Nov. 14, 1967 J. C. LEIBELT 3,352,232

CALIPER CONTROL IN THE CONTINUOUS PRODUCTION OF PAPER

Filed June 21, 1965

FIG. 1

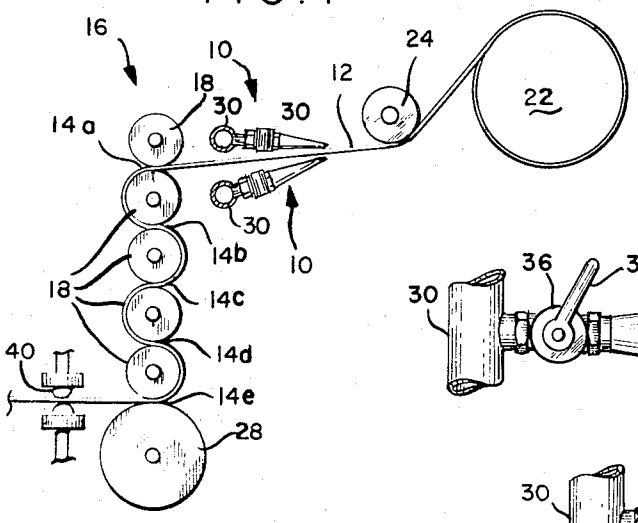
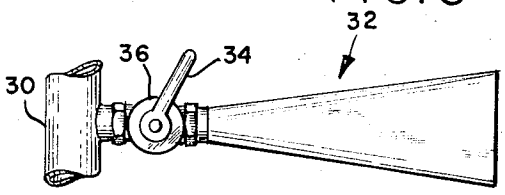


FIG. 3



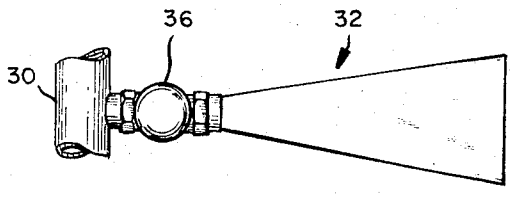


FIG. 4

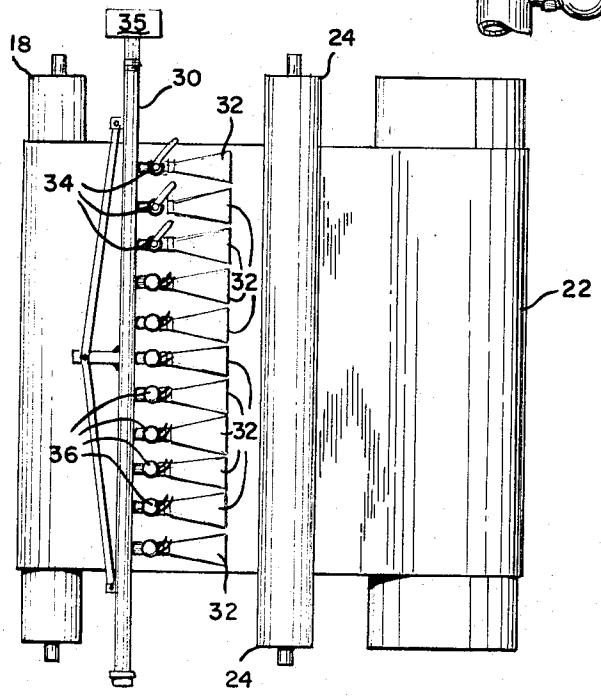


FIG. 2

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CALIPER CONTROL IN THE CONTINUOUS PRODUCTION OF PAPER

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This invention relates to the production of paper and more particularly to a novel method and means for controlling the caliper of a sheet of paper formed in a continuous paper making process.

In the manufacture of a continuous web of paper, control of the caliper of thickness of the web of paper in the transverse or cross direction of the web is of extreme importance for making high quality paper. Variations in caliper in the cross direction of the web can be caused by hard or soft spots, ridges, wavy edges, leading to corrugations in the web as it is rolled on the final product and which makes it virtually impossible to print. This variation in caliper generally occurs in the first machine calender and can be detected in the paper as it leaves the calender. These machine calenders usually include a plurality of vertically aligned steel rolls that are stacked one on top of the other. The paper web is passed between the rolls or nips after it has left the last of the conventional series of drier drums and while still hot to densify or compact the web.

The steel rolls in the machine calender generally have a diameter of approximately twenty inches and must be true cylinders; that is, there can be no variation in the roll or it will produce a variation in caliper. In studies of the temperatures of these rolls, it was found that the upper rolls where the paper enters are hotter than the lower rolls with a corresponding difference in diameter due to heat expansion of the roll. If the roll had a uniform temperature throughout, this difference would have little or no effect on the caliper, but it was also found that the temperature difference across the roll can be as much as 40° F. with corresponding differences in roll diameter in each roll of as much as five-thousandths (.005) of an inch. This variation in roll diameter is believed to be the cause of the production of transverse corrugations in the longitudinal direction of the paper web. Efforts have been made to alleviate this problem by cooling the roll where hot spots are found to exist in order to compensate for this temperature variation but this control has not proven satisfactory.

In further studying the temperature difference in the cross direction of the calender stack, it was also determined that the cross direction temperature of the paper web as it entered the stack also varied and that the cross direction profile of this temperature variation remained quite stable in the longitudinal or machine direction of the paper.

One of the principal objects of the present invention is to provide a more uniform caliper in a paper web as it leaves a machine calender stack.

Another object of the present invention is to reduce the amount of paper loss through prevention of corrugations in the paper roll.

A further object of the present invention is to provide a process and apparatus for controlling temperature in a continuously moving web of paper.

Still another object of the present invention is to provide an air shower for a continuously moving web of paper.

It was found that by thermally treating selected areas of the newly formed, forwardly moving heat dried paper web prior to subjecting it to calendering that the effects of the heat variations in the cross direction of the web could be minimized; that is, that by thermally treating

selected areas of one or both faces of a paper web as it leaves the last drier either by blowing, impinging, or showering gas (e.g., air) against selected areas of the web, the effect of heat variations in the cross direction of the rolls could be minimized, and paper webs could be produced with a more uniform cross direction caliper.

This has been accomplished by directing cooled air against the moving web by means of a plurality of expansion nozzles supported in a transverse relation to the direction of motion of the web with each of the orifices being individually controllable. Impinging of the cool air against the paper web produces a cooling effect on the paper web as it enters the first nip in the calender stack. The rolls in the calender stack will be heated in accordance with the temperature of the paper web in the cross direction of the moving web. It is also possible with the present equipment to reverse the effect of the temperature of the moving web by increasing its temperature by directing heated air at the web as it passes into the first nip of the calender stack.

This air shower technique has been found to provide a more rapid and sensitive control then has heretofore been available and has provided means not only for controlling variable expansion in the rolls after they have been heated by the paper web, but has also provided means to correct or compensate for variations inherent in the rolls.

The practice of the present invention can be employed in combination and correlated with a machine traversing caliper of well-known design which engages the paper web as it leaves the aforesaid calender stack to provide prompt and continuous indication of the paper caliper at all times. Once this variation has been determined, the air shower can be adjusted to produce a corresponding change in the temperature of the web.

Other objects and advantages of the present invention will be more readily apparent from the following detailed description when read in connection with the accompanying drawings, in which:

FIG. 1 is a side elevational view of a calender stack with the air shower located in front of the first roll of the stack.

FIG. 2 is a top view of the calender stack of FIG. 1.

FIG. 3 is a top view of an expansion type nozzle which has a manual control.

FIG. 4 is a top view of expansion type nozzle having a solenoid control.

Referring more particularly to the drawings, the air showers **10** are shown supported on the top and bottom of a paper web **12** as it leaves a drier drum **22** and enters the first nip **14***a* of a calender stack **16**. The calender stack includes a number of rolls **18** mounted in a vertical position above king roll **28**. The paper web **12** passes between the rolls, in this case five nips **14***a*, **14***b*, **14***c*, **14***d* and **14***e*, before leaving the calender stack.

The paper web passes around the drier drum **22** and under a guide roll **24** prior to entering the calender stack. The paper generally leaves the drier drum at a temperature of about 220° F. and normally has a temperature between 150° F.–180° F. as it enters the stack. The rolls on top of the calender stack are known to have a higher temperature than the rolls on the bottom of the stack. The top roll will assume a temperature of approximately 160° F.–180° F., depending on the temperature of the web while the bottom roll will have a temperature of 135° F.–145° F. The paper web as it leaves the drying drum and enters the calender stack has a cross direction temperature of varying degrees which remains fairly stable on the longitudinal direction of the web. The paper web can be 180° F. at the ends and in the center and 150° F.–170° F. on either side of the center. This variation may be at any of the range of temperatures indicated,

producing corresponding temperature variations in the roll temperatures in the stack.

The cross direction temperatures are controlled by the air shower **10** which includes a common header **30** supported above and below the paper web. A number of expansion type nozzles **32** are connected to the header with their ends aligned on a common line transverse to the longitudinal axis of the paper web. In FIG. 3 a manual control valve **34** is shown for controlling the flow of air from the header to the nozzle. In FIG. 4 a solenoid control valve **36** is shown for controlling the flow of air from the header to the nozzle. In FIG. 2 both types of control are shown by way of example only since the units are provided with one or the other type of control valve only.

High pressure air is delivered to the header from any suitable source **35** and on opening any of the valves will flow into the nozzle where it expands and cools prior to impinging on the surface of the paper web. One or more of the control valves may be actuated at any one time to provide a relatively cool stream of air against the paper web at the points where high temperature is known to exist. The high temperature points of the paper web can be determined by measuring the cross direction caliper of the paper as it leaves the stack. If low caliper is detected, cool air is directed at the paper web from the nozzle located at the same cross direction point that the variation was detected. If a high caliper is observed at any particular point in the cross direction profile, the air should be turned off.

The detecting system could be automatic if desired by using a traversing type caliper as shown at **40** and as high or low points are detected the solenoid valves **36** can be actuated to control the air. When manual control is used a graph is drawn by the traversing type caliper and the operator manually opens or closes the valves in accordance with the high or low spots noted on the graph.

It should be noted that this description of the air shower has been limited to the use of cool high pressure air. Hot air or gas could also be used with this equipment if it was considered necessary to heat the roll rather than to cool it and the air could be delivered at low pressure and high volume.

Although only one embodiment of the present invention has been shown and described it should be obvious that various changes and modifications can be made herein without departing from the scope of the appended claims.

What is claimed is:

1. The combination with a metallic machine calender roll stack which is used to densify a continuously moving web of paper having a variable cross direction temperature and a cross direction caliper to indicate the cross direction thickness of the paper as it leaves the stack, of means for controlling the cross direction temperature of said web as it enters the stack, comprising

a number of nozzles aligned on a common axis in close proximity to the upper surface of the web of paper in corresponding longitudinal position to the caliper, each of said nozzles having an independent control valve and means for delivering air to said nozzles, whereby the temperature at selected points in the cross direction of the paper web can be controlled by directing air from the nozzle against the web according to the thickness indicated by the caliper corresponding to each nozzle.

2. The combination according to claim **1** including a number of nozzles aligned on a common axis in close proximity to the bottom surface of said web of paper.

3. In a paper making apparatus, comprising

metallic calendering rolls disposed adjacent the last paper drier drum wherein a newly formed forwardly moving, dried web of paper is subjected to densification between said calendering rolls while retaining heat in varying degrees in the cross direction of the web and wherein said heat is transferred from said web to said rolls resulting in diametrical expansion of said rolls, caliper means indicating the cross direction thickness of the web as it leaves the calender rolls and comprising

means for thermally treating selected cross directional areas of said moving web of paper prior to calendering thereof is in accordance with the cross directional thickness of the web of paper as indicated by the caliper means, to thereby minimize the effects of said heat variations longitudinally of said rolls.

4. In a paper making apparatus according to claim **3** wherein said apparatus includes a series of selectively adjustable air jets disposed adjacent and parallel to the first of said rolls for thermally treating selected areas of said web of paper prior to entering the calender stack, means for delivering pressurized air to said nozzles, and means for controlling each of said nozzles independently to control the temperature of the paper web at selected positions on said web.

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