(12) UK Patent Application (19) GB (11) 2 341 232 (13) A

(43) Date of A Publication 08.03.2000

(21) Application No 9819370.9

(22) Date of Filing 07.09.1998

(71) Applicant(s)
Jean-Ray Charlier
1 Valley View, PONTLLANFRAITH, Gwent, NP2 2EE, United Kingdom

(72) Inventor(s)
Jean-Ray Charlier

(74) Agent and/or Address for Service
Jean-Ray Charlier
1 Valley View, PONTLLANFRAITH, Gwent, NP2 2EE, United Kingdom

(51) INT CL^7
B41F 33/00 , G01N 21/47 21/86 21/89

(52) UK CL (Edition R)
G1A AA9 AG6 AG9 AMBP AR7 ASD AT21 AT3

(56) Documents Cited
EP 0533305 A2 **EP 0531160 A2** **WO 96/09533 A1**
WO 95/34810 A1 **US 5223918 A**

(58) Field of Search
UK CL (Edition Q) **G1A AAJF AAJP ADK ADL AMBP AMBX ASD**
INT CL^6 **B41F 33/00 , G01N 21/47 21/88 21/89**
Online: WPI,Japio

(54) Abstract Title
Rate of change monitoring system

(57) In a system to monitor variations in articles eg printed sheets 7 produced in a continuous process, the level of light reflected by each article is detected by an array of sensors 3 and compared to both a threshold level and to the level reflected by previous articles. This allows detection of both randomly defective articles and of trends in variation of the articles' specification towards a limit.

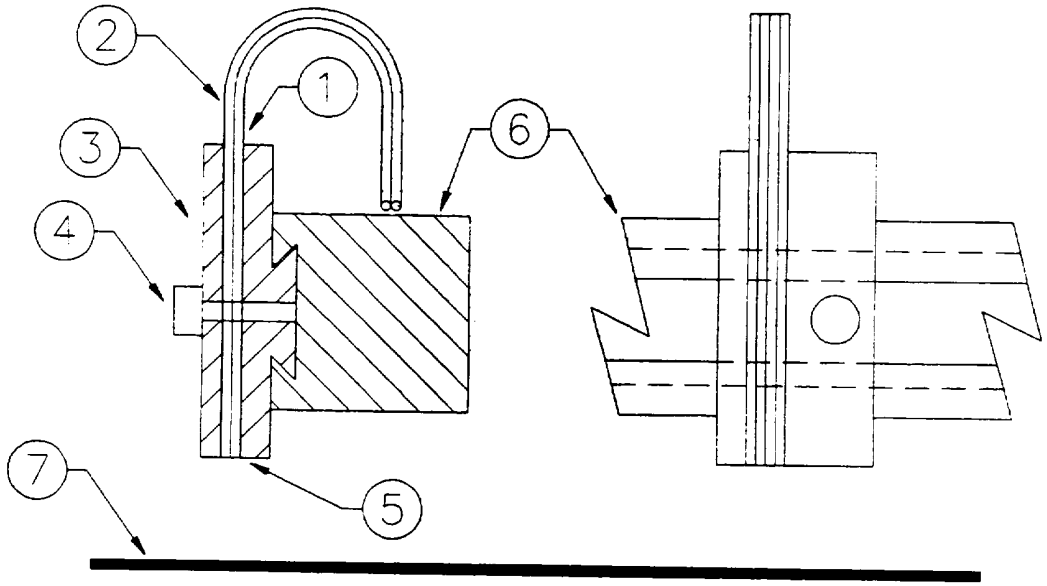

FIG. 1.

GB 2 341 232 A

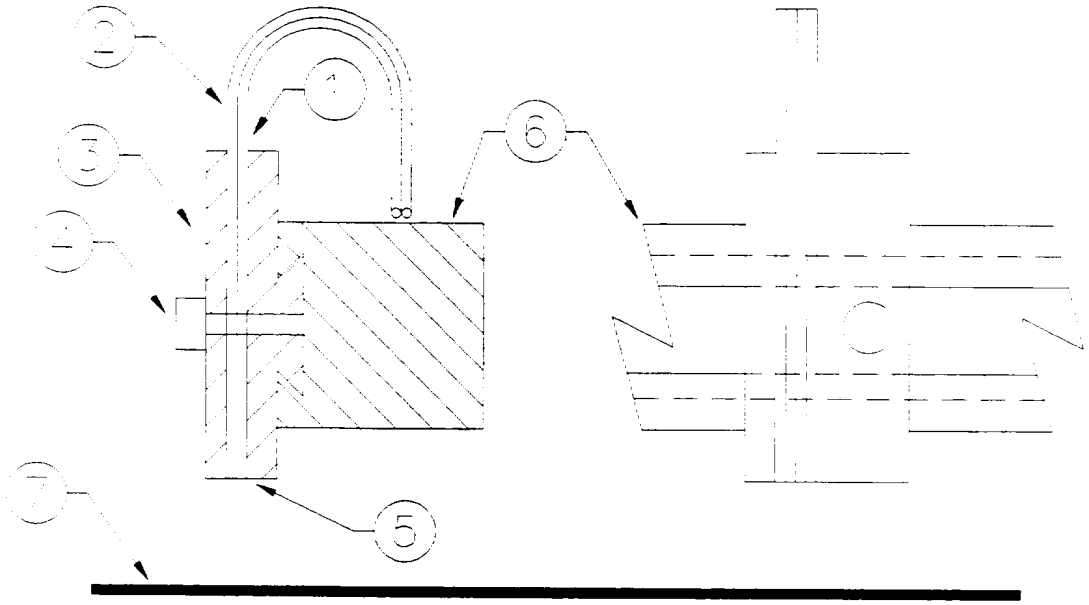

FIG. 1.

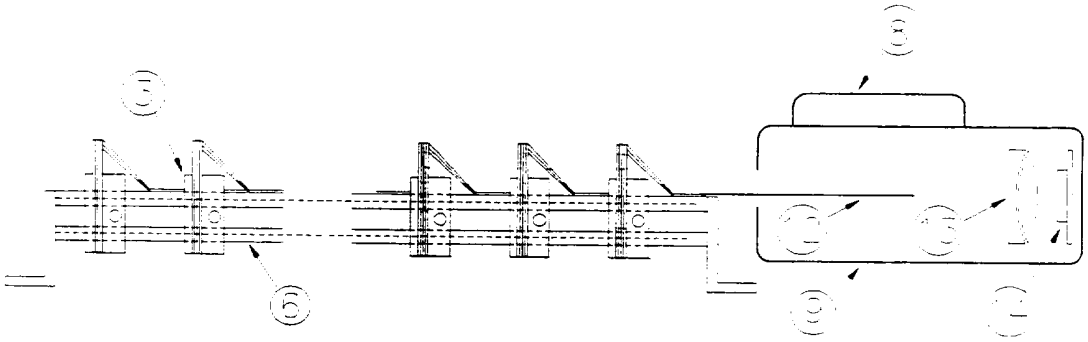

FIG. 2.

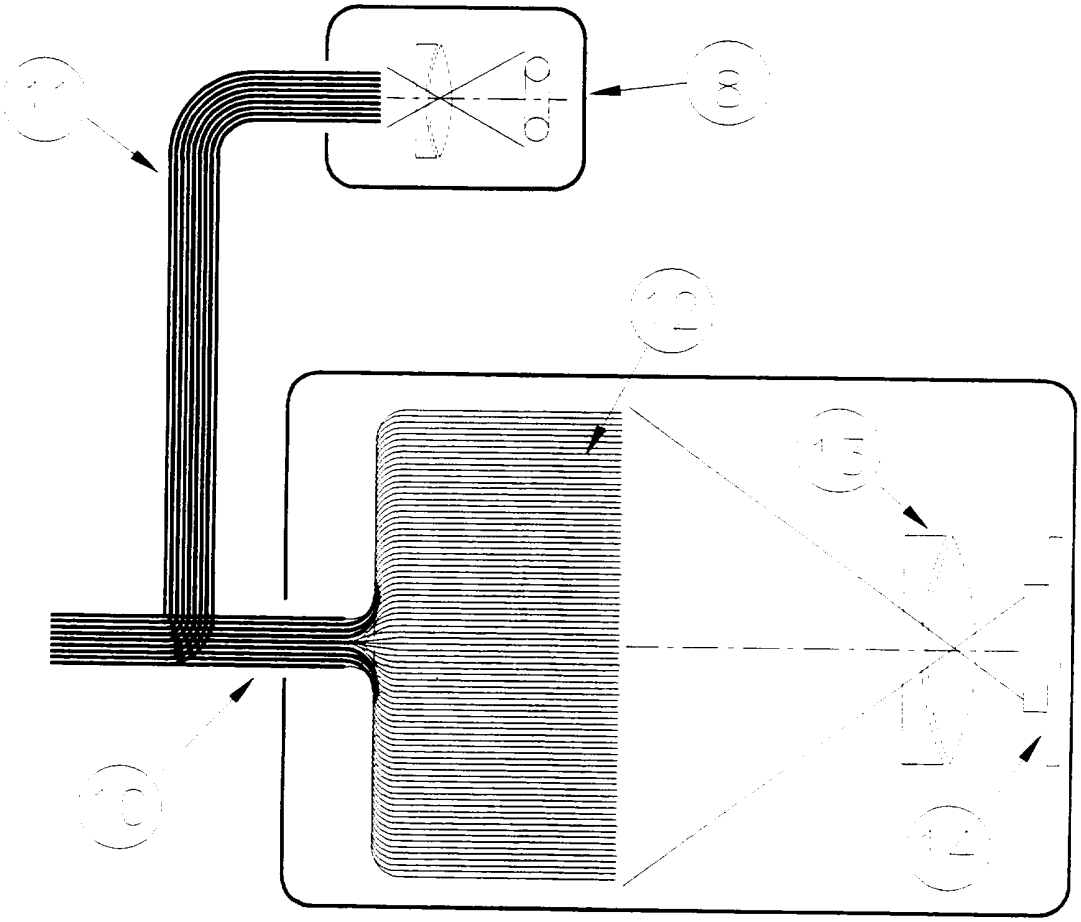

FIG. 3.

2341232

RATE OF CHANGE MONITORING SYSTEM

(R.O.C.)

General

This invention relates to a system capable of monitoring, in real time, the rate of changes occurring during a repetitive manufacturing process, such as continuous lamination, or web printing.

Background

In continuous processes, once the initial start-up is completed, defects occur.

These problems are of two kind: slow variations and instantaneous random errors.

Slow variations occur progressively, such as tooling wear or ink drying, leading to the manufacturing of a product slowly going out of specification, while instantaneous random errors occur accidentally, such as a broken tool or an ink duct getting temporarily blocked.

The first defect type usually leads to large amounts of rejected goods before the defect is noticed, but, if under control, should not reach the final customer, as incorrectly manufactured products can be rejected before packing by the Quality Control Inspection.

However, the randomly occurring defects need to be detected IN ALL CASES, as there will be only a few defects within a large amount of good products, in which case the inspection based on random sampling of finished goods can oversee these problems.

The ROC Monitoring System is providing BOTH these detection's of defects, by analysing the RATE OF CHANGE in the product quality, for EACH product being manufactured.

Principles

A controlled illumination of the substrate under monitoring results in a definite and quantifiable level of reflection which is measured by the ROC system, thus capable of detecting Trends in variations (by means of Statistical Process Control) and provide an early Operator warning of an imminent product shift toward specification limits, thus preventing large amounts of wasted materials.

On the other hand, in comparing instantaneous readings with expected pre-defined values and calculations of the rate of changes in reflected luminance, the ROC system offers also the detection of OCCASIONAL mishaps during the production (as the Rate of Change is beyond acceptable limits), thus providing automatic rejection of randomly defective products.

General description

The ROC is a Computer based system, coupled with a bespoke fibre optic sensor array, linked to a strobed light source and a linear scan camera. It is synchronised to the line (i.e. printing press) by means of a rotary encoder or similar, reset at each repeat length.

The strobed light box is triggered several times during a repeat length, supplying light pulses, through fibre optic, over the areas of interest, distributed across the web.

These light pulses are reflected back with a certain amount of loss (i.e. in printing, due to the ink deposition), to fibre optic receivers that guide the resulting refracted luminance toward a linear scan camera located at the end of the fibres.

The resulting luminance is captured by the camera and read directly in digital form by a purpose designed add-on card mounted in the computer.

Each luminance value is then compared with a pre-defined (or previously sampled) data, and calculations take place.

A statistical evaluation is performed, to detect Trends in changes of luminance. The trend, together with a repeat-length count information provided by the rotary encoder, leads to the calculation of a RATE OF CHANGE.

The analysis of instantaneous variations provides an immediate reaction when levels of changes exceed a pre-set limit, thus resulting in immediate rejection of randomly occurring accidents.

The analysis of the rate of changes provides an early warning for gradually increasing degradation of the product, and, at the limit, can provide a system stop information, thus avoiding large amounts of waste.

Detailed description

Each part forming the ROC Monitoring system is detailed hereafter.

Drawings annexed are:

Fig 1: Light sensors

Fig 2: Light sensor array

Fig 3: Fibre Optics splitter

Light sensors

The light sensors consist of an array of fibre optics, respectively transmitting light (1) and receiving reflected light (2). A certain number of transmitting & receiving fibres are grouped into the SENSOR HEAD (3), forming two parallel lines. All sensor heads are secured into location on the CARRIER (6) by means of bolts (4) or similar. The sensor head facing the product is polished (5) to allow the best light transmission/reception by the fibres, to and from the substrate under monitoring (7).

Sensor Array

The sensor array consists of a carrier (6) mounted across the web, carrying a certain number of individual sensors (3), that can be located and locked anywhere along the rod by the operator, during set-up. Each of these individual sensors are made of two rows of fibre-optics, one row being light transmitters, the other light receivers.

The light transmitters fibres return to a strobed light box (8), while the light receivers return to the line scan camera (7), both being located at the end of the carrier.

Light box

At the end of the transmitter fibres is a small enclosure (8) containing a strobe tube, a possible reflector, and some optics to concentrate the light on the transmitting fibres (11). The strobe is fired under the control of the central computer, and synchronised to the production line.

It supplies pulses of constant energy light, through the transmitting fibre's, to the sensor heads located over the web or the parts to be monitored.

Line Scan Camera

All receiving fibre's (10) carry the reflected light, from the substrate, to the optics (13) of a line scan camera (14). All fibre's are precisely aligned to the scanning array (12) (presenting a "comb array"), and focused to cover the width of the array.

At each "scan command", the CCD is reset and active for a fixed duration, (shutter effect), allowing reflected light to accumulate in the device. The video line profile is digitised by the ROC card in the computer, and data is treated.

Rotary Encoder

The rotary encoder is mounted in a fixed manner to the printing cylinder (or to any device rotating synchronously with the print cylinder). It provides one "Zero" pulse per complete rotation of the master cylinder, and a number of equally spaced pulses per revolution. These pulses are treated by the computer as the angular position of the cylinder (or a position ALONG the web, over one repeat length).

It is ESSENTIAL, for positional purpose, that the encoder Zero pulse occurs always at the same place in relation to the master cylinder (otherwise the firing position, and, consequently, the measurements will NOT occur over the same area of the web, thus defeating the purpose of the ROC system).

ROC Add-on Card

The Purpose Designed ROC card is a PC add-on card that controls all the operations of the ROC system.

It responds to the encoder pulses, to keep track of the sensors position over the web, whatever the speed, and controls the firing of the light box. The firing pulse also starts the line scan camera shutter. Once the image capture has been completed within the CCD line array, the video line equivalent is read by the ROC card and digitally converted for calculation purposes. The digital information is then read by the PC, for further treatment.

The ROC add-on card also provides a network to allow connection of several PCs together, or to communicate with external devices (such as alarms or ejector devices).

Program

The ROC program runs on the PC, under its own operating system. It provides the following modes of operation:

- INTERACTIVE: Unattended state. Scans once per repetition length and displays graphically the video line obtained.
- RUN: Prepare a work session, setting-up, sampling, running and reporting
- RE-RUN: Reload a previous set-up and run it again.
- OPTIONS: Allows to set alarms levels, stop press levels, and user preferences.

In RUN mode, the following options are available, and to be performed in sequence:

- SET-UP: Allows the Operator to select several monitoring positions along the repeat length.
- SAMPLE: Sample and average the currently selected positions, while storing values in memory.
- RUN: Once the sampling is completed, the copy counter is cleared and the analysis is started.
- REPORT: Once a job is finished, prints reports of results.

CLAIMS

1. A Rate of Change Monitoring system using the reflected luminance of the substrate under monitoring.

2. A Rate of Change Monitoring system using fibre optics or light guides to bring light toward the substrate under monitoring.

3. A Rate of Change Monitoring system using fibre optics or light guides to collect reflected light from the substrate under monitoring.

4. A Rate of Change Monitoring system that uses strobed light line scanning technics to collect data on reflection from the substrate under monitoring.

5. A Rate of Change Monitoring system that uses video to collect reflection information data.

6. A Rate of Change Monitoring system as claimed in Claim 1 to Claim 5 that uses information data to calculate the rate of change in reflected light.

7. A Rate of Change Monitoring system as claimed in Claim 1 to Claim 5 that uses statistical process control to determine levels of failure.

8. A Rate of Change Monitoring system as claimed in Claim 1 to Claim 5 that uses statistical process control to determine levels of warnings.

9. A Rate of Change Monitoring system as claimed in Claim 1 to Claim 5 that uses statistical process control to determine levels of immediate action required.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 9819370.9 **Examiner:** Andrew Bartlett
Claims searched: 1-9 **Date of search:** 23 February 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G1A (AAJF,AAJP,ADL,ADK,AMBP,AMBX,ASD)

Int Cl (Ed.6): G01N 21/47, 21/88, 21/89
B41F 33/00

Other: Online: WPI, Japio

Documents considered to be relevant:

Category	Identity of document and relevant passage			Relevant to claims
X	EP 0533305 A2	(KOMORI CORP)	Whole doc	1 & 5-7
X	EP 0531160 A2	(XEROX CORP)	Whole doc	1,6,9
X	WO 96/09533 A1	(VAN DITMAR)	See pp 6-8 in particular	1 & 5-9
X	WO 95/34810 A1	(JOHN HEYER PAPER)	Whole doc	1,2,3 & 6
X	US 5223918	(BERTHOLD et al)	Whole doc	1-3 & 5-8

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.