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TENSION CONTROLLER

This invention relates to control of tension in web materials and, more particularly, to the maintenance of an operating tension range in moving lengths of material.

Machines for making diapers now in use are arranged to laminate two different materials together, including a top sheet, which is usually of a non-woven hydrophillic material and a backsheet, which is generally of a waterproof film, such as polyethylene or polypropylene. These materials each have distinctly different characteristics and each modulus of elasticity is different from the other. My previous application, United States Serial No. 686,573, which corresponds to GB Application No. 8531732, Serial No. 2170485 for 'Stretch Control of Materials to be Laminated or Joined,' wherein the two unwinding assemblies were stretch controlled, made no provision for controlling the range of tension differential between the tension on the top sheet and the tension on the backing sheet.

The prior art shows use of control systems to achieve constant tension on individual or all materials to be laminated and required operator skill and careful monitoring of quality of the final laminate. This is disclosed in an article entitled "The Art of Roll to Roll Adhesive Laminating," as published in Converter magazine, December, 1981.

Load cells and dancer arms have been used in the past to control the tension on a web being fed as disclosed in United States Patent No. 2,753,128, as well as Japanese Patent No. 44-12163 and British Patent No. 1,371,760.

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United States Patent No. 2,627,296 to Secrest discloses an apparatus including means for adjusting the tension in a web of fabric.

United States Patent No. 3,239,161 to Dutro et al discloses a drive control mechanism which dispenses an elongated web of material with the speed and tension thereof being adjustable.

The United States Patent No. 3,510,374 to Walker discloses a control apparatus for sensing a property of a moving web and adjusting the moving web so that the desired property is uniform throughout the web.

United States Patent No. 3,107,679 to Pawlowski discloses an automatic tension control device which utilizes either pneumatic or electrical circuitry to maintain the tension in a web of material substantially constant.

United States Patent No. 3,762,125 to Prena discloses a device for controlling the lamination of one material onto another material which utilizes a photocell which is responsive to indicia on the film which sends the information to a control box of a clutch, which controls the stretch rollers, to thereby keep the two webs lined up with one another.

United States Patent No. 4,347,993 to Leonard discloses tension monitoring and controlling means which includes a controller responsive to outputs of the tension sensing transducer thereof and a reference tension selector for controlling torque applied to the tension control roll to thereby control the web tension.

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In my previous invention set forth in the above application called "Stretch Control of Materials to be Laminated or Joined," a diaper machine consisted of two unwinding systems, one for a top sheet and one for a bottom sheet. A prior art system such as this can be tension controlled or stretch controlled, as in my previous application; the balance of the converting section of the line is inherently a stretching process between pull stations. This involved modulation of the two unwind tensions in order to prestretch both sheets equally. A problem with this previous concept was that when a more inelastic material was used, the devices would increase the unwind tension or so-called pre-tension in order to stretch the sheet to a target value. As this inelastic material (loaded with higher pretension) passed into a later stretching zone of the machine, the additional stretching also created a higher additional tension increment than on the more elastic material. Essentially then an inelastic material leads to higher downstream tensions by these two multiplier effects.

The present invention envisages a control logic routine whereby a downstream commercially available web tension detector is used to initiate a correction in the stretching ratio between downstream pull stations.

According to the present invention a method of juxtaposing a first material to a second material comprises feeding the materials from individual supplies through a first pulling station to a second pulling station and sensing the tension in the materials between said stations and adjusting the pull at the second pulling station so as to keep the tension in the said materials within a predefined limited range of values, and in which the relationship of indicia on the juxtaposed materials to a predetermined datum is sensed and is used to compute a correction signal supplied to control the operation of a mechanism adapted to carry out a fabrication step on the juxtaposed webs between the first and second pulling stations so as to maintain the system in registration.

The invention also extends to apparatus for juxtaposing a first material to a second material which comprises means for feeding the materials from individual supplies through a first pulling station to a second pulling station, a first pulling station and a second pulling station, means for sensing the tension in the materials between the said stations and means for adjusting the pull at the second pulling station in response to the sensed tension so as to keep the tension in the said materials within a predefined limited range of values, and means for sensing and computing the relationship of indicia on the juxtaposed materials to a predetermined datum and means for computing a correction signal from the said

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relationship and supplying the said signal to control the operation of a mechanism adapted to carry out a fabrication step on the juxtaposed webs between the first and second pulling stations so as to maintain the system in registration.

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The present invention can be put into practice in various ways one of which will now be described to illustrate the invention with reference to the sole accompanying drawing which is a schematic diagram of apparatus in accordance with the present invention.

With reference to the accompanying drawing, reference numerals 10 and 12 generally designate unwinding arrangements for two materials of differing characteristics. A supply roll 14 for material 16 is provided and an unwind motor 18 drives an endless belt assembly 20 for initially unwinding the web 16 from the supply roll 14.

The web 16 is entrained about an idler roller 22 and thence about a roller 24 mounted on a dancer arm 26 pivotally mounted at 28.

The tension force exerted on the web by the dancer arm 26 is controlled by a compressed air pressure regulator operating an air cylinder 27 connected through its piston to the dancer arm 26. The speed of the endless belt 20, which serves as the unwind mechanism, is automatically modulated by a rotary sensor at 28 in order to maintain the dancer arm 26 in a mid position.

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After passing about the roller 24 on the dancer arm 26, the web passes over rollers 30, 32, 34 and thence to rollers 36, 38 and 42. The roller 34 in cooperation with a roller 86 (referred to below) constitutes a first pull station 34, 86. The roller 38 is connected to a load cell 40. A photoelectric cell 44 senses the registration timing/position of the web 16 and provides an input to a logic controller or micro-processor 50.

The web 16 then passes to unwinding means in the form of a downstream pull station 52 driven by a motor 54, whose speed is controlled by the microprocessor 50. The motor 54 receives its input from the microprocessor at 56.

The other unwinding assembly 12 is made up of a supply roll 60 for a web material 62, initial unwinding tension thereon being afforded by an endless belt 64 driven by an unwind motor 66.

The web 62 passes over a roller 68 and is thence entrained about a roller 70 mounted on a dancer arm 72, which is mounted at 74 for pivotal movement and which is monitored by a rotation sensor or potentiometer 75.

The web 62 thence passes over rollers 82 and 84 as it passes to the roller 86 which is part of the first pull station (34,86) before in

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turn passing over rollers 36, 38 and 42 and thence to the downstream or second pull station 52.

Thus it will be seen that the tension or stretch on the webs 16 and/or 62 are in fact controlled by the speed of unwinding in connection with the modulus of elasticity of the web material 16 and/or 62 and the inputs to the microprocessor 50.

Whenever the downstream tension detector detects a minimum tension or maximum tension condition, a routine is enacted to adjust the speed of the most downstream pulling unit in that zone by a preset incremental amount, in a direction and impact on the stretching ratio to bring tension back within the desired operating range; it is envisaged that the stretching ratio may be less than 1.0. This pulling unit speed change causes a change in the number of product lengths in the subject zone of the machine. Zones are defined by the location of pulling units. Within each zone there is/are a number of mechanisms, adapted to carry out a fabrication step on the juxtaposed webs, which mechanisms are, or must be, in synchronized registration with the web. It is foreseen due to the predictable registration shift caused by the aforementioned pulling unit speed change, that all registered mechanisms in that zone can be phase shifted automatically in proportion to their distance (in web path) from the upstream pulling unit. The logic of registration change for any following zones is, however, based upon a fixed registration adjustment for all registered mechanisms (rather than a varying adjustment as described for the subject zone). The

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basis for this fixed correction is also calculated from the percentage of speed change made in the original zone, multiplied by the total length of the web path in that zone. The adjustments can be verified with a feed-back signal from a single photo eye scanning near the end of the zone or can be based on the photo eye scanner reading itself with suitable programming per the above logic.

It is to be noted that variations in friction or drag within the machine cause registration drifts and, in the absence of a concurrent speed change, these can be monitored or tracked due to their effect on the number of fractional product lengths within a zone of the machine as a result of the change in the tension profile exerted in the web in the zone where friction/drag has varied. This can be done by monitoring one photoeye sensor versus the machine cycle position or by monitoring the differential readings between two photo eye registration sensors, one at the end of the subject zone and the other in the preceding zone. Once a variation in drag has been so identified, the logic for phase adjustment of registered mechanisms is accomplished in a similar manner to the phase shift logic previously described following a pulling unit speed change.

The present invention thus provides means for obtaining an operating tension range by incrementing downstream stretch ratios and has for an object to group correction devices under one detector and logic control system to minimize hardware.

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The present invention also provides means for maintaining line operating tensions within a desirable range automatically thereby improving output capacity and improving operating efficiency and reducing scrap levels.

CLAIMS

1. A method of juxtaposing a first material to a second material which comprises feeding the materials from individual supplies through a first pulling station to a second pulling station and sensing the tension in the materials between said stations and adjusting the pull at the second pulling station so as to keep the tension in the said materials within a predefined limited range of values, and in which the relationship of indicia on the juxtaposed materials to a predetermined datum is sensed and is used to compute a correction signal supplied to control the operation of a mechanism adapted to carry out a fabrication step on the juxtaposed webs between the first and second pulling stations so as to maintain the system in registration.

2. A method as claimed in Claim 1 in which each material is fed under tension to the first pulling station and the tension in each material prior to the said first pulling station is sensed and controlled to be within predetermined limited ranges of values.

3. A method as claimed in Claim 1 or Claim 2 in which when the tension in the materials between the first and second pulling stations is sensed to have reached a predetermined minimum or maximum value, the pull of the second pulling station is varied by a preset incremental amount in such a sense as to restore the tension in the materials to a value within the predetermined limited range of values.



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4. A method as claimed in Claim 1 substantially as specifically described herein with reference to the accompanying drawing.

5. Apparatus for juxtaposing a first material to a second material which comprises means for feeding the materials from individual supplies through a first pulling station to a second pulling station, a first pulling station and a second pulling station, means for sensing the tension in the materials between the said stations and means for adjusting the pull at the second pulling station in response to the sensed tension so as to keep the tension in the said materials within a predefined limited range of values, and means for sensing and computing the relationship of indicia on the juxtaposed materials to a predetermined datum and means for computing a correction signal from the said relationship and supplying the said signal to control the operation of a mechanism adapted to carry out a fabrication step on the juxtaposed webs between the first and second pulling stations so as to maintain the system in registration.

6. Apparatus as claimed in Claim 5 in which the feeding means for each material feed each material under tension to the first pulling station and means for sensing the tension in each material prior to the said first pulling station and means for controlling the tension to be within predetermined limited ranges of values.



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7. A device for maintaining an operating tension range on two different materials which are to be laminated comprising: a first material supply roll, means for unwinding a first web material from the said first supply roll, a second supply roll, means for unwinding a second web material from the said second supply roll, means for feeding the two materials to a first pull station, and means located downstream of the first pull station for sensing the differential tension on the said first web material and the said second web material and a second pull station located downstream of the said monitoring means, and microprocessor means for controlling the said second pull station to maintain the tensions on the said first and second web materials within a predetermined limited range of tensions, a sensing device being provided for measuring the stretch on the said first web after it has passed from the said supply roll, the sensing device supplying signals to the microprocessor means.

8. A device as claimed in Claim 7, including pneumatically operated dancer arm means for applying tension on the said first web material, the second pull station being controlled to limit the range of tension on the said first and second webs of material dependent upon the input to the microprocessor means of the said sensing means.



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9. A device as claimed in Claim 7 or Claim 8 including pneumatically operated dancer arm means for selectively applying tension on each of the said first web material and the said second web material.

10. Apparatus as claimed in Claim 5 substantially as specifically described herein with reference to the accompanying drawing.



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