Overview of tissue finishing and converting

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Converting lines running at high speeds transform raw materials into finished rolls of bathroom tissue and paper towels.

Toilet paper in roll form was introduced in 1871. In 1879, T. Seymour Scott & Bros. reorganized as the Scott Paper Co. Ltd., specializing in marketing toilet paper. Scott Paper produced the first paper towel in 1907. Unable to convert an unusually heavy run into toilet paper, Scott made the extra heavy crepe tissue into rolls of perforated towels.[1]

Have you ever wondered where those rolls of bathroom tissue (we in the industry prefer to call them bathroom tissue rather than toilet tissue) and paper towels come from? This article provides information about these roll products.

Background

Raw material is presented to a tissue or towel converting line as one or more tissue parent rolls on cylindrical cores. Rolls of bathroom tissue or paper towels leave the line as finished cases of product. A lot goes on in between. The individual components that make up a converting line can include an unwind stand, embosser, rewinder, accumulator, log saw, wrapper, and case packer. A typical tissue converting line (unwind stand through log saw) is shown in **Fig. 1.**

Unwind stands

Tissue parent rolls vary in width to match the paper machines that produce them. In the industry, parent rolls for tissue are a nominal 102-103 in. wide (some are used at full paper machine width) and 60-96 in. in diameter. This allows for 3-4 in. of trim. During the converting operation, the bathroom tissue or towel sheet or web is wound into a log on a paper core. The log diameter equals the product diameter of the bathroom tissue roll or towel roll. This log will produce either 22 bathroom tissue rolls 4.5 in. long or 9 towel rolls 11 in. long.

A bathroom tissue or towel sheet is too lightweight to be pulled from an unwind stand without driving the parent roll. This driving is done with individual drive belts, sometimes called tape drives. The drive belts contact the surface of the parent roll and unroll it. Since we are driving the outside of the parent roll, belt surface speed equals web surface speed. The belts are individually loaded against the parent roll.

A two-ply converting line can have two individual single-ply unwind stands or a single unwind stand with a two-ply parent roll. Unwind stands can use parent roll shafts or be shaftless and use parent roll core plugs. Since parent roll changes normally account for the largest single downtime item, unwind stands are designed with fast parent roll changes in mind.

Unwind stands are normally equipped with tension control. This provides a controlled draw between the unwind stand and the next line component. One way to sense tension is with a dancer roll system. When a change in tension is sensed, the unwind stand speed is changed to return to the original tension setting.

Bathroom tissue and towel unwind stands are essentially the same.

Embossers

Embossers give the tissue sheet a texture. They can do this in several ways. Steel-to-steel embossers are normally used for bathroom tissue sheets. They consist of a roll frame with two matched pattern, engraved steel rolls. The rolls are gear driven to hold the pattern match constant. Rubber-to-steel is also an option.

Towel embossing can be more complex, especially for a two-ply towel. In this case, one machine manufacturer's standard is to emboss each ply through its own rubber-to-steel nip. Glue is applied to one ply, which is then pressed against the other ply, forming a two-ply towel.[2]

When it is included in a converting line, the embosser is the base speed component. The unwind stand speed is caused to vary as required to maintain constant web tension, while the speed of the embosser remains constant.

Rewinders

The rewinder is the most complex component of the converting line. The rewinder perforates the sheet and makes individual logs of product, all at full machine speed.

[1]Grummer, A. E., PIMA Magazine 73(1): 44(1991).

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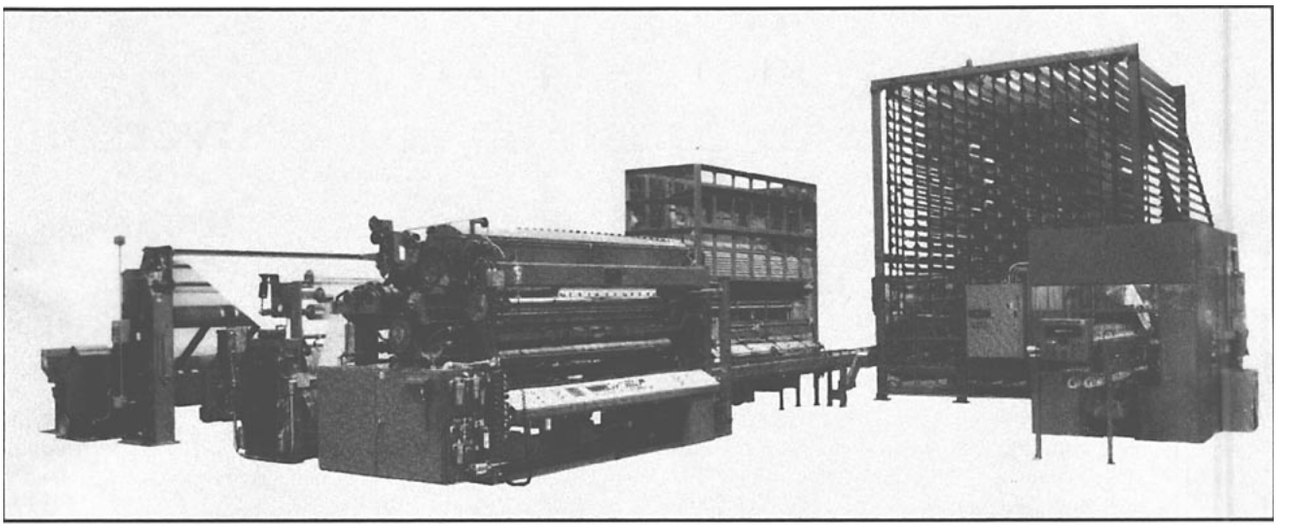
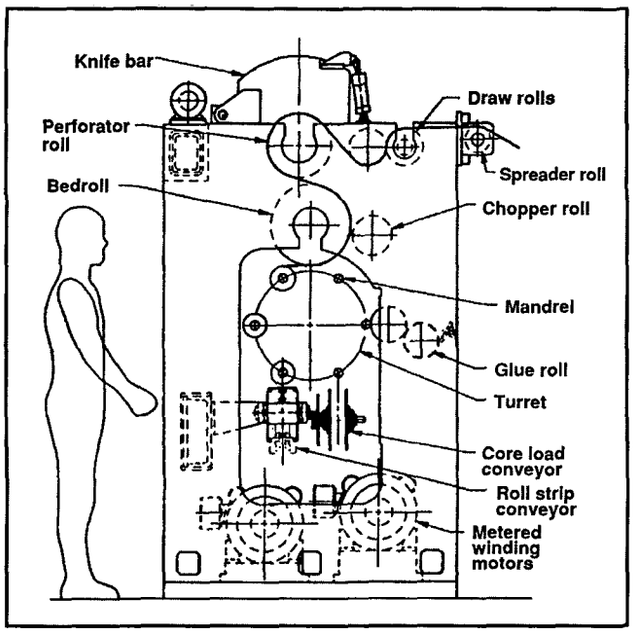
[2]Paper Converting Machine Company, Green Bay, Wis., Technical Bulletin, "Sanitary tissue, towel and napkin machinery," No. 02159003MA, p. 7.

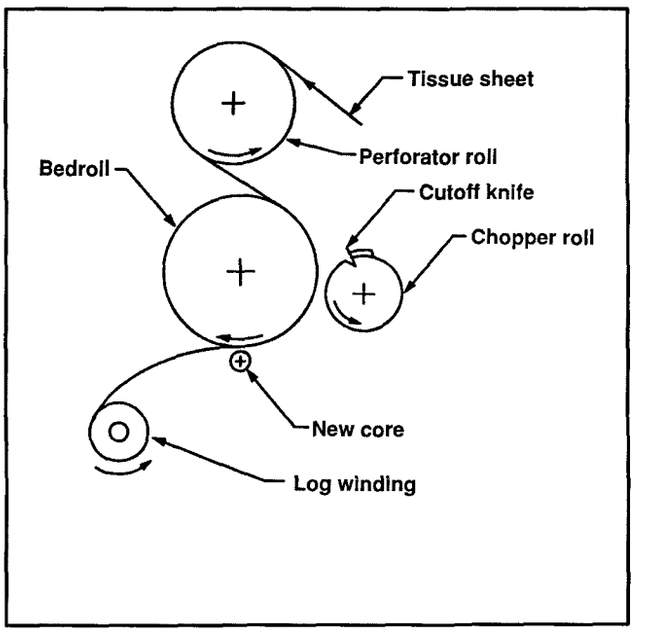
1. A typical tissue converting line—unwind stand through log saw. Photo courtesy of Paper Converting Machine Co., Green Bay, Wis.



2. Side view of a tissue rewinder. Diagram courtesy of Paper Converting Machine Co., Green Bay, Wis.



3. Tissue rewinder in normal running condition



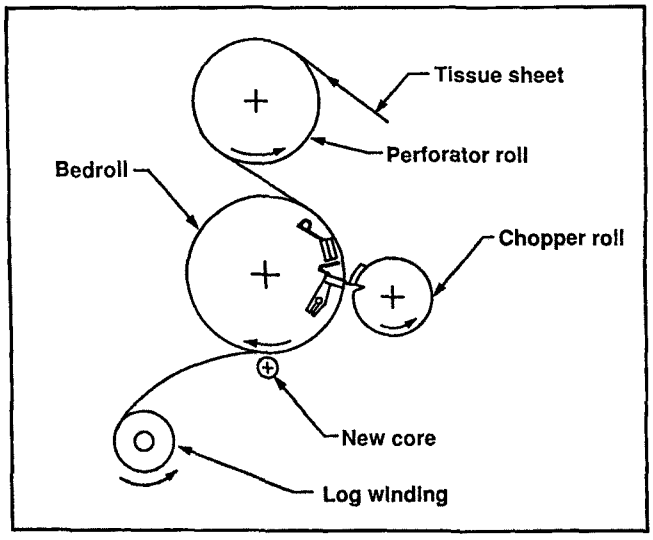
Depending on the converting line, that speed can be from 700 ft/min to over 2500 ft/min.

One breakthrough in tissue converting was the shear cut perforator. This concept allows the tissue web to be perforated in the rewinder at full machine speed. Multiple rows of replaceable perforator blades are mounted in a perforator roll. The roll centerline and all blade edges are perpendicular to the direction of travel of the tissue web. Each row of blades, running across the full width of the tissue web, will make one line of perforation on the web. The anvil head or knife bar is a heavy steel casting mounted directly over the perforator roll, as shown in **Fig. 2.** Tungsten carbide anvils are mounted in the shape of a helix in the anvil casting. These adjustable anvil segments are set to give a slight interference with the blades mounted in the perforator roll. The tissue web and the blades in the perforator roll are traveling at the same speed. The web is between the blade edges and the anvil segments. As the perforator roll rotates, the row of blades flexes against the stationary anvil segments (point of contact along the helix), shearing the web in a straight line along the blade edges. The result is a perforated web, with the perforation accomplished at full machine speed.

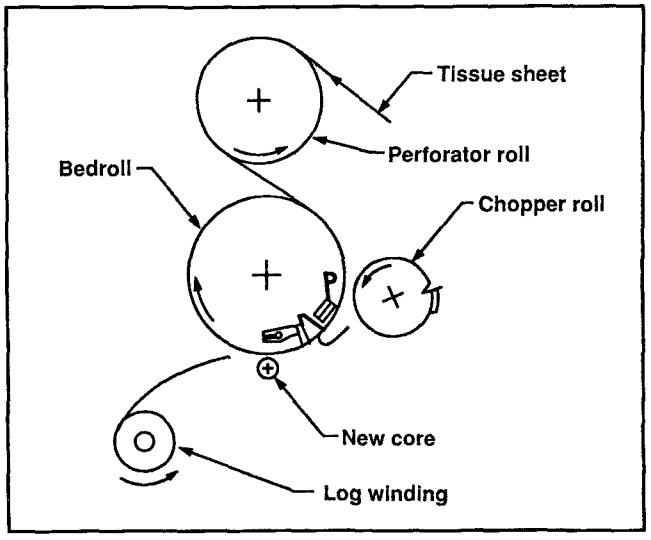
Depending on the type of rewinder, individual logs can be wound using a surface drive or a center drive concept. The center drive concept will be considered here.

The second breakthrough in tissue converting was a transfer system. This allows individual logs of full web width to be made without stopping the rewinder. The tissue web is transferred from core to core at full machine

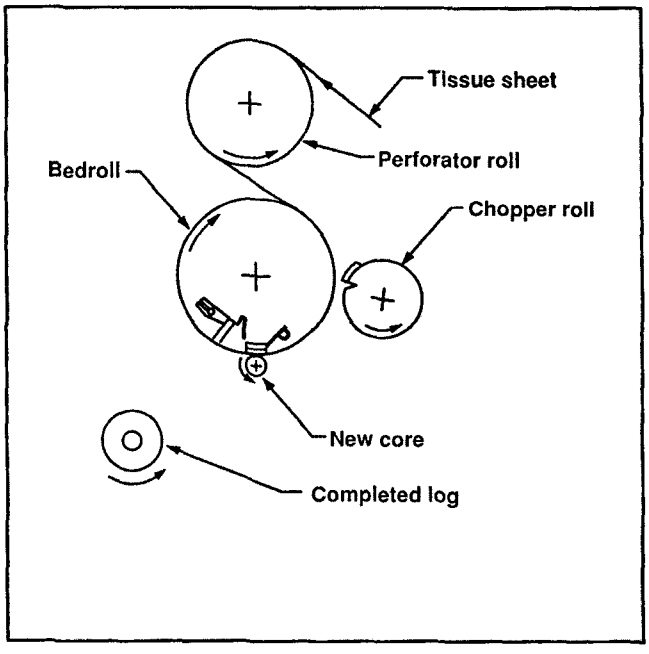
4. The first step: The sheet is separated at perforation



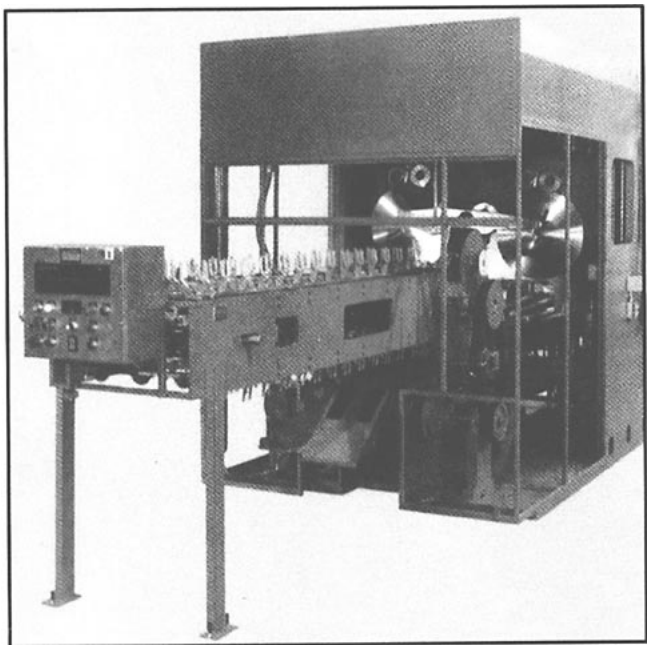
5. The cut sheet is carried to the new core



6. Transfer of the sheet to the new core is complete



7. Continuous motion log saw for cutting bathroom tissue logs into rolls. Photo courtesy of Paper Converting Machine Co., Green Bay, Wis.



speed. This is accomplished by a special roll in the rewinder, called a bed roll, working with another roll called a chopper roll. A later version of the system using a high speed bed roll will be discussed here. **Figure 3** shows a tissue rewinder in normal running condition.

In principle, the web is separated at perforation from the last sheet of the winding log and transferred to the glue-covered surface of the bare core of the new log. The bedroll contains a set of two parallel blades across its face. These blades are normally held within the surface of the bedroll. On the last revolution of the wind, the parallel blades move out slightly from the surface of the bedroll, raising the tissue web away from the bedroll surface. **Figure 4** illustrates this step.

The chopper roll is mounted above the high-speed bedroll's surface. It has a single blade similar to the two bedroll blades mounted across its face. The chopper roll slightly clears the surface of the high-speed bedroll. The chopper roll is geared to the bedroll so that the chopper roll blade meshes with and sweeps between the two bedroll blades as they move out of the bedroll's surface. The rewinder is always set up so that a line of perforation falls between the two bedroll blades. With this arrangement, the chopper roll blade breaks the tissue web at perforation as the last log is finishing its wind.

At the same time, a row of pins has been rising out of the bedroll surface. These pins pierce through the tissue web and into a sponge on the chopper roll. The sponge acts as a backup surface for the pins. As the bedroll rotates, the pins carry the sheet to the glue-covered surface of the

bare core for the new log as shown in **Fig. 5**. The surface speed of the core matches the surface speed of the web. As the pierced web approaches the core, pads rise out of the high-speed bedroll, pushing the web off the pins and onto the glue-covered surface of the spinning core. **Figure 6** illustrates this process. The transfer is complete and the operation has taken place at full machine speed.

Accumulators

Significant gains in efficiency can be made by protecting the rewinder from being stopped by short-duration downstream disturbances. This is accomplished by using a log accumulator. The logs are supported by cradles or buckets suspended from chains. The tallest component in Fig. 1 is a log accumulator. With no downstream disturbances, the logs take a short path through the machine. When downstream equipment stops, logs are collected in the accumulator, allowing the rewinder to keep running. Accumulators are available from several manufacturers.

Log saws

The tissue or towel log is now complete. The log is stripped from the rewinder and conveyed to a log saw. The log saw cuts the log into rolls of bathroom tissue or paper towels. Log saws can be of an intermittent or continuous motion type. Both use a round thin steel disk for a blade. The blade has no teeth. It is sharpened to a razor edge as the saw operates.

The intermittent motion saw moves the logs (usually two, side by side) past the blade at product length intervals (4.5 in. for bathroom tissue and 11 in. for towels). The trim is cut off at the beginning and end of each log.

The continuous motion saw, illustrated in **Fig. 7**, has the highest speed potential. It can be designed with one or two blades. The logs (usually two, side by side) are carried past the blade or blades at a constant speed. The blade or blades are held perpendicular to the centerline of the logs at all times. However, the plane of movement of the blade or blades is not perpendicular to the centerline of the logs. The plane of movement is slightly greater than 90° to the logs' centerline. This angle is adjusted so that the velocity component of the blade face in the direction of travel of the log is exactly equal to the surface speed of the log's movement. This means that the blade can make a perfect square cut while the log is moving at a constant speed through the saw.

Wrappers

After being cut into individual rolls of bathroom tissue or paper towels, the product must be wrapped. This can be a paper wrap for single rolls of bathroom tissue or a plastic or polyethylene wrap for single towel rolls, multiple bathroom tissue rolls, or multiple towel rolls. Depending on the wrapping machine, paper wrappers can be applied with and without glue. Polyethylene wrap is heat sealed around the product.

Both domestic and European wrapping machine manufacturers are presently supplying machines to the U.S. tissue market.

Case packers

After the bathroom tissue or paper towel rolls have been wrapped, they are normally packed in a corrugated case and sent to the warehouse. Packing can be done manually or with a semi-automatic or fully-automatic case packer. The semi-automatic machine requires an operator to load corrugated cases on the machine one at a time. Fully automatic machines theoretically operate unattended, except for filling the case magazine with corrugated cases. Case packers can be equipped with integral case sealers. A case leaving a case packer of this type can be transported directly to the finished product warehouse.□

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