normal and auxiliary set point arms 54 and 55. When such micrometer adjustments are made, the angle arms 58 and 67 are adapted to the changes by being moved about their pivots 58' and 67'.

However, in the normal moisture control operation of this control apparatus, the auxiliary, paper break temperature control unit 63' has no effect on the steam control valve 23 since the auxiliary or paper break control pneumatic output is blocked in the valve V3.

On the other hand, when the paper breaks, the result is that the valve V3 is automatically operated to shut off the normal temperature control unit 63 from the steam control valve 23 and to connect the auxiliary temperature control unit 63' to the steam control valve 23. Thus when the paper breaks, the steam temperature control set point is automatically changed, to reduce the steam temperature a fixed amount, with respect to the normal control point setting immediately preceding the paper break, as established by the difference between the normal and auxiliary set point arm positions.

When the paper process is under way and under automatic control, the pneumatic flow through each of the valves V1, V2, and V3, is from X to Z. That is, the pneumatic relay R1 has its output directly applied to the output bellows 45, and the steam control valve 23 is operated by the normal control unit 63.

When the apparatus is under manual control, the pneumatic flow in valve V1 is from Y to Z, and is variable by the manual valve 38. In this case the pressure in the output bellows 45 is controlled from the manual valve, and it is immaterial which of the temperature control units, normal (63) or paper break (63'), is actually controlling the steam control valve 23.

The operation of the valves V1, V2, and V3 is accomplished through the use of the electrical switching circuit 24, as shown in Figure II. The operation of valve V1 is the result of a manual switching action in the switching circuit 24, and the operation of the valves V2 and V3 is automatic, with means for such operation being provided in the switching circuit 24 in the general arrangement and manner disclosed in the hereinbefore cited Lothrop patent.

The electrical switching circuit 24 includes a manual switch 69 for operating the valve V1, and an automatic switching arrangement including a set of contacts in the contact unit 32. These contacts are operable in rotation together through the mechanical connection 31 in response to movement of the moisture measurement indicator arm 27 about its pivot 28. Such pivotal movement is produced by the mechanical movement output (26) of the bridge circuit 25 in representation of the moisture measurement. The automatic switching circuit 24 also includes an electrical relay 70 which is energized or de-energized through the set of contacts in the contact unit 32 and, in connection the relay 70, other contacts 3, 4, are opened and closed in a manner and for purposes which will be detailed hereinafter.

In the normal course of operation, that is, when the paper is in contact with the moisture sensing element 16, the manual switch 69 is in position 1, as shown. Consequently, the valve V1 is set for automatic control and the pneumatic flow therethrough is from X to Z. When the manual switch 69 is in position 2, the V1 solenoid 39 is not electrically actuated, but is so positioned by a return spring, not shown, as to block off the pneumatic flow from X to Z in the valve V1 and to open the valve V1 to flow from Y to Z, to provide for manual control.

In the switching circuit 24, the manual switch 69 must be in position 1 to complete the circuitry which is necessary for the automatic operation of valves V2 and V3 when the paper breaks. In the arrangement shown, valves V2 and V3 are operated simultaneously. Referring to the switching circuit contact set unit 32, it comprises three discs, *a*, *b*, and *c* fixed on a single center shaft as indicated by the mechanical connection line 31. Each of the discs has an electrically conductive area as indicated by the shaded portions thereon, with these conductive areas electrically connected to each other by a connection network 71. Each of the discs, further, has a slider contact thereon for making electrical contact with the conductive portion of its respective disc. As the contact set unit 32 is rotated, certain of the slider contacts are changed from nonconductive to conductive engagements with their respective discs. Disc *a* is conductive throughout its slider contact area and represents one side of the electrical line in the switching circuit 24. Disc *b* with its slider contact provides an actuating switch for the relay 70, with a minor area of the disc *b* being conductive. Disc *c* with its slider contact provides a holding switch for the electrical relay 70 and has a somewhat greater area of conductivity as related to disc *b*. At the relay 70 itself, contact 3 is the relay holding contact, and contact 4 is the switching contact through which valves V2 and V3 are simultaneously operated. These contacts, 3 and 4, are open as shown, when the relay 70 is not energized.

Thus, when the paper breaks, the bridge circuit 25 responds as if the sensing element were confronted with dry paper, with the result that the indicator arm 27 is moved about its pivot 28. Consequently, the contact set unit 32 is rotated. While, as between discs *b* and *c*, disc *c* is thereafter the first to connect its conductive area with its contact slider, no action results because the relay contact 3 is open and the relay 70 is not energized. However, very shortly thereafter, disc *b* connects its conductive area with its contact slider and the relay 70 becomes energized. With the relay 70 energized, the relay holding contact 3 is closed, and the valve (V2, V3) actuating contact 4 is also closed. When the paper is rethreaded, the contact set unit 32 is reversely rotated. In this direction the disc *b* is the first to disengage its conductive area from its slider contact, but the relay 70 remains energized through the holding contact 3 until the disc *c* disengages its conductive area from its slider contact. At this time the valve actuating relay contact 4 is opened and the valves V1 and V2 are returned to their normal operating positions by biasing springs (not shown).

Figure III illustrates various connections which may be used in association with the apparatus of Figure II. The output of the bridge circuit 25 is shown as actuating a double solenoid arrangement 73 to produce an output movement which is used to rebalance the bridge circuit 25 by adjusting a variable condenser 74, with this movement also used to move the indicator arm 27 about its pivot 28. A recording pen 27' is fixedly connected to the indicator arm 27 as a means of recording moisture content variation on the rotatable chart 30. The bridge circuit 25 is a null balance device, and the indicator arm 27 may be brought to null balance position by adjusting a variable resistor 75. Such adjustments are recorded by an independently pivoted pen 76 through a mechanical connection 77 thereto which transmits the adjustment movement with respect to the resistor 75. A further record is provided on the moisture instrument chart 30 by a pen 78, also independently pivoted, which is moved about its pivot through a mechanical connection 79 in representation of pneumatic pressure changes at the steam control valve 23, as applied to a bellows 80.

The temperature controller of Figure III is the same as that of Figure II except that two indicator arms 81 and 82 are provided for movement over the rotatable temperature chart 61, with these arms 81 and 82 providing indications of the two temperature control set points, as established through mechanical connections 81' and 82' respectively from the temperature set point arms 54 and 55. Further, the temperature measurement arm 60' of Figure III is preferably a pen arm instead of the temperature measurement indicator arm 60 of Figure II.

While the paper is being processed normally, with the sensing element 16 in firm contact with the paper, the operation of the apparatus as shown in Figure II proceeds normally. The moisture sensing element produces responses to changes in the moisture content of the paper, and the moisture indicator arm 27 is moved about its pivot 28 in accordance with these responses. Although such movement of the indicator arm 27 results in rotation of the switching circuit contact disc unit 32, this rotation is normally not sufficient to actuate the switching circuit 24. Such movement of the indicator arm 27 does, however, operate the relay R1 to apply an output pressure to the output bellows 45 as a means of adjusting the normal control set point arm 54 of the temperature controller.

As previously mentioned the moisture controller reset bellows 49 is connected pneumatically to the output side of the valve V2, and also is connected mechanically, as indicated by the dotted line 53, to the first nozzle-baffle unit 33. Thus when the paper breaks and the pneumatic pressure in the proportioning bellows 35 drops rapidly, the reset bellows (49) pressure drops less rapidly because of the reset restrictor 51 in the reset bellows supply pipe, and also, after valve V2 blocks off the output of relay R1, the pressure in the capacity "memory" tank T is applied to the reset bellows 49 through the flow path Y—Z of the valve V2 and through the reset bellows supply pipe 50 and the reset restrictor 51. As a result, the reset bellows (49) pressure, after the paper breaks, approximates its pressure immediately preceding the paper break, and reset "windup" is avoided. Accordingly, the pneumatic system is ready for quick readjustment to normal control. The output bellows 45 loses pressure at first when the paper breaks and the moisture controller reacts to drop the temperature controller set point. However, such pressure reduction is retarded by the variable restrictor 47, and after the valve V2 is actuated through the switching circuit 24 to block off the pneumatic flow in valve V2 from X to Z and to open the valve V2 to pneumatic flow from Y to Z, the capacity "memory" tank pressure is applied to the output bellows 45 with the result that after a paper break the pressure in the output bellows 45 approximates the pressure therein immediately preceding the paper break. The volume

of the capacity tank T is of the order of 100 to 1 with respect to the combined volumes of the reset and output bellows systems. In the normal operation of this apparatus, with the capacity tank T otherwise blocked off from the pneumatic systems, the output bellows (45) pressure is established in the capacity tank T by bleeding through the by-pass restrictor 48.

This invention therefore provides a new and improved moisture control wherein the moisture control is accomplished by controlling a drying medium. Further, a specific embodiment of this invention provides means responsive to a paper break for automatically changing the drying medium control point a predetermined amount with respect to the drying medium control point immediately preceding the paper break. As an associated feature, the pressure in the moisture controller reset bellows is locked up after a paper break, to prevent reset "windup."

As many embodiments may be made of the above invention and as changes may be made in the embodiments above set forth without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a paper manufacture control device for regulating the moisture content of the paper by regulating the temperature of a paper drying medium, in combination; a moisture control system comprising a first pneumatic nozzle-baffle unit operable in response to changes in the moisture content of the paper, a valve in the output of said nozzle-baffle unit, a pneumatic reset unit pneumatically connected to said system at a point beyond said valve and mechanically operatively connected to said nozzle-baffle unit, a pneumatic capacity memory tank operatively associated with said valve and arranged to be automatically connected to that part of said system which is beyond said valve in an action related to the operation of said valve, a pneumatic bleed connection from said capacity tank to said system at a point beyond said valve, and a bellows as a terminus of said system beyond said valve, whereby movement is produced in said bellows in response to said changes in the moisture content of the paper; a temperature control system with a set point adjustment arrangement operable through a connection to said terminal bellows, said temperature control system comprising a pair of pneumatic nozzle-baffle units as a duplex control device, an operative connection between said units as a means of providing a predetermined operating difference relation between said units, and a duplex unit valve operable to shift the control of said drying medium from one of said duplex nozzle-baffle units to the other; and electrical switching and valve operating means operable responsively with respect to a break in the paper for automatically operating both of said valves.

2. A paper manufacture control device for regulating the moisture content of the paper by regulating the temperature of a paper drying medium which is used to heat the paper to reduce the moisture content thereof, comprising, in combination, a moisture control instrument operable responsively with respect to changes in the moisture content of the paper, a temperature control instrument operable responsively with respect to changes in the temperature of said paper drying medium, means for adjusting the control point of said temperature control instrument, an operative connection between said first instrument and said control point adjusting means, whereby the adjustment of the control point of said temperature control instrument is controlled from said moisture control instrument, a pneumatic system arrangement wherein a first valve is established as a pneumatic connection and dividing point between a pair of pneumatic systems, said system arrangement being partially included in each of said instruments and including said operative connection be-

tween said instruments, whereby said control point adjustment is controlled through said pneumatic system arrangement, said system arrangement comprising a first pneumatic system for producing a pneumatic output pressure, a first pneumatic nozzle-baffle unit in said first system, means for operating said first pneumatic system by operating said first nozzle-baffle unit responsively with respect to said changes in said moisture content, a second pneumatic system for receiving said output pressure of said first pneumatic system, with said second system including said operative connection between said instruments, a pneumatic reset arrangement pneumatically connected to said second system and mechanically operatively connected to said first nozzle-baffle unit in said first system, said first valve being arranged to separate the pressures of said systems to at least substantially isolate the pneumatic pressure in said second system with respect to the pneumatic pressure of said first system, electrical switching and valve operating means operable responsively with respect to a break in the paper for automatically operating said first valve to accomplish said pressure isolation, a pneumatic capacity memory tank operatively associated with said first valve and arranged to be automatically connected to said second system by an action related to said paper break operation of said first valve, whereby after a break in the paper the pressure in said second system is established and locked at a value which approximates the pressure in said second system immediately preceding the occurrence of the said break in the paper, a pneumatic bleed connection between said tank and said second system whereby the pressures in said tank and said second system tend to be equalized even when said tank is otherwise pneumatically disconnected from said second system, and a duplex control unit in said temperature control instrument for controlling the temperature of said paper drying medium and subject to control point adjustment by said control point adjusting means, said duplex unit comprising a pair of pneumatic nozzle-baffle units, an adjustable mechanical connection between said units as a means of providing and maintaining a predetermined operating difference relation between said units, and a duplex unit valve operable by said electrical switching and valve operating means for shifting the control of said drying medium from one of said duplex nozzle-baffle units to the other, whereby after a break in the paper, the temperature of said drying medium is controlled at a predetermined value which is a predetermined amount less than the value at which it was controlled immediately preceding the paper break.

3. In a paper manufacture control device for regulating the moisture content of a paper by regulating the temperature of a paper drying medium, in combination, a moisture control system comprising a pneumatic system operable in response to changes in the moisture content of the paper, a primary temperature control system with a set point adjustment arrangement operable in response to the operation of said pneumatic system, standby condition producing means operable responsively with respect to a break in the paper as a means of providing and holding in said pneumatic system a condition approximating the condition of said pneumatic system just prior to said paper break, a secondary temperature control system operable to control said paper drying medium during a paper break period, and electrical switching and valve operating means operable responsively with respect to a break in the paper for operatively disassociating said primary temperature control system from said temperature regulation of said paper drying medium and for operatively associating said secondary temperature control system with said temperature regulation of said paper drying medium.

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