U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE
FOREST PRODUCTS LABORATORY • MADISON, WIS.
In Cooperation with the University of Wisconsin

U. S. FOREST SERVICE
RESEARCH NOTE
FPL-0219
1972

METHOD FOR MEASURING AND CONTROLLING WEB TENSION OF CORRUGATING MEDIUM DURING SINGLEFACING PROCESS

By

W. D. GODSHALL, Engineer
and
J. W. KONING, JR., Technologist

Forest Products Laboratory,[1] Forest Service
U.S. Department of Agriculture

Abstract

Installation of an automatically controlled tension device, electronically coupled to a magnetically operated disk brake system, resulted in accurate measurement and control of the web tension of the corrugating medium on an experimental singlefacer. This method improved accuracy in determining the runnability characteristics of corrugating medium. Evaluation of the system indicated that web tension could be regulated for increments as small as 0.3 pounds per inch of web width.

[1]Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Introduction

Single-faced corrugated fiberboard is manufactured by bonding two sheets of paperboard together. In this combining operation, one paperboard, the corrugating medium, is fluted by being passed between a matched set of fluted steel rollers in the singlefacer. An adhesive is applied to the tips of the flutes and the other paperboard is adhered as a facing.

The speed at which this operation can be conducted is partially dependent on the runnability or flute fracture characteristics of the corrugating medium. As indicated by McKee and Gander,[2] one of the major factors influencing runnability is the amount of web or transport tension on the corrugating medium as it passes into the labyrinth of the corrugating rolls. Web tension is defined as the tension stress applied to the medium as it is transported from the roll of paperboard through the singlefacer to the corrugating rolls.

In previous work conducted on the FPL experimental singlefacer, a tension measuring device was used to indicate web tension as the medium unwound from the roll. This was a useful measurement of the stress required to overcome brake friction, but did not include the additional stresses incurred by the medium as it passed over the preheater and idler rolls. This system also required an operator to make constant manual brake adjustments to compensate for changes in roll diameter, and was not capable of producing close, uniform control of web tension.

In addition to accurately measuring tension, it is important to be able to vary the tension during the run to evaluate the runnability of corrugating medium in terms of both constant tension and varying speed, and constant speed and varying tension.

Based on these requirements, a commercial tensioning system was acquired and installed to replace the former manual system.

Tension Control Device

The tension device, as shown in figure 1, consists of an air-cylinder spring (A) acting on a frame (the dancer arm) supported by a pivoted shaft (B). This in turn supports a dancer roll (C), over which the web passes. A position-sensing transducer (D), connected to the pivoted shaft, carries a signal to the control box (E) which governs the brake system at the mill roll stand. A block diagram of the system is shown in figure 2.

---

[2] McKee, R. C., and Gander, J. W. 1967. Properties of corrugating medium which influence runnability. Tappi 50(7): July.

The dancer roll of the tension device was located to sense the web tension just prior to entry into the corrugating rolls. This allows the device to respond to changes in both the roll of corrugating medium and the frictional forces in the singlefacer. The only sources of web tension after the dancer roll are a single idler roll, which should have constant friction regardless of the material being run, and the top corrugating roll on which approximately six flute tips have contact with the medium.

Measuring and Controlling Tension

The tension of the web is initially set to the desired value by adjusting the stiffness of the air spring acting on the dancer arm. This is done by regulating the pressure in the air cylinder. The air pressure in the cylinder tends to force the dancer arm to swing outward away from the machine, while the tension of the paper web tends to pull the dancer arm back in. The dancer arm stabilizes at midtravel position (in this case, vertically) which is the neutral position on the position-sensing transducer when the desired tension is reached. Any subsequent changes in the retarding torque to the paper web will cause a momentary change in the angular position of the dancer arm. As the arm moves, the position-sensing transducer varies a d.c. signal to the control box. The control box compares this signal with a signal for setting the preselected neutral dancer roll position, and varies an electrical current to apply more or less magnetic force to the disk brakes (fig. 3); this will cause the dancer arm to return to its set neutral position, thereby regulating the web tension.

So long as the dancer arm is within its free working range of ±15 degrees from the neutral position, the tensile force applied to the web is 1.8 times the air pressure in the cylinder. This factor of 1.8 represents the mechanical lever ratio of the dancer arm assembly and the piston working area. Thus the tension of the web can be determined by the relationship:

$$\text{Tension}\ \left(\frac{\text{lb.}}{\text{in.}}\right) = \frac{1.8 \times \text{air pressure (p.s.i.)}}{\text{Width of web (in.)}}$$

This can be verified directly, with the corrugator stopped, by breaking the web at the corrugating nip and applying a tensile force to the web in series with a calibrated force gage. The air spring cylinder has a low spring factor so the force applied to the web does not vary appreciably over the working range of the dancer arm.

The air pressure in the cylinder is measured by a gage at the operator's position, and is also recorded on a strip chart recorder from a strain gage pressure transducer.

Varying the Tension

To vary the tension during the run, air pressure to the air spring cylinder is either increased or decreased, and the electronic control box varies the brake signal to return the dancer roll to the neutral position.

Evaluation of the System

Initial evaluation of the system indicated that its response characteristics were satisfactory. It appeared to hold the tension constant at all selected increments of tension and was successfully used in operations in which the speed of the corrugating medium was held constant at 600 feet per minute and web tension varied from 0.6 to 5.4 pounds per inch of width of web. With maximum web width, adjustments as small as 0.3 pounds per inch of width can be made.

The control system operated satisfactorily at all operating speeds, including emergency stopping of the singlefacer.

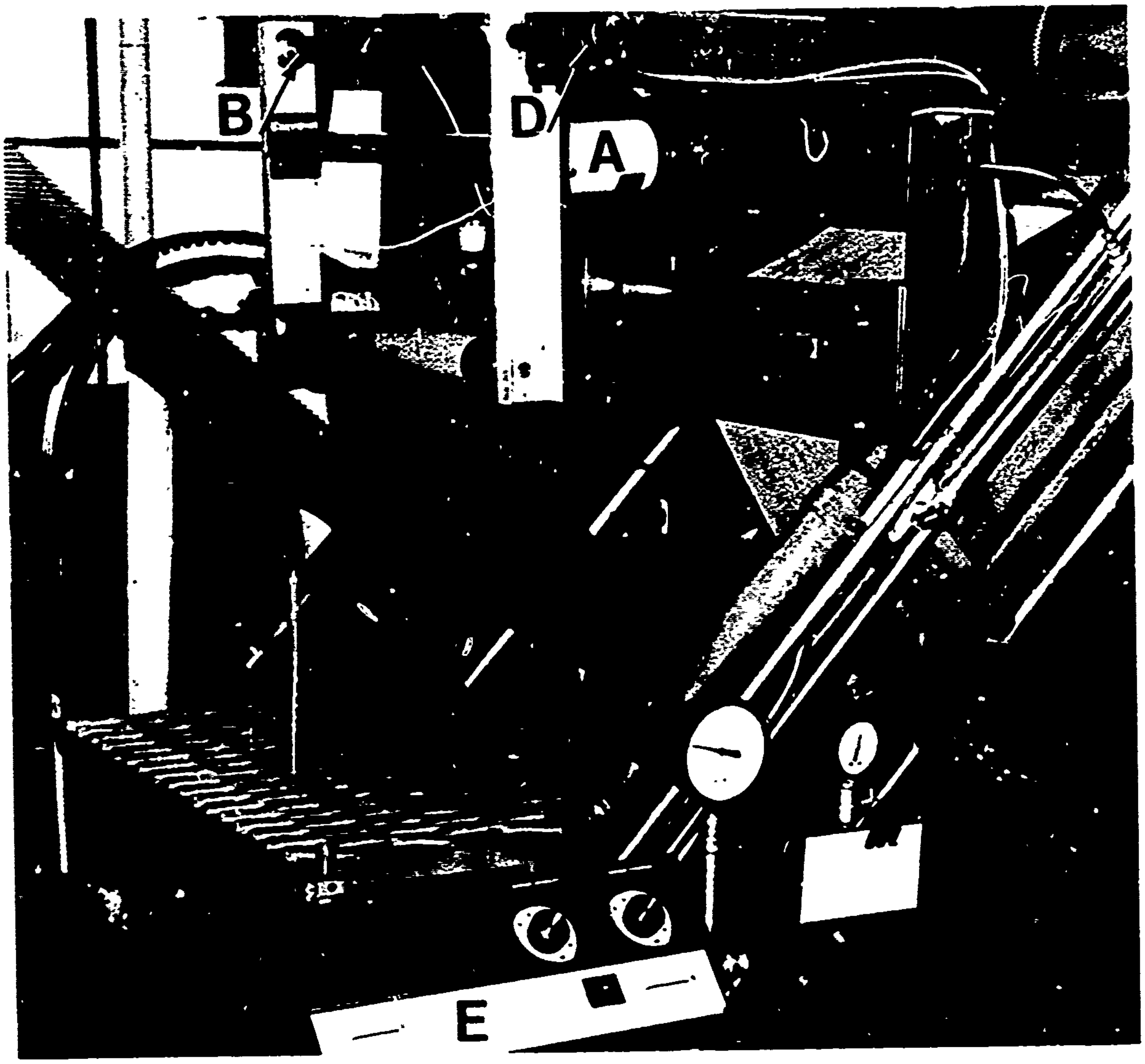

Figure 1.--Tension control device: A, air-cylinder spring; B, pivoted shaft; C, dancer roll; D, position-sensing transducer; and E, control box.

M139-367-9

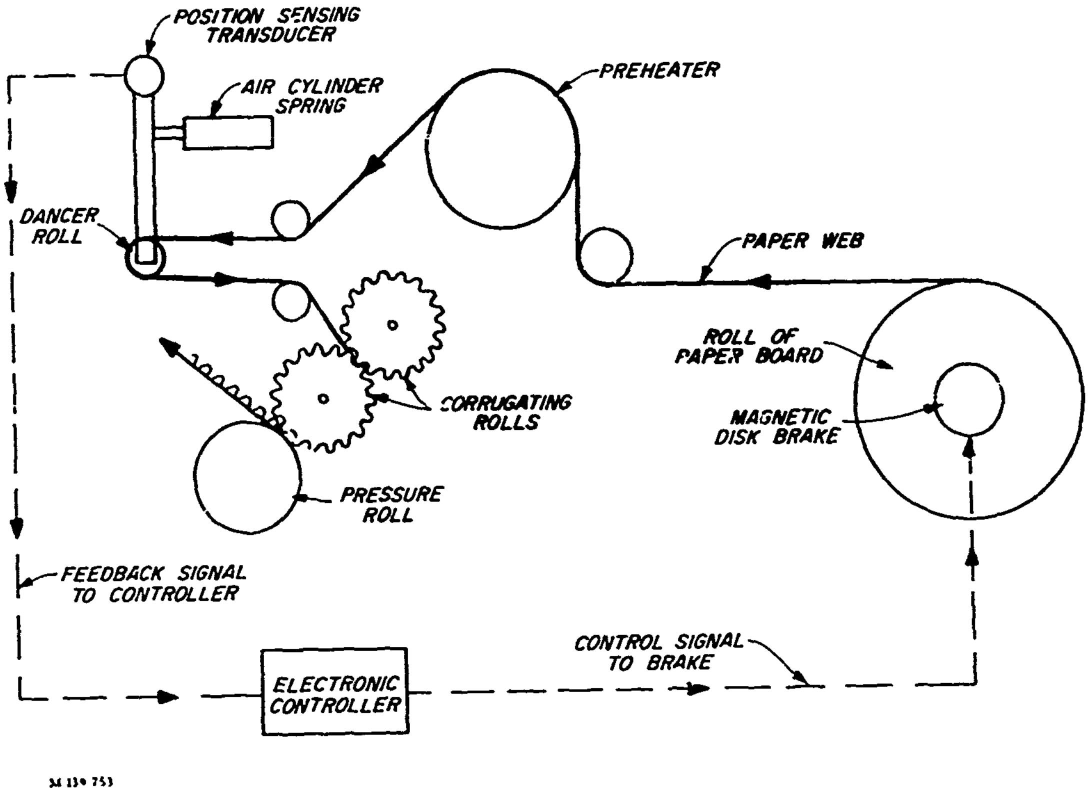

Figure 2.--Block diagram showing the tension device, control box, and disk brake.

M139 753

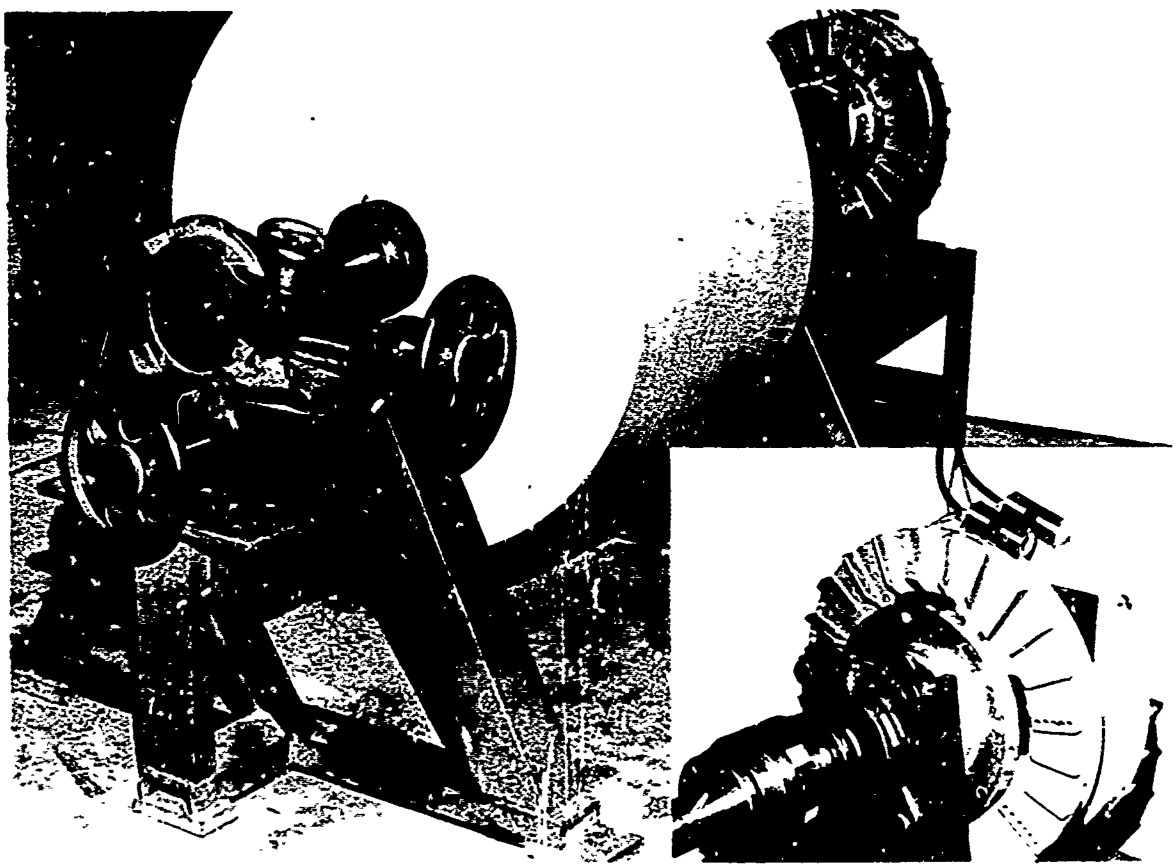

Figure 3.--Corrugating medium on mi.l roll stand with magnetically controlled disk brakes at the right of the roll. Inset shows closeup of disk brakes. Mechanical hand brake on operator's side of the roll has been removed.

M140-046

GPO 827-643