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Spurrell

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[54] **METHOD FOR CONTROLLING CALIPER**

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[52] **U.S. Cl.** **162/206,** 34/25

[51] **Int. Cl.** **D21f 7/06**

[58] **Field of Search** 162/205, 206, 207; 34/25, 48

[56] **References Cited**

UNITED STATES PATENTS

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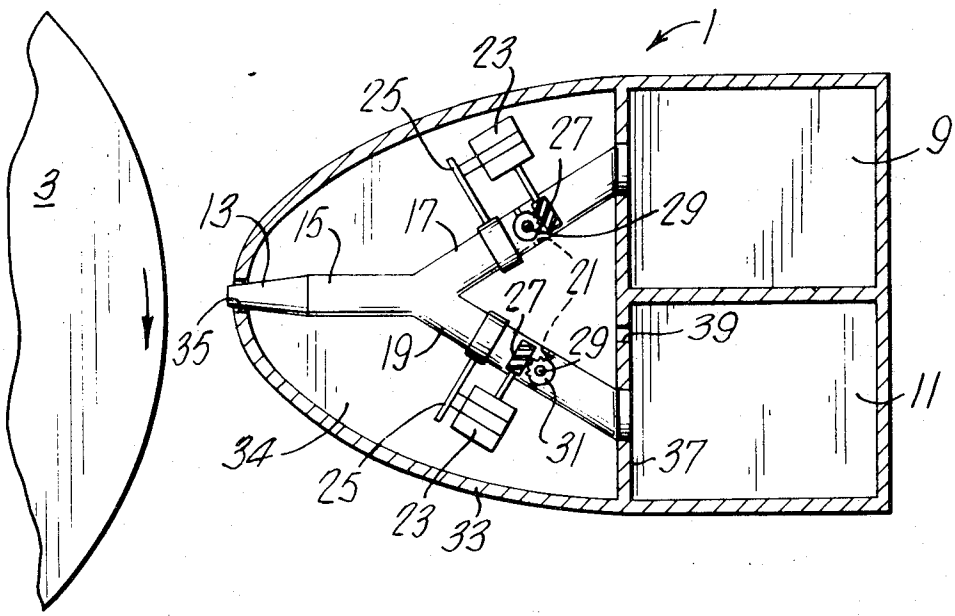
[57] **ABSTRACT**

Method for controlling the caliper of sheet material being calendered by calender rolls, comprising selectively directing air at one temperature onto a region of at least one of the calender rolls corresponding to that region of the sheet passing over the roll which has a thickness different than the thickness of adjacent regions of the sheet to bring the thickness of this region of the sheet closer to the thickness of the adjacent regions, while simultaneously directing air at a second temperature onto the adjacent regions of the roll corresponding to the adjacent regions of sheet passing over the roll in order to retain the thickness of the sheet at these regions.

6 Claims, 5 Drawing Figures



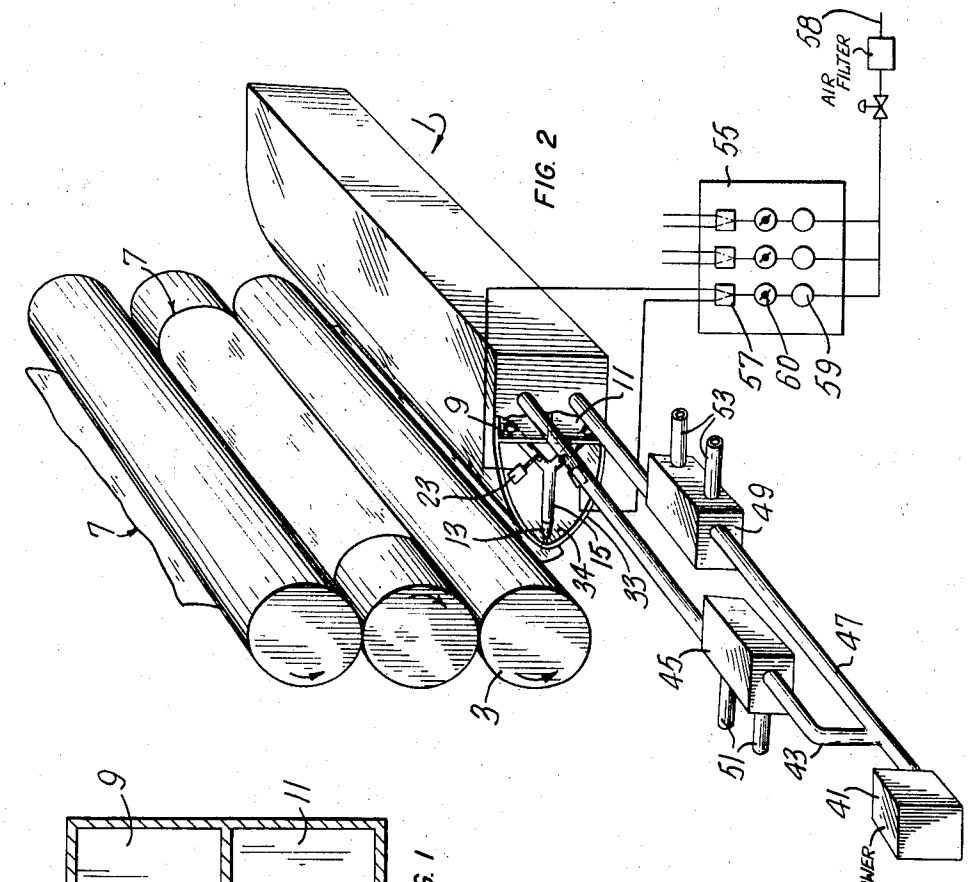


FIG. 2

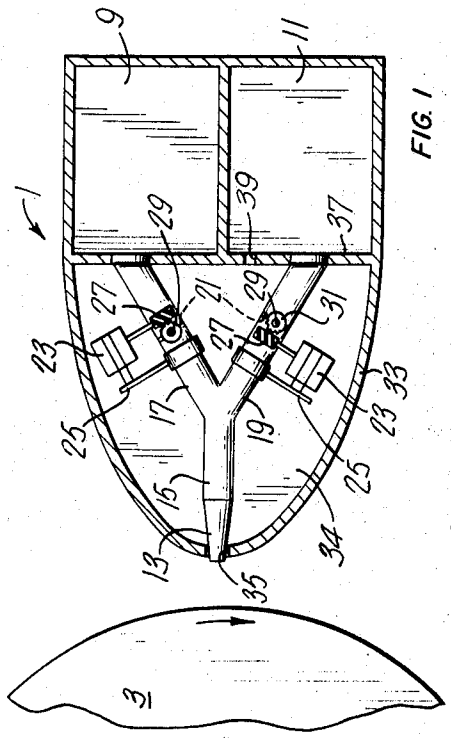


FIG. 1

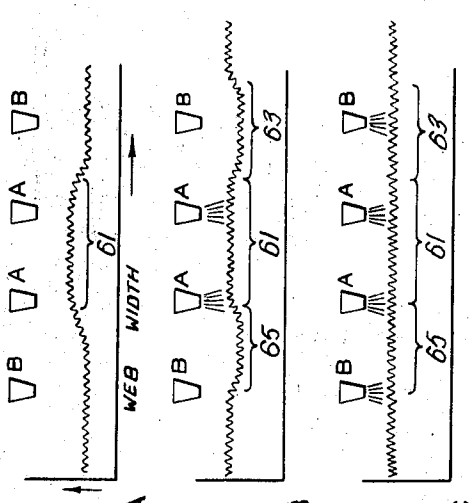


FIG. 3A FIG. 3B FIG. 3C

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METHOD FOR CONTROLLING CALIPER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an improved method and apparatus for use in calendering a web to obtain a web of more uniform thickness.

2. Description of the Prior Art

A common problem in the manufacture of paper webs is the uneven thickness or caliper of the web, across its width, due to variations in the machine and process forming the web. This problem is accentuated when passing the finished web of paper through a calender stack and winding it into a reel. When wound into a reel, the uneven thickness of the web shows up as hard spots, where the web is thicker than adjacent portions of the web and as soft spots, where the web is thinner than adjacent portions of the web.

In an attempt to obtain a more uniform thickness or caliper in the web and thus reduce soft spots in the reel, cold air has been selectively directed onto calender rolls in the calender stack to reduce the calender roll diameter at locations corresponding to those portions of the web passing over the roll which are thinner than adjacent portions of the web. This effectively increases the thickness of the thinner portions to a value more closely approaching the thickness of the remainder of the web. This method is of no use, however, in eliminating hard spots or raised portions in the reel which are caused by a greater thickness in those portions of the web than adjacent portions of the web.

In an attempt to obtain better caliper control by being able to eliminate either hard or soft spots in the reel, it has been proposed to selectively direct hot or cold air onto the calender rolls, to adjust roll diameter, and thereby effectively obtain a more uniform thickness or caliper in the web. See U. S. Pat. No. 2,981,175, issued Ap. 25, 1961, Francis H. Goyette, inventor, for example.

The apparatus shown in the patent employs a series of nozzles, each of which, through the use of a single, manually adjustable, control valve, can selectively direct either hot or cold jets of air against selected portions on the calender rolls corresponding to selective portions of the web being calendered. One or more nozzles corresponding to a particular portion of the web to be treated are operated to blow either hot or cold air only onto a portion of the calender rolls corresponding to that particular portion of the web passing over the rolls, depending upon whether the portion of the web is thinner or thicker than adjacent portions of the web.

Devices of this type have not, however, been all that more effective in obtaining a web having a more uniform thickness. Upon further investigation, it has been found that one of the main reasons in failing to obtain a more uniform thickness is the fact that when employing one or more nozzles to direct hot air against the calender rolls, to reduce the thickness of the web, or hard spots in the reel, to substantially the same thickness as adjacent regions, the jet of hot air from the nozzle or nozzles tends to adversely affect the adjacent regions of the web which are already of desired thickness. This is due to the dissipation of heat in the steel calender rolls which causes the rolls to expand in the regions immediately adjacent to the areas where the nozzle or nozzles are directed. Conversely, when blowing cold air on the calender rolls, corresponding to regions of the web to be thickened, adjacent regions, already of desired thickness, are also increased in thickness. It has also been found difficult to satisfactorily control the selective blowing of hot and cold air in proper amounts in order to obtain a more uniform web thickness, particularly during high speed operation, because of the use of a single, manually adjustable, control valve to control both the hot and cold air.

SUMMARY OF THE INVENTION

Applicant's invention relates to a method and apparatus for obtaining more uniform web thickness which overcomes the above disadvantages. More particularly, the invention relates to a method of adjusting the thickness of a web of paper passing through a calender, wherein the web has a thickness in one region which is different from the desired thickness, comprising directing a treating medium, at one temperature, onto the regions of a calender roll corresponding to said region in said web passing over the roll to adjust the web thickness towards the desired thickness and simultaneously directing a treating medium, at a different temperature, onto regions of a calender roll corresponding to regions of the web passing over the roll adjacent said one region, to minimize the effect of the treating medium at the one temperature on those adjacent regions.

The invention is further directed toward an apparatus for adjusting the thickness of a web of material having an uneven thickness to obtain a more uniform thickness, which apparatus comprises a first duct for carrying a first treating medium, a second duct for carrying a second treating medium adjacent the first duct, a series of spaced apart nozzles, first and second conduit means connecting each nozzle to the first and second ducts respectively, valve means in each conduit, operator means for opening and closing the valves, and control means for selectively actuating said operator means.

One operator means preferably is provided for each valve, there being two operator means associated with each nozzle. Preferably, the conduits and operator means are enclosed in a third duct connected to the first and second ducts.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in detail having reference to the accompanying drawings, wherein:

FIG. 1 is a cross-sectional view of the apparatus for treating a web of material;

FIG. 2 is a schematic view of the apparatus shown in FIG. 1 shown in partial section; and

FIGS. 3A, 3B and 3C are graphs representing the caliper profile of a web showing:

a. the original profile of a web before treatment;
b. the profile after directing hot air only against a region of the calender roll corresponding to a thick region in the web passing over the roll; and
c. the profile after directing hot air against a region of the calender roll corresponding to a thick region in the web passing over the roll with simultaneous direction of cold air onto regions of the calender roll on opposite sides of the region on which the hot air is directed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. 1, the improved caliper control apparatus 1 is mounted to extend along and adjacent a roll 3 in a calender over which the web 7 passes. The apparatus 1 includes a hot air duct 9 and an adjacent cold air duct 11 extending the length of the roll 3. The hot air duct is insulated. A plurality of nozzles 13 are carried by the ducts 9, 11 pointing toward the surface of roll 3 and being spaced apart longitudinally of the roll. Each nozzle 13 is connected to main conduit 15 which has branch conduits 17, 19 connecting it to the hot and cold air ducts 9, 11 respectively. Located in each banch conduit 17, 19 is a valve 21 for controlling the flow of hot or cold air through the respective branch conduit to the nozzle 13. An operator 23 carried by a bracket 25 on the branch conduit closely controls the setting of the valve between and including closed and fully open positions. Preferably, the operator 23 is of the rolling diaphragm type, pneumatically controlled. A suitable rolling diaphragm operator is one manufactured by Bellofram Corp. under Model No. B10530. A rack section 27 is attached to the shaft extending from a piston within the casing of the operator. The rack section 27 cooperates with a pinion segment 29 axially connected to a shaft 31 mounted diametrically through the wall in the conduit, the shaft carrying the valve 21 within the conduit. A casing 33, connected to ducts 9, 11, forms a duct 34 enclosing the main conduits 15, branch conduits 17, 19 and operators 23 for each nozzle 13, with each nozzle extending through an opening 35 in the casing wall. Preferably, the wall 37 of the cold air duct 11, forming a part of the wall defining duct 34, has perforations 39 permitting the cold air to pass into the duct 34 to provide an overpressure in the duct and thus keep out dust or particles which might otherwise enter the duct and interfere with the operation of the valves or regulators.

A blower 41 is provided for directing air into the hot and cold air ducts. The feed from the blower 41 is split with one conduit 43 carryng a portion of the flow from the blower through a heating means 45 and then into the hot air duct 9, and a second conduit 47 carrying flow from the blower means to means 49 for regulating the temperature of the cold air and then into the cold air duct 11. The heating means 45 can comprise steam coils 51 capable of heating the air fed to the hot air duct to a temperature of 350°F. The regulating means 49 can comprise cooling coils 53 for maintaining the temperature of the air fed to the cold air duct at a temperature no greater than 90°F. and preferably between approximately 65° to 75°F.

An operating station 55 is provided remote from the nozzles and associated valves. The station 55 includes a grouping of a two-position, three-way switch 57, a pressure regulator 59 and a pressure gauge 60 for each nozzle. The switch 57 is connected to selectively operate the hot air operator or the cold air operator. The pressure regulator 59 pneumatically operates the operator 23 selected by switch 57 from a pneumatic source 58 to cause rack section 27 to move and thus control the amount of valve opening and the volume of hot or cold air directed through the nozzle. The gauge 60 measures the pneumatic pressure supplied to the selected regulator to provide an indirect visual measure of the volume of hot or cold air directed through the nozzle.

The apparatus operates as follows:

Assume that a sheet passing over the calender roll 3 produces a hard spot region in the reel providing a caliper profile such as that shown in FIG. 3A with the hard spot region designated as 61. The hard spot is a thick region in the web. In order to reduce the thick region and thus provide a more uniform thickness in the sheet, one or more nozzles A at or adjacent the area of a calender roll over which this thick region of the sheet travels, are operated by opening the valve leading from the hot air duct so as to direct hot air onto the area of the calender roll corresponding to the thick region in the web and thus reduce the web thickness in this region. If only hot air is directed onto the area of the calender roll corresponding to the thick region of the web, after a certain period of time, the hot air affects regions 63, 65 adjacent to the hard spot region in the reel 61 to produce a web caliper profile as shown in FIG. 3B. It will be seen from this that, while the hard spot region in the reel 61 has been eliminated, soft spot regions in the reel 63, 65 have been formed adjacent the former hard spot and the uniformity of caliper of the web is no better than before. It is, therefore, necessary, when raising the hard spot in the reel, to direct cold air from nozzles B, located adjacent those nozzles A supplying hot air onto the areas of the calender roll corresponding to the hard spot region, against the areas of the calender roll corresponding to the regions of the web adjacent the hard spot regions so as to minimize the effect of the hot air on the adjacent regions. When this is done, a profile is obtained as shown in FIG. 3C. It will be seen that the streams of cold air from nozzles B prevent the formation of soft spots in the reel which would otherwise occur as shown in FIG. 3B, and thus assist in providing a web with more uniform caliper as shown in FIG. 3C.

The apparatus would be operated oppositely when treating a region of the web which is thinner than adjacent regions and corresponding to a soft spot or depression in the reel. Cold air would be directed onto areas of the calender roll corresponding to the thin region of the web from one or more nozzles adjacent thereto. Simultaneously, hot air would be directed onto areas of the calender roll corresponding to the regions of the web adjacent either side of the thin region so as to control the effect of the cold air to obtain more uniform caliper.

The volume of hot or cold air directed onto the region to be treated, together with the volume directed onto adjacent regions, is controlled, depending on the variations in caliper between the regions, to obtain more uniform caliper.

It has been further discovered that the maximum temperature of the air in the hot air duct should be no greater than 350°F. If the temperature is greater than this, corrugations are produced in the web. Preferably, the temperature in the hot air duct should be between 300° and 325°F. Suitable controls on the steam coils 51 are provided to maintain this temperature range.

Considerable difficulty was experienced in selecting proper operators 23 to control the valves 21 in each branch conduit so as to obtain proper valve settings to thereby control the volume of hot or cold air passed through the nozzles and also to operate reliably in the high temperatures. It is important to use operators 23

which do not exhibit a hysteresis effect so as to always be able to obtain repeatable volume settings regardless of whether the valve is being opened or closed and thus properly control the volume of hot or cold air. Pneumatic operated cylinders exhibit a hysteresis effect which is detrimental to the control. The same volume setting cannot always be obtained. It has been found that a rolling diaphragm-type cylinder is best suited since the hysteresis effect is substantially eliminated. In addition, the positive drive of the rack 27 and pinion 29 connection operating the valves further eliminates hysteresis, thus providing very effective volume control in the flow of hot or cold air from the nozzle.

I claim:

1. A method of adjusting the thickness of a web of paper passing through a calender, wherein the web has a thickness in one region which is greater than the desired thickness, comprising directing a treating medium at a temperature greater than 300°F. onto an area of a calender roll corresponding to said region of said web passing over said roll to adjust the web thickness toward the desired thickness and simultaneously directing a treating medium at a temperature of less than 90°F. onto the area of the calender roll corresponding to regions of the web adjacent said one region, to minimize the effect of the treating medium at the temperature greater than 300°F. on these adjacent regions.

2. A method of adjusting the thickness of a web of paper passing through a calender, wherein the web has a thickness in one region which is less than the desired thickness, comprising directing a treating medium at a temperature less than 90°F. onto an area of a calender roll corresponding to said region of said web passing over said roll to adjust the web thickness toward the desired thickness and simultaneously directing a treating medium at a temperature greater than 300°F. onto the area of the calender roll corresponding to regions of the web adjacent said one region, to minimize the effect of the treating medium at the temperature of less than 90°F. on these adjacent regions.

3. A method as defined in claim 1, wherein the temperature of the treating medium directed against the area of the roll corresponding to the one region is between 300°F. and 350°F.

4. A method as defined in claim 2, wherein the temperature of the treating medium directed onto the adjacent regions is between 300°F. and 350°F.

5. A method as claimed in claim 2, including adjusting the volumes of the different temperature treating mediums directed onto the regions.

6. A method as claimed in claim 1, including adjusting the volumes of the different temperature treating mediums directed onto the regions.

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