



- (51) **International Patent Classification:**  
*G01N 25/72* (2006.01)    *G01N 33/44* (2006.01)
- (21) **International Application Number:**  
PCT/PL20 13/0000 13
- (22) **International Filing Date:**  
7 February 2013 (07.02.2013)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**  
P.39953 1    15 June 2012 (15.06.2012)    PL
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- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

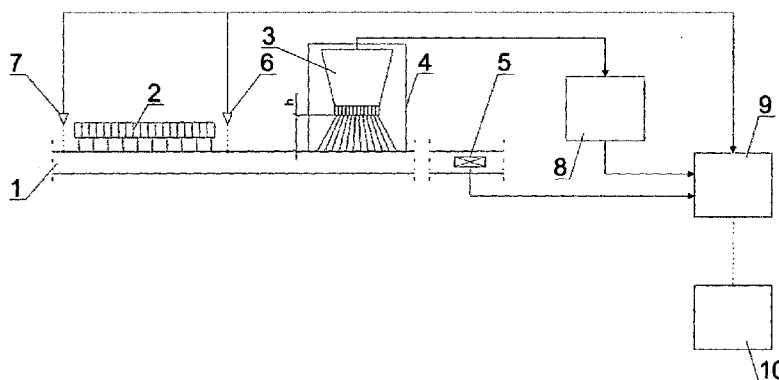
**Declarations under Rule 4.17:**

- *as to the identity of the inventor (Rule 4.1 7(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.1 7(H))*

**Published:**

- *with international search report (Art. 21(3))*

(54) **Title:** METHOD AND DEVICE FOR ASSESSING THE SURFACE CONDITION OF RUBBER OR PLASTIC STRANDS



(57) **Abstract:** A device for assessing technical condition of the surface of strands made of rubber or plastic comprising temperature generator, temperature detector, interface, image analyzer, and decision element is characterized in that it has an infrared detector (3) located over the examined structure of strand (1) at appropriate distance (h) and in an antireflection shield (4), whereas uniformity of the temperature gradient over the whole surface of the examined structure of strand (1) is ensured by a temperature generator (2) after which temperature sensors (6 and 7) are located. A method of assessing technical condition of strands made of rubber or plastic is characterized in that that signals from sensors (6, 7) measuring the temperature gradient and the signal from the transducer (5) providing non-contact and/or contact measurement of velocity of strand (1) and the image from interface of detector (8) are transmitted to image analyzer (9) and decision element (10).



## METHOD AND DEVICE FOR ASSESSING THE SURFACE CONDITION OF RUBBER OR PLASTIC STRANDS

The subject of the present invention is a device for assessing technical condition of the surface of strands made of rubber or plastic and a method of assessing technical condition of strands made of rubber or plastic offering the possibility to implement the solution also for assessing technical condition of the surface of the belt rubber mantle of belt conveyors used in the mining industry.

Known from description of Polish patent PL 181202 is a device for measuring of stretching and breaking force of strands that has hydraulic actuators attached by their bases to the front plate of a frame, with piston rods of said actuators mounted in a transversal movable beam moving on guides by means of carriages provided with rollers. In the middle of the movable beam, the front catch is mounted. In the rear plate, a rear catch is installed with grooves for edged ring locking position of the catch in the rear plate. The front catch is attached to the beam by means of a pin on which a bushing is mounted with strain sensors glued on it. The rear travelling catch allows to bring the catches close to each other for the required distance so that both short and long elements can be tested.

In the framework of modernization of lift technology, steel-polyurethane strands are used instead of steel cables. To assess the quality of such structure in the course of service it is necessary to determine both technical condition of steel cords and the state of polyurethane mantle surface. The presented idea allows to assess condition of the surface and possible presence of structure cracks or gaps in the mantle. The problem of carrying out inspection of the rubber mantle surface in belt conveyors where people can be occasionally transported on the belts, also remains unsolved. Before each running cycle in which people are to be carried, the belt must be inspected visually for possible cracks which is obviously a time-consuming procedure. Application of the present invention would eliminate human intervention and increase detectability of defects.

The device for assessing technical condition of the surface of strands made of rubber or plastic comprising temperature generator, temperature detector, interface, image analyzer, and decision element is characterized in that it has an infrared detector positioned over the examined strand structure at appropriate

distance and in an antireflection shield, whereas uniformity of the temperature gradient over the whole surface of the examined strand structure is ensured by a temperature generator after which temperature sensors are located.

The method of assessing technical condition of the surface of strands made of rubber or plastic is characterized in that signals from sensors measuring the temperature gradient and the signal from the transducer for non-contact and/or contact strand motion velocity measurement as well as the image from the detector's interface are transmitted to an image analyzer and to a decision element.

The device for assessing technical condition of the surface of strands made of rubber or plastic comprises the following components:

The invention concerns a machine vision system in the infrared range; as opposed to the computer vision that is focused mainly on image processing on the hardware level, the machine vision requires the use of additional I/O (input/output) devices and computer networks for transmitting the resulting information to other elements of the analyzing system. The machine vision falls into the category of engineering dealing with computer science, optics, mechanics, and industrial automatics. Machine vision systems are used on a continuously increasing scale to solve industrial inspection problems, allowing for full automation of the inspection process at improved precision and efficiency.

The invention is shown in an example embodiment in the Figure presenting its schematic view.

The device is equipped with infrared detector 3 located under the examined strand 1 at distance  $h$  and in an antireflection shield 4. The detector's observation field depends on the distance  $h$  guaranteeing appropriate resolution of the image. In the strand 1, temperature gradient is generated by means of generator 2. In the measuring system, temperature is measured by sensors 6 and 7 (in the MEMS technology — before and after the temperature gradient generator) and temperature values are transmitted to image analyzer 9. The measured temperature provides the feedback used in the image analyzer. The image from interface of detector 8 is also transmitted to the image analyzer 9. This can be also e.g. an operator's computer in which qualitative analysis of the image and localization of defects is carried out. For localization of defects, non-contact or contact strand motion velocity measurement 5 is used.

The system operates in real time. A very important feature of the device is the method used to generate a temperature gradient in the inspected structure (continuous or pulsed).

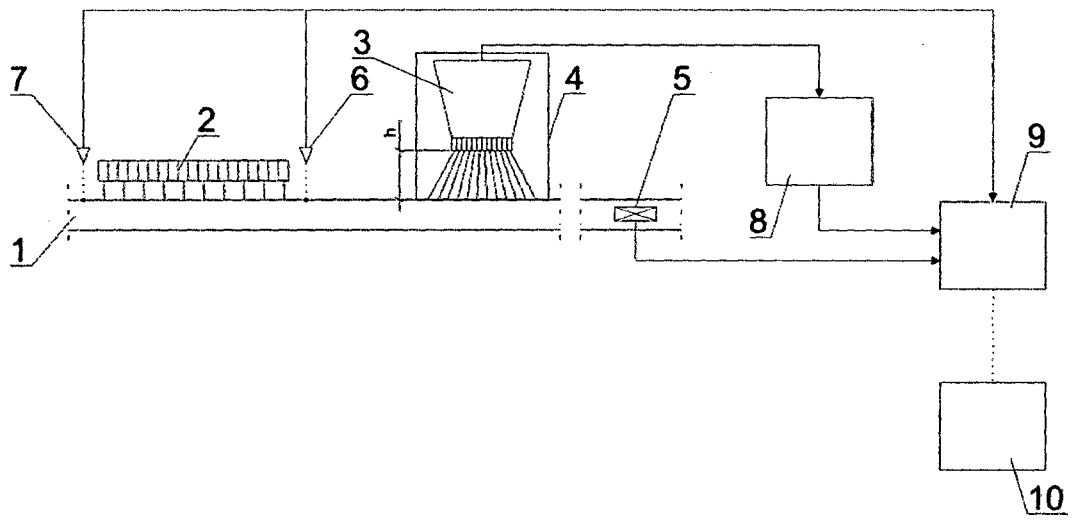
The method of assessing technical condition of the surface of strands made of rubber or plastic is characterized in that signals from sensors 6, 7 measuring temperature gradient and the signal from the sensor 5 for non-contact and/or contact measurement of motion velocity of strand 1 as well as image from interface of detector 8 are transmitted to image analyzer 9 and decision element 10.

The device for assessing technical condition of the surface of strands made of rubber or plastic comprises the following components:

- sensor with infrared detector 3 (digital or analog camera with optics);
- camera interface for image digitalization 8 (the so-called "frame interceptor");
- image analyzer 9 (usually a PC computer or integrated processor, e.g. DSP); (In some cases, all elements listed above are components of a single device known as the intelligent camera which, besides the image capturing system, comprises a processor function of which consists in "picking up" required information from the image without necessity to implement any external image processing device and the interface sending the generated information to other devices.)
- I/O (input/output) device or communication links (e.g. RS-232) used to send reports on the system operation results;
- a specialized source of temperature gradient 2 adapted to the system;
- sensors 6, 7 verifying the image obtained in analyzer 8;
- a program for image processing and detecting common features of images.

## Patent claims

1. A device for assessing technical condition of the surface of strands made of rubber or plastic comprising temperature generator, temperature detector, interface, image analyzer, and a decision element characterized in that it has infrared detector (3) located over the examined structure of strand (1) at appropriate distance ( $h$ ) and in an antireflection shield (4), whereas uniformity of the temperature gradient over the whole surface of the examined strand structure (1) is ensured by temperature generator (2) after which temperature sensors (6 and 7) are located.
2. A method of assessing technical condition of the surface of strands made of rubber or plastic characterized in that signals from sensors (6, 7) measuring the temperature gradient and the signal from the transducer (5) providing non-contact and/or contact measurement of velocity of motion of the strand (1) as well as the image from interface of detector (8) are transmitted to image analyzer (9) and decision element (10).



INTERNATIONAL SEARCH REPORT

International application No  
PCT/PL2013/000013

A. CLASSIFICATION OF SUBJECT MATTER  
INV. G01N25/72 G01N33/44  
ADD.  
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED  
Minimum documentation searched (classification system followed by classification symbols)  
G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
EPO-Internal , WPI Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003/230717 AI (REILLY THOMAS L [US] ET AL) 18 December 2003 (2003-12-18) paragraph [0015] - paragraph [0017] ; figures 1,2	1,2
A	DE 196 50 883 AI (SAECHSISCHES TEXTILFORSCH INST [DE] ) 10 June 1998 (1998-06-10) the whole document	1,2
A	US 5 399 016 A (MARTIN JOSEPH [FR] ) 21 March 1995 (1995-03-21) column 1 - column 4	1,2

Further documents are listed in the continuation of Box C.  See patent family annex.

\* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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Date of the actual completion of the international search <b>8 July 2013</b>	Date of mailing of the international search report <b>19/07/2013</b>
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer <b>Joyce, David</b>
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No <b>PCT/PL2013/000013</b>
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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DE 19650883	AI	10-06-1998	NONE
US 5399016	A	21-03-1995	DE 69212299 DI 22-08-1996
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