Title: REMOTE CONTROLLED ACTUATION OF A LASER HEAD

Abstract: A control system for remotely actuating a laser processing head includes a laser processing head and an actuation mechanism located remotely from the laser processing head. A translation mechanism is connected between the laser processing head and the actuation mechanism. The translation mechanism translates movement of the actuation mechanism into movement of the laser processing head. The translation mechanism includes a cable control having a first end coupled to the laser processing head and a second end coupled to the actuation mechanism. The laser processing head is slidably coupled to a robot arm. The actuation mechanism imposes relative linear motion of the laser processing head with respect to the robot arm. A height sensing system includes a height sensor for generating a height signal based on a measurement between the laser processing head and a work-piece. A height sensor electronics module is located remotely from the height sensor and receives the height signal.

Declarations under Rule 4.17:
— as to the applicant’s entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations

Published:
— with international search report

(88) Date of publication of the international search report: 25 January 2007

For two-letter codes and other abbreviations, refer to the “Guidance Notes on Codes and Abbreviations” appearing at the beginning of each regular issue of the PCT Gazette.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC: B23K 26/02(2006.01), 26/08(2006.01)
USPC: 219/121.78, 121.79, 121.83, 121.6
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)
U.S.: 219/121.78, 121.79, 121.83, 121.6

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 6,231,565 B1 (TOVEY et al.) 15 May 2001 (15.05.2001) abstract, figures and complete text</td>
<td>1-4, 9</td>
</tr>
<tr>
<td>Y</td>
<td>US 5,374,804 (UCHINO et al.) 20 December 1994 (20.12.1994) abstract, figures and complete text</td>
<td>5-8</td>
</tr>
<tr>
<td>Y</td>
<td>US 6,211,483 B1 (BISHOP) 3 April 2001 (03.04.2001) abstract, figures and complete text</td>
<td>10</td>
</tr>
</tbody>
</table>

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

* Special categories of cited documents

"A" document defining the general state of the art which is not considered to be of particular relevance

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

"D" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"G" document referring to an oral disclosure, use, exhibition or other means

"F" document published prior to the international filing date but later than the priority date claimed

=" document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"P" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"A" document member of the same patent family

Date of the actual completion of the international search 31 August 2006 (31.08.2006)
Date of mailing of the international search report 29 SEP 2006

Name and mailing address of the ISA/US
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M. Alexandra Elve
Telephone No. 703-308-0661

Form PCT/ISA/210 (second sheet) (April 2005)
**INTERNATIONAL SEARCH REPORT**

**Box No. II**  
**Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:  
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:  
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III**  
**Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:  
Please See Continuation Sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of any additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☑ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-10

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet(2)) (April 2005)
BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s) 1-10, drawn to apparatus.
Group II, claim(s) 11-14, drawn to apparatus.
Group III, claim(s) 15-19, drawn to method.
Group IV, claim(s) 20, drawn to apparatus.

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the different inventive entities are as follows: (i) a control system for a laser beam, (ii) a remote control system for an actuating tool, (iii) a method for laser processing a workpiece and (iv) a laser apparatus.