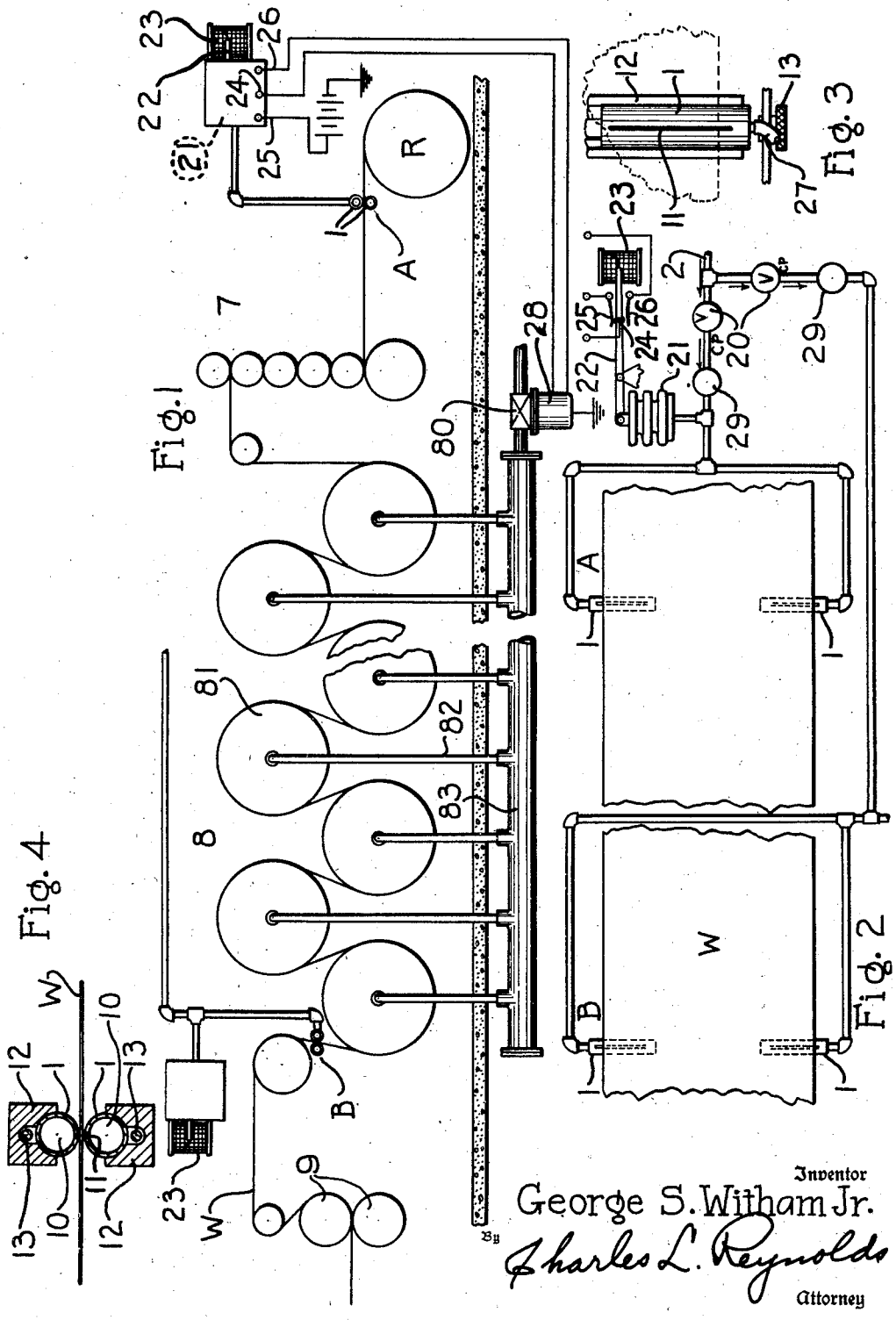
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INDICATOR AND CONTROL, PARTICULARLY FOR PAPER MACHINES

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INDICATOR AND CONTROL, PARTICULARLY FOR PAPER MACHINES

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In the manufacture of paper, maintenance and control of the proper moisture content at each stage of the web's progress is necessary to produce a product of a desired and uniform quality. It is recognized to be of extreme importance that the moisture content of the finished web be correct, and that the web contain neither too much nor too little moisture. Various attempts have been made heretofore to indicate, preparatory to regulating, or to regulate, the amount of moisture in the finished web; but never with entire success. The plan now most generally used comprises the application to opposite surfaces of the web, or to spaced points thereof, of terminals incorporated in a high frequency electrical circuit, and since the conductivity of the paper web to such current varies in accordance with the moisture content, such devices furnish an indication of the moisture content, but this indication is an imperfect one; it is rendered inaccurate by such differences as changes in the thickness of the web, the quality of the fiber content thereof, and like factors, so that it is not an accurate indication; furthermore, such devices can only be applied to small areas, and therefore they indicate only the conditions which obtain in the region of these areas, and it is found in practice that they are not a fair indication of the moisture content of the entire web.

I have discovered that the width of the web, as it leaves the drier section, or the calender stack, or indeed, at any point in its progress, is a direct index of the moisture content of the web, regardless of the character of the paper, of the quality of the fiber content of the paper, and like considerations. In other words, the width shrinks by a given degree with the removal of a given percentage of moisture, and this shrinkage can be accurately measured and it can be employed as a direct index of the moisture content. It is therefore, a principal object of my invention, as applied to the manufacture of paper, to give an indication, more accurately than by any means or method heretofore known, of the moisture content of the web, or alternatively, to operate corrective devices by and in accordance with changes induced by variations in the width of the web. In this connection it may be noted that any automatic corrective device of necessity partakes of the nature of an indicating device, and that various corrective devices are known and may be employed, hence, in this specification, when an indicating device is referred to, the term is intended to include, as well, corrective devices, for to observe is to initiate correction, whether automatically or through the conscious action of one observing the need for correction.

The above indicates a specific application of this invention in a field where such means are and have been long desired. However, it is also of advantage to apply the same principles in other fields. For instance, in the shrinking of textiles, it is of importance to indicate correctly, and to initiate corrective measures to govern, the shrinkage of the cloth. In a printing press, or in any reeling or unreeling operation, shrinkage may be measured as an indication of moisture content, and accurate knowledge thereof permits adjustments to be made to improve the quality of the printed product. In the rolling of metal plates, or sheets, the width of the sheet is an index of its thickness, and to provide accurate means to measure variations in the width of the sheet or plate, is to provide accurate means to determine the thickness of the plate. In consequence, it is an object of this invention, more generically considered, to provide a means for accurately determining the width of the web (including in this term, any sheet, plate or web-like element), particularly a traveling web, and where its width varies in direct relation to some other characteristic, as moisture content or thickness, to provide means for indicating, through indications of the variation in width, the variations in this related characteristic, and as in the former case, to provide means which may be operable automatically, if desired, to correct any departure in the observed characteristic from a desired normal.

As has heretofore been suggested, and as will become apparent hereafter, the indication or measurement of the width of a traveling web arises as a result of variation in the position of an edge of the web, to dispose that edge, transversely of the direction of movement of the web, to one side or the other of a normal or desired position. As will be further apparent hereafter, such variation of the position of the edge from a normal position may be made to operate automatically certain corrective agents. Since these corrective agents may vary widely in form and in effect, it follows that departure of the edge of a web from a desired position may be made to operate automatic alignment-correcting devices, to return that edge to its proper position, and thus the principles of my invention may be made use of to maintain alignment of the web at any point in its travel, or for any purpose—for instance, in rerolling, or in feeding the web to a press. In consequence, it is a further object of

this invention to provide a means suitable to preserve edge-alignment of a traveling web or the like.

While the principles of this invention may be incorporated in various forms, it is one of the objects of the invention to provide such mechanism which may be operated simply and conveniently through the medium of producing a differential pressure between the interior of a hollow body and the atmosphere in which the web is running; which differential pressure is variable by variations in the width of the web as it travels past a slit, at opposite sides of which the differential is applied, thereby making possible the measurement of such variations in the pressure differential to indicate accurately and directly variations in the width of the web, though these be small in amount; or if it is variations in some other characteristic, dependent upon variations in the width, that is the thing to be observed, then indicating directly as a function of the variations in pressure differential, the variations in the ultimate characteristic to be observed.

Such webs are sometimes, or at some stages of their progress, delicate and can not be contacted by tangible elements or feelers, and to avoid any possibility of marring the web, it is preferable that the web never have any physical contact with the feelers or measuring devices. It is a further object to provide such feelers which, while very sensitive to small variations in width, will keep the web floating in air, and will not contact with the web.

It is also an object to provide such an arrangement which is adaptable to webs of different widths.

It is also an object to provide such an arrangement which will indicate the change in moisture content between one point and another in the path of travel of such a web.

Additional objects will become apparent as this specification progresses.

My invention, then, comprises the novel apparatus, both generically and specifically, as disclosed diagrammatically in the accompanying drawing, and as will be more particularly disclosed in this specification and defined by the claims which will terminate the same.

The accompanying drawing illustrates apparatus suitable to carry out my invention, and suitable for incorporation in paper making machinery, to indicate or to correct for variations in the moisture content of the web. The drawing is purely diagrammatical in character.

Figure 1 is, in general, a side elevation of the drier section and calender stack of a paper making machine, illustrating my invention applied thereto.

Figure 2 is, in general, a plan view of the web with the feelers or contact members applied thereto, and illustrating diagrammatically certain indicating and correcting devices.

Figure 3 is a plan view of such a feeler or contact device, and Figure 4 is a cross-section therethrough, showing its relationship to the web.

The last press rolls of a paper making machine are indicated at 9, from whence the paper web W passes to the drier section 8 and thence to the calender stack 7 to be wound upon a reel R. The drying rolls 81 are heated by suitable means, such means being customarily steam pipes 82 leading from a main 83. The temperature of the drying rolls 81 is controlled by regulating the pressure of steam admitted to them, and a pressure regulating valve 80 is shown as representative of means to control the steam pressure and hence the temperature of the drying rolls. Since these elements are all common in the art, and form part of the paper machine, with which my invention is not directly concerned, no further description in detail is believed to be necessary.

As pointed out above, I have discovered that the width of the web varies in direct ratio to its moisture content. The edges of the web, when formed, are a precise and known distance apart, and as the web is dried, these edges approach one another, and the more moisture is eliminated, the closer they approach. There is a point of approach or spacing of the edges of the web at each point in its travel, which for any given web is the desired normal spacing, corresponding to the desired proper and normal moisture content for that particular web at that particular point; and this is true regardless of the weight or thickness of the paper, the character of its fiber, or any other characteristic of the web. Accordingly, feelers are provided to contact the opposite edges of the web, or, one edge being guided for movement in a given path, to contact the opposite edge of the web and to determine the spacing from the fixed path of the opposite edge; if, then, the edge of the web is inside of such a feeler, or inside of the feeler's position for normal width and normal moisture content, too much moisture has been eliminated, and steps should be taken, manually, or automatically, to lessen the temperature of the drying rolls, to regulate the quality of the stock, or to regulate the atmospheric condition of the surrounding air. If, on the other hand, the edge of the web is determined by the feeler to be outward of this normal position, not enough moisture has been eliminated from the web, and steps must be taken to increase the temperature of the drying rolls, or reversely to regulate the other factors affecting moisture content of the web. Regulation of the temperature of the drying rolls is an obvious (and generally effective) way of controlling the moisture content of the paper web, but by no means is it the only way, nor necessarily the sole or the only way in which moisture control will be effected. Other ways have been suggested above, and any of these ways, or indeed any suitable way, may be employed, as necessity or experience requires or suggests. However, insofar as this specification is concerned, where regulation of temperature of the drying rolls is mentioned, this is intended to include, as an equivalent, the regulation of any such factor as suggested above.

Obviously it is impracticable to contact the edge of the web with a feeler pressing inwardly in the plane of the web. Especially is this impracticable when, as in some cases, it is desirable not only to measure the width of the web (as an index of its moisture content) as it leaves the drier section or the calender stack, but also to measure the width of the web for a similar purpose, or for comparative purposes, as it enters the drier section, or even while it is in the paper-making section. Accordingly, the feelers are in effect elements which are placed beneath the edge of the web, but not necessarily in contact with the surface of the web, to be covered more or less by the web as the web varies in width. In using the word "beneath" I do not intend to imply that the feeler is below the web—only that the feeler, whether above or below the web is "beneath" it to the extent that the web in part,

at least, covers the feeler, and is the more uncovered by the web as the latter is of less width, or as its covering edge shifts inwardly relative to the feeler. The feelers are sensitive to such covering or uncovering by the web, or alternatively, they affect some other instrument which is sensitive to the covering or uncovering of the feeler, thereby generating a force the amount of which is in direct ratio to the width of the web, and in consequence in direct ratio to the moisture content, which force can be made use of to indicate, or when desired, to effect automatic compensation for, excessive or insufficient moisture thus shown to be present within the web.

Generically considered, it is quite immaterial what form such a feeler may take. It may be a photo-electric cell, or it may be a target upon which such a cell is directed. The feeler may project a medium, in this instance light, or may be the target for a projected medium such as a light ray; or the feeler may take the form of a device to enable the creation of a pressure differential on opposite sides of a narrow slit or other opening extending transversely of the web, which slit, by reason of its being covered to a greater or lesser degree, effects variations in the pressure differential at the opposite sides of the slit, and this in turn will operate indicating or automatic correcting devices. It is immaterial whether the pressure differential be created by a higher external pressure acting upon the web and inwardly through the slit, or acting from the slit outward upon the web.

Thus, as is best shown in Figures 2, 3, and 4 the feeler 1 may take the form of a small tube constituting a chamber 10 within which a pressure may be created by suitable means, which pressure is permitted to escape through a narrow slit or other small opening shown at 11, and extending generally transversely of the edge of the web, and just beneath an edge of the web and in contact with the surface of the web. Pressure is supplied, for instance, by a line 2 past regulating means indicated at 20, which will produce in the line 2 a constant pressure, and past an orifice 29 the capacity of which is equal to the total capacity of the slit or slits supplied by this line. The pressure in the line 2 affects a pressure sensitive element such as the Sylphon bellows 21, and by its action upon an arm 22 there may be indicated, upon a chart or drum 23, any variation in the pressure in the line 2. The slit 11 is very narrow, say .007 or .008 inch, and offers considerable resistance to relief of pressure through it, and the more of its length is covered, the greater is this resistance. If it is fully covered the resistance is the maximum permitted by the constant pressure device 20; if it is fully uncovered the pressure medium escapes from the slit as fast as it passes the orifice 29, and there is no pressure in the line beyond this orifice.

It will be evident that since the slot 11 is nearly or substantially wholly covered by the edge of the web when the latter is of normal width, corresponding to normal moisture content, the pressure within the tube 1 will be permitted to escape only from any small uncovered portion of this slit, if the tube is adjusted so that the slit 11 at normal width of the web is completely closed, no pressure will be permitted to escape through the slit. Now, if the drier rolls become too hot or extract too much moisture from the web, the feeler, located at the point A, preferably between the calender stack 7 and the heel R, will be acted upon by the consequently narrower web to uncover the slot 11 to a greater degree; thus the pressure can escape, or if it has been permitted partly to escape, it will escape with greater facility, with the result that pressure within the chamber 10 is lowered. This lowering of the pressure is immediately communicated to the Sylphon 21, and to the arm 22, and indicated upon the drum 23, with the result, if the device is to be manually controlled, that measures are taken by the attendant to decrease the temperature of the drying rolls by reducing the pressure of steam therein. If an automatic control is desired, there may be mounted upon the arm 22 a suitable contact 24 which will engage with spaced contacts 25 and 26, in circuit with an electrically energized control device 28 operatively connected to the steam valve 80 to move the latter in a direction to compensate for the greater or lesser moisture content which is found in the web at the point A. Alternatively, as indicated earlier in this specification, the manual or the automatic control may effect variations in the character of the raw material, in the atmospheric condition in the conversion room, in the mechanics of conversion, or in any material or condition affecting moisture content. The arrangement shown and described is purely illustrative and rather primitive in character, and any suitable control may be employed, it being the purpose only to indicate how, through the medium of variations in the width of the web due to variations in the moisture content thereof, suitable indications can be given and corrections automatically made; or the condition may be simultaneously and automatically corrected for and indicated to an attendant.

Preferably at the point A two such feelers 1 are provided at opposite edges of the web, and in this case if one edge of the web is not guided to run precisely in a true path, without variation to one side or other of that path, the indication will still be correct inasmuch as the pressure within each chamber 10 will be the aggregate of the pressure as it is affected by the total length of the slits 11 in the two feelers 1 at opposite edges of the web. If the edges of the web shift to one side or the other, without any change in the width of the web itself, while one slit will be opened a greater amount the slit in the opposite feeler will be closed by the same amount and the aggregate pressure in the interconnected feelers will be identical, and in consequence, there will be no adjustment and no change in the indication. If, however, there is a change in the width of the web, the combined length of the slits in the two feelers will change, and suitable indications will appear and correction be made.

It is preferable also in some instances to provide a feeler or feelers at the point B or near the entrance of the web to the drier section. These will indicate the width of the web at this point, and those at the point A will indicate the lesser width of the web at the latter point, beyond the drier section, and in this way there is obtained an indication of the degree of drying in the passage of the web through the drier section. There may be provided an indicator 23' to indicate the width of the web at the point B or to indicate any changes in its width at that point. This indicator 23' is, or may be in all respects analogous to that shown at 23, but is connected to the line 2 past individual constant pressure and orifice controls, separate from those at 20 and 29.

It may be desirable to accommodate the ma-

chine to webs of different width, or because of varying temperature conditions or other conditions, to effect adjustment of the feeler 1 inward and outward of the edge of the web. To this end, each such feeler, or at least one of each pair at the opposite edges of the web, is mounted in a support 12 which is fixed in position, and which carries a screw 13, engageable with a threaded lug on the tube 1, whereby by a fine adjustment the tube may be moved inwardly or outwardly of the edge of the web. Since the tube is thus adjustable, it is necessary to provide for the connection of the pressure line 2 through flexible connections or the like, as indicated at 27 in Figure 3.

While heretofore the feeler 1 has been described as a single slitted tube, disposed only along or beneath one surface of the web, this description has been purely for simplicity of understanding. Such a single feeler will operate, and by itself is within the scope of my invention, but for most satisfactory operation it is preferred that it be constituted as two such slitted tubes, one at one surface of the web and one directly opposite at the other surface of the web, and both connected to a common pressure line 2 through a constant pressure device 20 and orifice 28 common to the two feelers. The arrangement is shown in Figure 4.

Thus arranged, pressure from one (designated for convenience the lower one) tends to lift the web; substantially equal pressure from the other (designated, to distinguish it, the upper one), directed immediately towards and opposing the pressure from the lower feeler, tends to press down the web. As a result, the web tends to float midway between the upper and lower feelers, but to contact neither. If the web's edge moves inwardly, both the upper and lower feelers have their slits uncovered by the same amount, and being connected in parallel to the same constant pressure and constant volume devices 20 and 29, the reduction in pressure within their chambers 10 is identical, and they operate as previously described.

Again, the thickness of the web may be indicated by passing it between two such feelers, spaced apart by about the amount of the maximum thickness desired. If the web is of maximum thickness the pressure jets are interrupted by a given amount, and the pressure value furnishes an index of this thickness. If the web is less than maximum thickness, the interruption of the jets is less, and the pressure drops as an indication of the lesser thickness. If the web exceeds the maximum desired thickness, the interruption of the jets is graeter, or may be total, and the increased pressure indicates the greater thickness.

It will now be evident that the line 2, instead of supplying pressure to the interior chamber 10 of the members 1, might instead produce a reduced pressure within that chamber, so that the medium, air, is projected through the slit 11 from the open atmosphere into the interior. It will be further evident that the member 1 might also be formed as the target of a photo-electric cell, or might be the cell itself, so that the strength of the current is a function of the amount of coverage of the member 1, which of course is dependent upon the position of the edge of the web.

It will also be evident that the invention is applicable with equal facility to the measurement of the width of any web; for instance, in the shrinking of textiles, as previously mentioned, or in the rolling of plates and sheets. Since, in the latter instance, the width of the plate or sheet is a function of its thickness, a similar arrangement to that described may be provided to measure, and if desired, to correct the thickness of the plate or sheet in accordance with variations in its width which are a direct result of variations in its thickness. The invention, therefore, generically considered, is a device and a method for measuring and indicating (including the conception of correcting) variations in the position of an edge of or in the width of a web, usually a traveling web, and for indicating variations in characteristics such as moisture content, thickness, character of material or workmanship, atmospheric conditions in the conversion room, in the mechanics of conversion, in the adjustment of the machine itself, or in any of the many characteristics or conditions which affect and which are a direct function or criterion of variations in the width of the web.

What I claim as my invention is:

1. Means to determine the width of a traveling web, comprising two interconnected hollow members, disposed beneath but substantially out of contact with opposite edges of the web, and each having a small slit extending transversely of the adjacent edge of the web, in position to be masked more or less in accordance with variations in the width of the web, means to create a pressure differential, through the slits, between the interior of said members and the atmosphere, which pressure differential will vary in amount in accordance with the aggregate amount of masking of the slits by the opposite edges of the web, and indicating means responsive to such changes in the pressure differential.

2. Means to determine the width of a traveling web or the like, comprising two interconnected hollow members, disposed one above and one below the web, each having a small slit extending transversely of the same edge of the web, in position to be masked more or less in accordance with variations in the width of the web, means to create a pressure difference between the atmosphere and the interior of said members, through their slits, which pressure difference will vary in amount in accordance with the aggregate amount of masking of the slits by the displacement of the edge of the web, as the web varies in width, and indicating means responsive to such changes in the pressure difference.

3. Means to determine the width of a traveling web or the like, comprising two interconnected hollow members, disposed beneath opposite edges of the web and each having a small slit extending transversely of the adjacent edge of the web, in position to be masked more or less, in accordance with variations in the width of the web, means to adjust one such member, relative to the other, transversely of the web, means to create a pressure difference between the atmosphere and the connected interior of said members, through their slits, which pressure difference will vary in amount in accordance with the aggregate amount of masking of the slits by the opposite edges of the web, and indicating means responsive to such changes in the pressure difference.

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