



US006273483B1

(12) **United States Patent**
Bone

(10) **Patent No.:** **US 6,273,483 B1**
(45) **Date of Patent:** **Aug. 14, 2001**

(54) **THREE ORTHOGONAL DIRECTIONS
MOVABLE FINGERS FOR HOLDING
AND/OR MANIPULATING A
THREE-DIMENSIONAL OBJECT**

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Proceedings of the 24th International Symposium on Industrial Robots, Tokyo, Nov. 4-6, 1993.

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **09/208,995**

Developing a flexible automated fixturing device, Karl Kurz et al, Mechanical Engineering Jul. 94 pp. 59-63 inc.

(22) Filed: **Dec. 11, 1998**

An Update on Nissan Intelligent Body Assembly System, Abe et al, IBEC Oct. 31-Nov. 2, 1995, pp. 1-7 inc.

Related U.S. Application Data

Flexible Grippers for Mechanical Assembly, Baartman and Storm, (5 pages) Industrial Robot vol. 21 No. 1 1994.

(63) Continuation-in-part of application No. 08/824,721, filed on Mar. 26, 1997, now abandoned.

Various grippers (8 in total, product information sheets/catalog pages), No Date.

(60) Provisional application No. 60/014,434, filed on Mar. 28, 1996.

Programmable Robot Gripper for Accurately Fixturing Three-Dimensional Sheet Metal Parts (3 pages), No Date.

(51) **Int. Cl.**⁷ **B25J 15/10**

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(52) **U.S. Cl.** **294/86.4; 294/88; 294/93; 294/119.1**

(58) **Field of Search** 294/15, 16, 27.1, 294/34, 86.4, 88, 93-97, 103.1, 106, 115, 119.1, 902; 269/156; 414/941; 901/16, 23, 31, 36-39

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(57) **ABSTRACT**

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A robotic gripper for fixturing and manipulating a sheet of substantially rigid material, e.g. a sheet metal part, has three fingers with circumferential grooves thereon. Each of the fingers has three degrees of movement. The sheet metal part has at least one opening of a size suited to accommodate one of the fingers. The other fingers can engage the edges of other openings in the sheet metal part or the outside edge of the part. The fingers can be moved away from each other or towards each other respectively depending on the positioning of the fingers, whereby the sheet metal part is fixtured by means of the grooves of the fingers. By using three fingers each having three degrees of movement, and having grooves thereon, an object can be held and kinematically locked without the application of force.

16 Claims, 12 Drawing Sheets

