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NASA TECH BRIEF

Goddard Space Flight Center

Position Sensing Materials Wound on a Reel

The problem:

Until recently, most devices used to indicate the layer number of material wound on a reel physically contacted the reel. These included mechanical counters geared to monitor directly the reel-turns number. However, mechanical counters load the reel, are inaccurate, and require considerable maintenance.

The solution:

An electro-optical counter measures the number of layers of web wound on a reel and indicates the layer number and web position digitally, without physically contacting the reel or requiring numerical interpolation from a mechanical readout index. While the device is designed to work in conjunction with magnetic tape, it is applicable to other thin-web materials.

How it's done:

The counter works by measuring the circumference of only the outermost layer of web. For relatively-large web radii, the loci of the layers of a thin material wound on a reel approximate a family of concentric circles, with their radii respectively and successively increasing by the thickness T at a rate of $2\pi T$. For large radii, the difference in circumferences between adjacent layers is substantially constant and equal to $2\pi T$.

As shown in the figure, an aperture is provided on the periphery of the storage reel. A transducer, such as a lamp/photocell unit, is positioned at the periphery of the reel; light from the transducer passes through and strikes the photocell during each turn of the storage reel. The transducer generates a reset pulse for each complete turn of the reel. These pulses are supplied to one of the digital-processing circuit inputs. Ideally, a pulse-shaping network such as a Schmitt trigger should be provided to prevent false triggering.

A code wheel with tachometer markings spaced around its periphery is connected to one end of the capstan shaft and rotates with it. The markings are sensed by a suitable transducer, such as a lamp/photocell and are converted into electrical tachometer pulses. The transducer input to the digital circuit should be provided with suitable signal conditioning.

Capstan transducer markings are spaced apart from each other on the code wheel by a fixed distance; when the capstan passes a $2\pi T$ length of web, one capstan pulse is generated. A motor rotates the capstan at a speed independent of the amount of web wound on the storage reel, maintaining a repetition rate of the transducer output dependent on motor speeds. The storage reel rotates at a speed which depends on the amount of web wound on. Since the differences in circumferences between adjacent web layers are each $2\pi T$, each layer of web, extending outwardly from the hub of the reel, causes exactly one more tachometer pulse to be generated than the immediately preceding layer. By monitoring the number of pulses generated during each complete turn of the reel and by subtracting a fixed number corresponding to the circumference of the hub of the reel, the number of layers of web wound on the reel are determined.

The digital readout circuit consists of a down counter, a pair of up counters, and control logic functions. The signal processor monitors layer number and functions as a vernier to monitor the position of the web within each layer. The down

(continued overleaf)

counter is preset to a fixed number corresponding to the circumference of the hub of the reel. Tachometer pulses generated in response to linear web movement are supplied to the countdown circuit.

The countup circuit is divided into two halves: The input of the first is initially blocked by the control logic, but the second receives the pulses continuously. When the down counter pulses to zero, the control logic supplies tachometer pulses to the first up counter. Each reset pulse, generated upon the completion of a full turn of the reel, steers the output of the first countup circuit to a register where it is stored and simultaneously resets the down counter and both up counters. The binary number stored in the register is equal to the outermost web layer. The outputs of both countup circuits are continuously monitored to provide web position within each layer.

Output data can indicate the number of layers and position, or it can address data stored in the web. This is performed with a digital comparator that compares the layer number and position data with corresponding preselected data. The comparator output controls a servo which drives the reel.

Note:

Requests for further information may be directed to:

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Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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