Web support in the press section with a lightweight belt

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ABSTRACT

The authors installed a lightweight belt in the press section of a pilot paper machine to cover the solid roll and to carry and support the wet web between press nips. An air doctor, transfer roll system detached the web from the belt to transfer it to the next section. This concept could lead to the elimination of open draws in existing press sections and more reliable operation at high speeds and with weak webs. Because the paper contacts the belt rather than the press roll, special roll covers are not necessary for good sheet release.

Application:

A lightweight, impermeable belt with a web transfer system can support a web through the press section of a paper machine. This can eliminate open draws and give more reliable operation at high speeds or with weak webs.

After pressing a web into contact with the solid roll in the wet press of a paper machine, it is necessary to apply tension to strip it from the roll surface for transfer to the next paper machine section. In this open draw, the tension on the wet web overcomes adhesive, inertial, and aerodynamic forces. It therefore must have adequate strength to withstand this tension. Wet webs are weak especially when they have high moisture contents, low basis weights, or contain certain furnishes.

To find ways to improve wet web runnability, we directed our research to improving water removal *(1, 2)*, understanding the interactions between the web and the surfaces it contacts *(3, 4)*, and examining behavior in open draws *(5, 6)*.

Providing a surface independent of the roll's structure might overcome the difficulty in developing solid roll surface materials to provide optimum release characteristics consistent with the structural demands of an operating machine. Although a sleeve could achieve this, a preferred solution would be a belt that would also support the web when conveyed to the next machine section.

While we found no description of belt pressing in the trade journals, there are several patents describing this technology *(7, 8)*. Press belts described in most patents are adaptations of or derivations from shoe press belts that are strong, thick, stiff, polymer-covered products. Such belts might be hard to install and expensive. Their smooth surface might cause difficulties with web release, especially if not used with a web transfer system *(9)*.

BELT MATERIAL

A suitable belt must be endless with no perceptible joint, have an adequate length and width, be sufficiently flexible to install conveniently on a paper machine, and have a reasonable cost. Solutions such as a metallic belt (hard to join, difficult to install), plastic film (poor dimensional stability), and felts (too permeable, difficult to clean) are impractical or unsuitable for this application. A specially manufactured belt—perhaps made of composite materials—might provide acceptable solutions.

The function of the press belt is to cover the surface of the solid roll, to avoid open draws, and to support the web during the transfer rather than to receive the water from the wet sheet. It is therefore desirable that the belt be essentially impervious. For ease of installation and low cost, the belt should also have simple construction and low weight.

In preliminary experiments on Paprican's pilot paper machine, we found that thick and stiff belts were not practical and that lightweight fabrics were satisfactory. Since fabrics developed for sailboat sails are available in a variety of weights and structures, we selected several for testing.

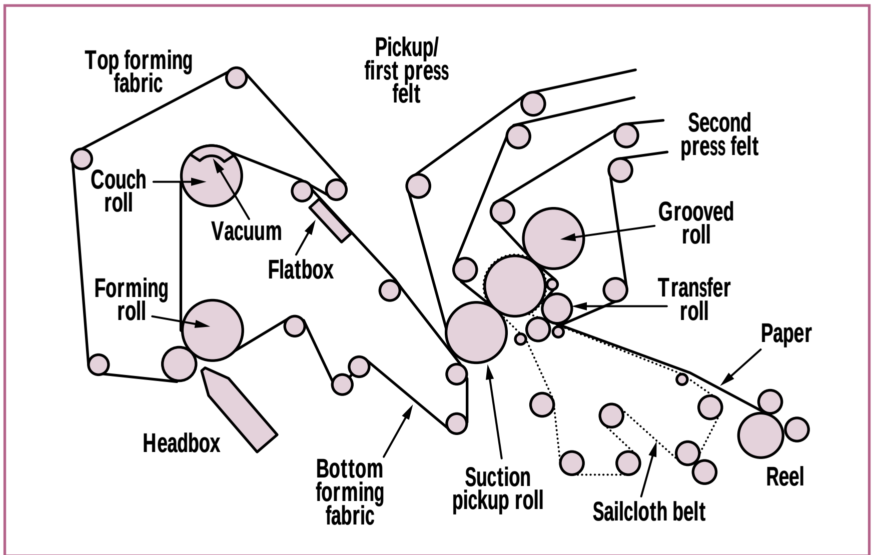
One must carefully consider the nature and microscopic roughness of the surface. Low adhesion of a web to the belt surface is desirable, although a small amount of residual adhesion is necessary to ensure that the web follows the belt rather than the press felt.

Very light or limp cloths are difficult to guide and wrinkle with concomitant marking of the paper by creases. Permeable fabrics become plugged with fines in irregular patches and are very difficult to clean. Some impermeable fabrics cause air bubbles before the press nip. Providing void areas in the side of the fabric contacting the roll or in the roll itself and carefully controlling the ingoing run of the fabric could overcome these problems.

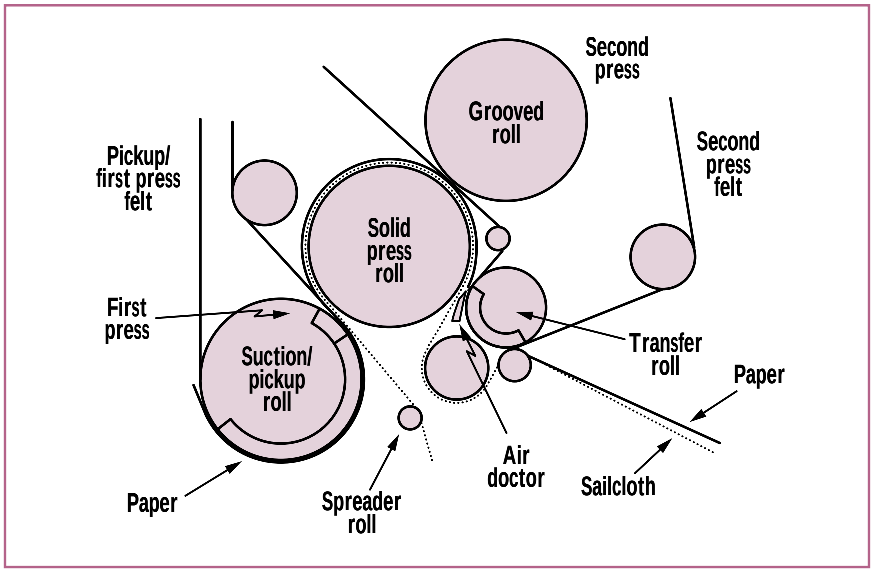
Web marking occurred with some sailcloth having prominent or coarse weaves. A fine weave with a treated surface is acceptable. We had difficulty in uniformly stripping the pressed web from a smooth surface. We believe that a surface having a fine texture with selected hydrophilic and hydrophobic characteristics is more effective in controlling web release. A satisfactory compro-

Press nip load, 1st/2nd, kN/m	Solids content after 2nd nip, %	Basis wt., g/m²	Caliper, µm	Bulk, cm³/ g	PPS S10 (felt/belt), µm
15/30	33.0	42.5	108	2.54	8.1/8.2
30/60	33.8	43.2	105	2.43	8.1/8.0
45/90	35.6	43.3	107	2.47	8.3/8.2
60/120	38.4	43.7	106	2.43	8.4/8.2

I. Water removal and paper properties



1. Pilot paper machine with transfer belt



2. Pilot paper machine press section with transfer belt

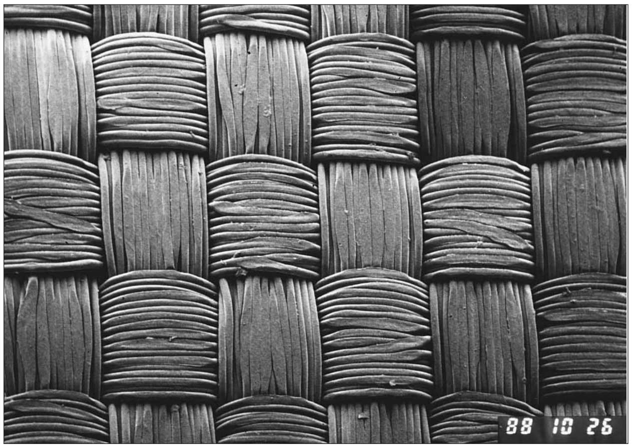
mise for the pilot machine trials was a medium weight (107 g/m²) resin-impregnated polyester sailcloth.

PAPER MACHINE TRIAL

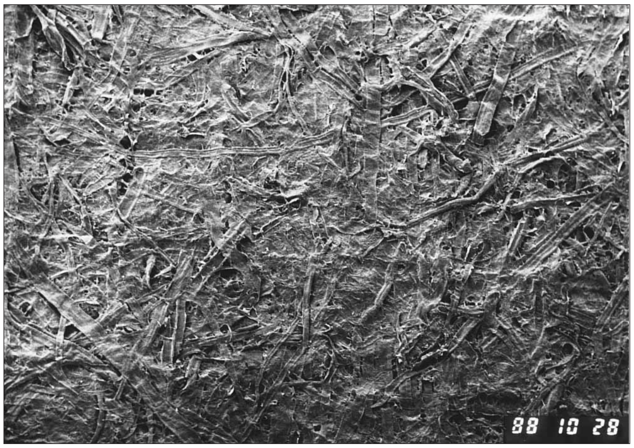
The trials with belt pressing used Paprican's pilot machine configured as a roll-former followed by a three-roll inclined press. See Fig. 1. The sailcloth belt wrapped around the granite roll and transferred the pressed sheet close to the sampling section as **Figs. 1 and 2** indicate. The pilot paper machine press design limited the options for the belt run. Although the belt loop was not optimal, it was satisfactory for our experiments. The two free ends of the belt overlapped by several centimeters. Gluing them and sewing with a domestic sewing machine formed an endless loop. Although this method of making an endless belt was adequate for pilot machine trials, it would not be sufficiently durable for commercial applications.

A web transfer system consisting of an air doctor with a soft blade and a vacuum transfer roll *(9)* separated the paper from the sailcloth after the second press nip. The paper was subsequently sandwiched between the press felt and the belt and carried to the sampler. (See Fig. 2.) A conventional felt guiding system guided the sailcloth.

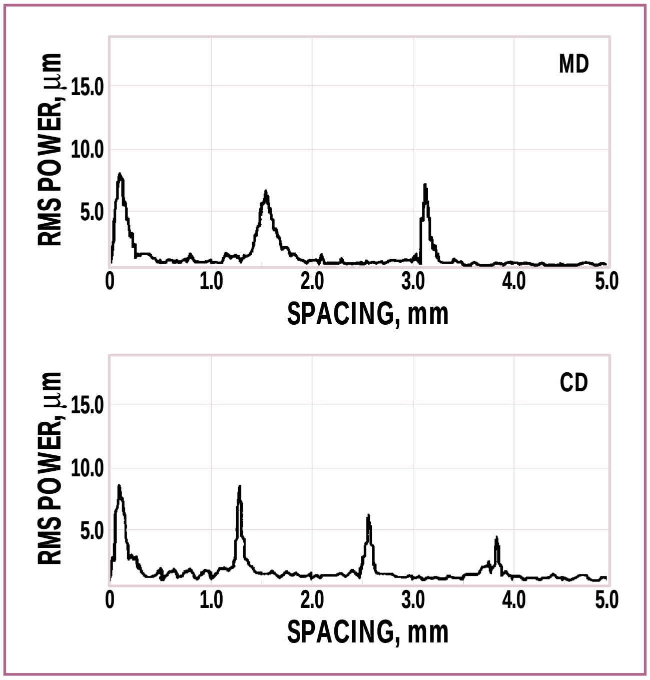
The furnish was a never-dried, low-freeness mixture of 62% groundwood, 29% sulfite, 3% kraft, and 6% broke from a mill producing groundwood specialty grades. The paper with a basis weight of approximately 48 g/m² was made at 600 m/min using the four combinations of first



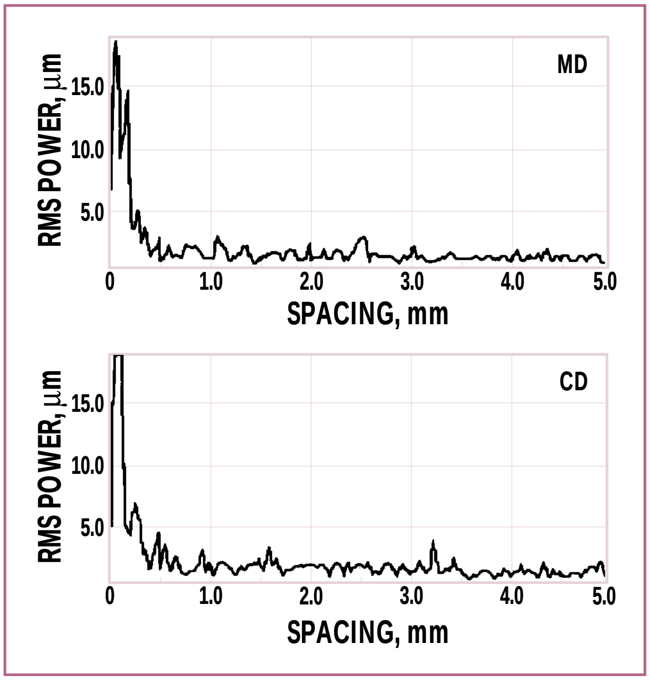
3. Photomicrograph of sailcloth surface



4. Photomicrograph of paper surface pressed against the sailcloth with first/second press nip loads of 60/120 kN/m at 600 m/min



5. Power spectrum of profilometer trace of the sailcloth surface



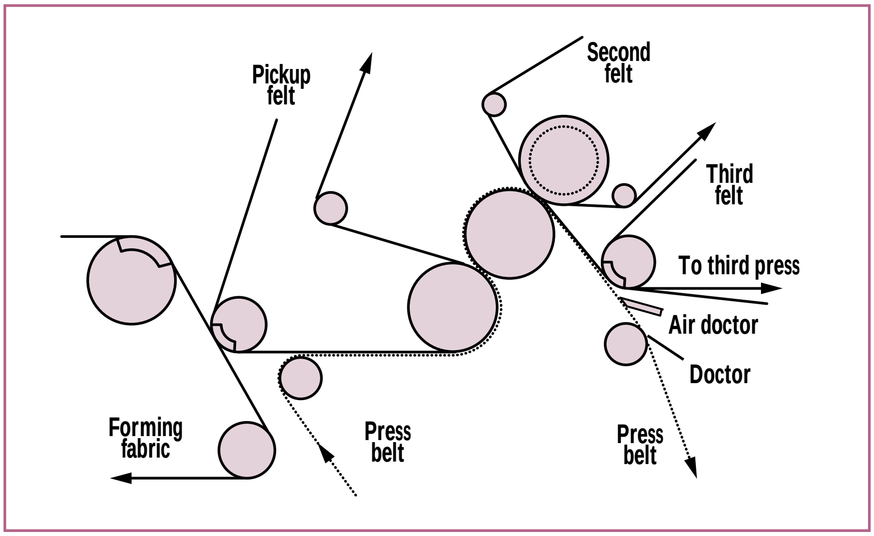
6. Power spectrum of the paper surface pressed by sailcloth at first/second nip loads of 60/120 kN/m

and second press nip loads shown in **Table I.** With the air doctor, transfer roll system installed as shown in Fig. 2, it was possible to transfer reliably the web from the second press to the sampler. The water removal and therefore the solids content of the paper after the press nips were identical to that of the conventional press configuration.

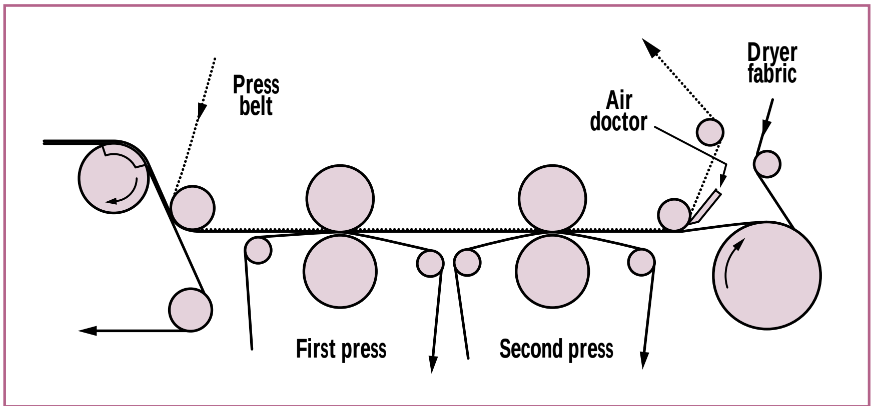
The performance of the sailcloth was satisfactory—particularly considering the crude seam, although the trials were too short to evaluate durability. The web transfer system was essential for removal of the web from the fabric. There was no evidence of sheet-stealing by the felt.

EVALUATION OF PAPER QUALITY

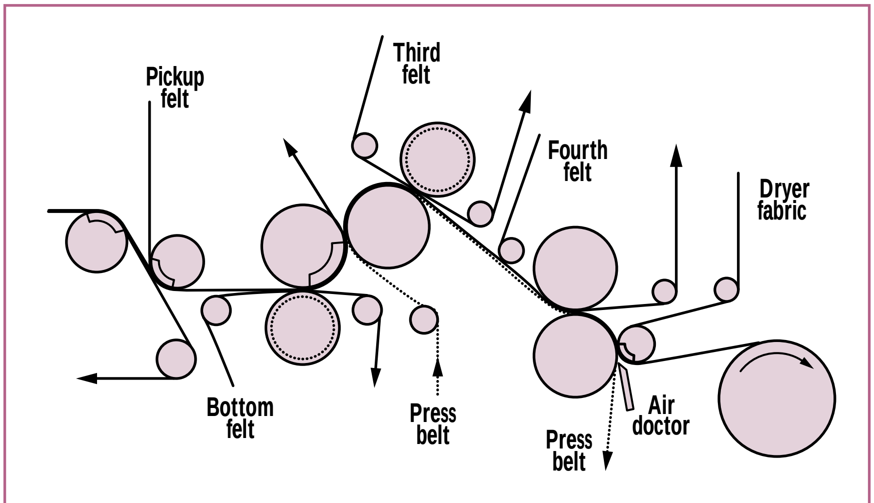
Measurements used to evaluate paper quality were primarily Parker Print-Surf (PPS) roughness, photomicrographs, and profilometer measurements. The PPS (S10) roughness of the uncalendered paper from this trial was similar to that of conventionally pressed paper as Table I shows. The belt side of the paper became smoother than the felt side with increasing press nip load. We observed similar values and trends *(10)* for the smoothness of granite



7. Application of a belt to replace the surface of a solid press roll in a three-roll, inclined press



8. Application of a belt to support the web between two straight-through presses



9. Closed draw, three-nip press with belt to support web through the fourth press

roll side and felt side of papers pressed in a conventional single-felted press.

Although the sailcloth used in our trials had prominent knuckles as shown in **Fig. 3**, it left only a slight impression on the paper surface **(Fig. 4)**. Profilometer measurements with a 2-μm-diam. stylus showed that the belt weave pattern at approximately 1.3-mm spacing measured on the sailcloth **(Fig. 5)** did not appear in the paper surface **(Fig. 6)**. The results in Table I and Fig. 4 indicate that the press belt caused almost no embossing of paper.

IMPLICATIONS FOR COMMERCIAL PAPER MACHINES

A flexible belt combined with a web transfer system could convert existing presses to high-speed operation by closing the open draws. Technology for weaving endless impermeable belts is currently available in the paper machine felt and sailcloth industries. Although the sailcloth in the trials was not optimal, we believe that better fabrics could be developed with desired surface and structural properties including controlled web release and durability. A metal roll covered with a belt could replace the solid roll in existing presses **(Fig. 7.)**. This would eliminate the need for press roll materials with good sheet release properties such as granite, ceramics, or specially formulated roll covers. One could optimize press roll design for high strength and low cost.

Four-roll, three-nip presses are a way to support continuously the web throughout the press section. These presses are expensive, vibration prone, and consume considerable time for maintenance and roll and felt changes. A belt press could convert two straight-through presses to a closed-draw design. This arrangement in **Fig. 8** allows easier maintenance and quicker felt changes. In another example, the

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Belts, nip, press sections, properties, solids content, surface properties, web transfer.

press belt transfer system could close the open draw between a three-nip press and a fourth press as **Fig. 9** shows. This could eliminate open draws between the former and the dryer section.

CONCLUSIONS

A lightweight, impermeable belt with a web transfer system can support the web through the press section on a pilot paper machine without any detrimental effects on sheet surface properties. With the development of suitable belt materials, this concept could lead to the elimination of open draws in existing press sections and more reliable operation at high speeds or with weak wet webs. Since the press belt prevents the direct contact between the press roll and the wet sheet, it eliminates the need for press roll materials with good sheet release properties such as granite, ceramic, or other special roll covers. **TJ**

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