

(12) **United States Patent**
Kilibarda et al.

(10) **Patent No.:** **US 9,410,895 B2**
(45) **Date of Patent:** **Aug. 9, 2016**

(54) **PROCESS AND APPARATUS FOR INSPECTING A HIGH VOLUME MATERIAL JOINTING OPERATION**

(71) Applicant: **Comau, Inc.**, Southfield, MI (US)

(72) Inventors: **Velibor Kilibarda**, West Bloomfield, MI (US); **He Wang**, Southfield, MI (US); **Martin Kinsella**, Southfield, MI (US)

(73) Assignee: **Comau LLC**, Southfield, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 77 days.

(21) Appl. No.: **14/206,246**

(22) Filed: **Mar. 12, 2014**

(65) **Prior Publication Data**

US 2014/0259600 A1 Sep. 18, 2014

Related U.S. Application Data

(60) Provisional application No. 61/778,481, filed on Mar. 13, 2013.

(51) **Int. Cl.**

G01B 11/06 (2006.01)
G01N 21/84 (2006.01)
G01B 11/25 (2006.01)
G01N 21/95 (2006.01)
B21J 15/02 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **G01N 21/84** (2013.01); **B21J 15/025** (2013.01); **B21J 15/28** (2013.01); **B23K 31/125** (2013.01); **G01B 11/25** (2013.01); **G01N 21/9515** (2013.01); **B23P 19/06** (2013.01); **Y10T 29/49769** (2015.01); **Y10T 29/49947** (2015.01); **Y10T 29/53078** (2015.01)

(58) **Field of Classification Search**

CPC . G01N 21/84; G01N 21/9515; B23K 31/125; B21J 15/025; B21J 15/28; G01B 11/25; G01L 5/00; Y10T 29/53078; Y10T 29/49947; Y10T 29/49769; Y10T 29/53087; Y10T 29/5343; Y10T 29/49764; B23P 19/06
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,691,815 A * 11/1997 Huber G01B 11/0608 250/559.19

5,741,096 A 4/1998 Olds

(Continued)

OTHER PUBLICATIONS

Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration, dated Jul. 11, 2014.

(Continued)

Primary Examiner — David Bryant

Assistant Examiner — Jun Yoo

(74) *Attorney, Agent, or Firm* — Young Basile Hanlon & MacFarlane, P.C.

(57) **ABSTRACT**

A method of sequentially performing a plurality of jointing operations includes positioning an automated device to form a mechanical joint into a workpiece and forming a mechanical joint into the workpiece. Once the mechanical joint is formed, the workpiece is scanned to generate data indicating the surface geometry of the workpiece at a location including the mechanical joint. One or more geometric features of the surface geometry are identified, and if the identified geometric features are within respective predetermined specification thresholds, the automated device is repositioned to form a subsequent mechanical joint into the workpiece.

16 Claims, 7 Drawing Sheets

