A surgical instrument includes an elongate portion arranged, in use, to be inserted through a restricted opening into a body, the elongate portion being movable from a first configuration to a second, different configuration in which second configuration two parts of the instrument that are spaced from each other in the first configuration at least partially cross each other in second configuration. In particular the instrument comprises a segmented rod (7), which is initially straight. Segments (3, 32, 35, 36, 38, 40, 42) may be moved such that there is a crossover at two locations.
REFORMABLE ENDO SCOPI C SURGICAL INSTRUMENTS

The present invention relates to surgical instrument and a method of controlling a surgical instrument. The invention is particularly applicable to endoscopic surgical instruments.

EP 0 623 004 discloses a surgical instrument comprising a retractor.

Figure 1 is a side view of a surgical instrument comprising a surgical retractor 1 with an end 2 in a straight configuration;

Figure 2 is a view of the end 2 of the retractor shown in Figure 1 in a straight hook configuration;

Figure 3 is a view of an end 2 of a retractor similar to that shown in Figure 1 in an angled hook configuration and

Figure 4 is a schematic perspective view of one of the segments 3 at the end 2 of the retractor shown in Figure 1.

Figure 1 shows a retractor 1 having a handle 6 which is connected to the end 2 via a hollow rod 7. In use, with the end in the configuration shown in the drawing, the end 2 and part of the rod 7 are fed through a tube in the abdominal wall. The surgeon is then able to manipulate the retractor by the handle 6 and change the configuration of the end 2 into the straight hook shape shown in Figure 2 by rotating a knurled actuating nut 8.

The nut 8 is threadably connected to a screw member 9 whereby, when the nut 8 is rotated in a clockwise direction, looking from the free end of the handle, the screw member 9 is caused to move translationally away from the end 2. A loop of wire 10 is connected at its free ends to the member 9, and both sides of the loop pass through openings 11 in each segment 3. Accordingly as the wire 10 moves further into the rod 7 the segments are caused to tighten against each other.

As the segments 3 bear against each other they are caused to move out of the axial extent of the rod as the end faces 12 of each segment are formed at a slight angle to the perpendicular to the axis of the rod. In Figure 1 the upwardly facing surfaces of each segment are parallel with each other as are the downwardly facing surfaces. Accordingly adjacent faces come into abutment with each other as the wire is tightened, and they take up the configuration shown in Figure 2 in which a straight, substantially rigid hook which subtends approximately 180° is formed.
Accordingly in the position shown in Figure 1, each face extends at an angle of approximately 10° to the axis of the tube.

In order for the segments to take up the shape shown in Figure 3, in which a substantially rigid hook which subtends approximately 180° in a direction generally at right angles to the axis of the rod, the face of at least one of the segments is angled differently. For instance, when the end 2 is in the relaxed position and extends generally in line with the axis of the rod 7, the uppermost segment faces the rod with a face extending at 45° to the axis of the rod, and the rod may be correspondingly angled at its end. Thus when the wire is tightened, the segment adjacent to the rod is caused to turn through 90°. The remaining upper and lower faces of the other segments may be parallel to each other in the configuration shown in Figure 1 as previously described.

The hooks shown in Figures 2 and 3 can be used to displace or hold the organs in the required position.

To release the segments from the configuration shown in Figures 2 or 3 the nut 8 is rotated in the opposite direction to release the tension in the wire. The wire is sufficiently strong, and the distance between the segments sufficiently small for the flexure of the wire to hold the segments generally straight for ease of insertion or removal when the hook configuration is not required. As the wire is threaded through two openings in each segment the strength of the wire and the close proximity of the segments prevents any significant relative turning of the segments around the longitudinal extent of the end 2.

The face of each segment which is caused to abut against another part of the retractor when in the hook configuration is formed with styrations 13 which are parallel to each other and parallel to adjacent styrations such that co-operating faces do not tend to slip in a rotational or translational sense.

With such retractors the remote end includes an exposed end 20. When pushing tissue aside this end can cause trauma to the body, particularly the liver. In addition there is inevitably some flexure in the segments. Such flexure causes the end section to have a reduced effect on pushing the liver.

Furthermore, whilst it is relatively easy to achieve the configuration shown it can be difficult to effect more complicated configurations.

It is an object of the present invention to attempt to overcome at least one of the above or other disadvantages.
According to one aspect of the present invention a surgical instrument includes an elongate portion arranged, in use, to be inserted through a restricted opening into a body, the elongate portion being movable from a first configuration to a second, different configuration in which two parts of the instrument that are spaced from each other in the first configuration at least partially cross each other in second configuration.

According to a further aspect of the present invention a method of controlling a surgical instrument comprises causing an elongate portion to move from a first configuration in which two parts are spaced from each other to a second configuration in which those parts at least partially cross each other.

The present invention also includes a method of performing surgery when using the instrument of the present invention or when controlling the instrument of the present invention.

The first configuration may be a straight configuration.

The present invention will be now be described, by way of example and with reference to the accompanying drawings, in which:-

Figure 5 is a front view of a first embodiment of a retractor;

Figure 6 is a front view of a second embodiment of a retractor, and

Figure 7 is a perspective view of a third embodiment of a retractor.

Each of the embodiments of the retractors shown may be operated as described in relation to Figures 1 to 4. Accordingly only the differences will be described. In addition, each retractor is able to have a straight configuration to enable the retractor to be inserted or removed and only the second configurations are shown in which each adjacent segment abuts each other to inhibit further bending.

In Figure 5 there are four segments 3 adjacent to the hollow rod 7 and four at each of the further corners. Long segments 22 and 24 extend between the short segments and a longer segment 26 has its tip 20 extending back under the rod 7. Ideally the tip 20 should be concealed in the view shown by the hollow rod.

This arrangement has advantages over the segmental arrangements shown in Figures 2 and 3 in that no twisting of the retractor about the shaft 7 occurs if the retractor is urged in a direction
out of the plane shown or into the plane shown. In addition at least part of the tip 20 is concealed by the rod 7 or can trail the rod 7 thus effecting less trauma.

Figure 6 has the same general shape of that of Figure 5. However the shaft 7 includes a further control cable 28 that is connected to the tip 30 of the elongate portion. The cable exits the shaft 7 just short of the first series of segments.

In use, either before the segments are tensioned by the wires 10 to take up the configuration shown, or after, or during at least part of that tensioning or any combination thereof the control cable 28 is tensioned to draw the tip 30 towards the shaft 7. A recess 32 may be provided in the shaft 7 in which the tip 30 may be drawn into and held by the cable.

This configuration allows greater force to be applied with less trauma being provided than that of Figure 5. In addition the retractor can be urged in either direction to equal advantage as the configuration is symmetrical from the front and back.

Whilst the angles that the short segment of Figures 5 and 6 allow the retractor to turn are approximately 45°, 135° and 135° respectively the embodiment of Figure 7 is more complicated.

In Figure 7, starting from the rod 7, four short segments 3 allow the next long segment 32 to extend at 90° to the extent of the rod. Then six short segments 3 cause an even longer segment 34 to extend back towards the rod 7 at an angle of 45° to the rod. Then two short segments cause the "shortest" long segment 36 to cross over the rod 7, possibly in contact therewith, before two further short segments cause a further turn of 45° for the next long segment 38. Then eight short segments 3 cause a further turn of 180°. This brings two long segments 40 and 42 back over the rod 7 with the end of the segment 42 being tucked under the long segment 34.

The long segments 40 and 42 are connected by angled faces that allow the segment 40 to be inclined upwardly as it extends towards the rod with the segment 42 being inclined downwardly as it extends away from the rod 7. The movement of the segments 40 and 42 can be coordinated to take place as the end of the instrument moves back over the shaft towards the segment 34. Alternatively the segments 40 and 42 may be fixed together to form an angled suit such that they can not move relative to each other. The segments 40 and 42 may be urged against the long segment 32 and the short segments 3 adjacent to the rod 7 as the segments 40 and 42 are being moved into place such that relative flexure of those parts occurs. When the joint between the segments 40 and 42 pass the segments 3 adjacent to the rod they spring back to allow the segment 42 to pass beneath the segment 34 and to maintain
the shape shown under flexure with those parts crossing the rod being urged against the rod. Furthermore, that binding force may also cause the segment 36 to be biased. The biasing forces may be assisted by the angled slope of the segment 42 sliding along the segment 34 and pushing further against the segment 34 as the segment 42 slides further beneath the segment 34.

The configuration of Figure 7 affords stability and strength in either direction. Furthermore trauma is reduced because of the considerable cross sectional area provided by the retractor or both sides of the shaft 7.

Although not shown in the drawing of Figure 7, the end segment 42 may be connected to the shaft 7 by a control cable. The control cable may be tensioned to assist in the retractor leaving the straight configuration. As the wires tension the segments and as the retractor takes up the shape shown the cable may be tensioned or relaxed to assist in the shape being taken up.

As the retractor crosses the rigid rod in Figures 5 and 7 (and as the retractor is fixed in Figure 6) when the rod is urged towards a liver with the cross parts being located between the rod and liver a rigid retractor is provided with a broad area of even force being applied.

Whilst the above described instruments are retractors it will be appreciated that the instrument could be other than a retractor or may, for instance, have a tool operating from the end such as a cutter or a gripper of a suture.

Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.
The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.
CLAIMS

1. A surgical instrument including an elongate portion arranged, in use, to be inserted through a restricted opening into a body, the elongate portion being movable from a first configuration to a second, different configuration in which second configuration two parts of the instrument that are spaced from each other in the first configuration at least partially cross each other in second configuration.

2. An instrument as claimed in Claim 1 in which the parts contact each other in the second configuration.

3. An instrument as claimed in Claim 1 or 2 in which the parts completely cross each other in the second configuration.

4. An instrument as claimed in any preceding claim in which the parts completely cross each other such that the instrument extends over itself.

5. An instrument as claimed in any preceding claim in which one of the parts comprises an end region.

6. An instrument as claimed in any preceding claim in which the parts comprise parts that are spaced from the end region.

7. An instrument as claimed in any preceding claim in which there are at least two pairs of parts that are spaced from each other in the first configuration and at least partially cross each other, at different extents for the pairs, along the instrument in the second configuration.

8. An instrument as claimed in Claim 7 in which, going along the elongate extent of the instrument, the first pair cross on one side of the instrument with the second pair also crossing on that side.

9. An instrument as claimed in Claim 7 or 8 in which there are at least three pairs of parts that are spaced from each other in the first configuration and that at least partially cross each other at different extents, for the pairs, along the instrument in the second configuration.
10. An instrument as claimed in Claim 9 in which, going along the extent of the instrument, the first and second pairs cross on the same side with the third pair crossing on the opposite side.

11. An instrument as claimed in any preceding claim in which the end region includes a portion that is movable to extend up towards the location where the parts cross and down from the location where the parts cross.

12. An instrument as claimed in any preceding claim in which the instrument includes a rigid portion, which rigid portion comprises at least one of the parts that at least partially cross each other and which rigid portion does not take part in any movement from the first to the second position.

13. An instrument as claimed in Claim 12 in which a plurality of parts that cross each other include the rigid portion.

14. An instrument as claimed in any preceding claim in which, in the first configuration, the instrument extends in a common first direction and in which, in the second configuration part of the instrument extends in a second direction which is opposed to the first direction.

15. An instrument as claimed in Claim 14 in which, in the second direction, the one part of the instrument is caused to extend back towards another part.

16. An instrument as claimed in Claim 14 or 15 in which, in the second configuration two spaced elongate extents of the instruments both extend at an angle to the first direction.

17. An instrument as claimed in any preceding claim in which the instrument includes spaced joint regions that enable the instrument to move from the first to the second configuration.

18. An instrument as claimed in Claim 17 in which the spaced joint regions allow the instrument to cross itself at least twice in the second configuration.
19. An instrument as claimed in Claim 17 or 18 in which the joint regions comprise a plurality of segments movable relative to each other to assist in causing the movement from the first to the second configurations.

20. An instrument as claimed in any preceding claim including first control means arranged to cause the movement from the first to the second configuration.

21. An instrument as claimed in any preceding claim in which, in the second configuration, the two parts are biased towards each other at the region where they at least partially cross each other.

22. An instrument as claimed in any preceding claim including a flexible member extending outside of the instrument from the end region to a location spaced from the end region.

23. An instrument as claimed in Claim 22 in which the flexible member is arranged to assist in effecting movement from the first to the second configuration.

24. An instrument as claimed in Claim 23 in which the flexible member is arranged to be tensioned, initially, as movement from the first configuration commences and subsequently to be slackened.

25. An instrument as claimed in any of Claims 22 to 24 including second control means arranged to control the operation of the flexible member.

26. An instrument as claimed in Claim 20 and any of Claims 21 to 25 when dependent on Claim 19 in which the first and second control means are arranged to be coordinated to effect the movement from the first to the second configurations.

27. An instrument as claimed in any preceding claim in which, in the second configuration, one previously spaced part of the instrument is arranged to be connected to another part of the instrument.

28. An instrument as claimed in Claim 27 in which one part comprises the end portion of the instrument.
29. An instrument as claimed in Claim 27 or 28 in which the connection is arranged to be by means of a plug and socket.

30. An instrument as claimed in any of Claims 27 to 29 when dependent on Claim 19 in which the flexible member is arranged to extend within the instrument and then out of the instrument in the region of where the parts are arranged to be connected and then to extend externally of the instrument to the other part that is to be connected whereby tensioning the flexible member is arranged to assist in effecting the connection.

31. A method of controlling a surgical instrument comprising causing an elongate portion to move from a first configuration in which two parts are spaced from each other to a second configuration in which those parts at least partially cross each other.

32. A method as claimed in Claim 31 comprising the instrument to move to a second configuration in which the instrument crosses itself twice.

33. A method as claimed in Claim 31 or 32 when controlling an instrument as claimed in any of Claims 1 to 28.
**INTERNATIONAL SEARCH REPORT**

**PCT/GB2010/051680**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. A61B 17/02

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)

A61B

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 practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>US 6 277 089 BI (Yoon INBAE [US]) 21 August 2001 (2001-08-21)</td>
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[ ] 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
- "E" earlier document but published on or after the international filing date
- "L" 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)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "Q" later 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
- "Y" 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.
- "S" document member of the same patent family

Date of the actual completion of the international search: 30 November 2010

Date of mailing of the international search report: 06/12/2010

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: Barton, Simon
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<td>EP 0 623 004 BI (MCAHON MICHAEL JOHN [GB]; MORAN PETER [GB]) 2 May 1997 (1997-05-02) cited in the application column 8, paragraph 4; figure 14</td>
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**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. [X] Claims Nos.: 31—33
   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:
   
   see **FURTHER INFORMATION** sheet PCT/ISA/210

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:

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 an additional fees, this Authority did not invite payment of additional fees.

3. [X] 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.:

**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)
Continuation of Box II.2

Claims Nos.: 31-33

Rule 39.1(iv) PCT - Method for treatment of the human or animal body by therapy, to the extent that these claims find support in the description as required by Article 6 PCT

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.
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<td>US 6277089 B1</td>
<td>21-08-2001</td>
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<td></td>
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<tr>
<td>US 6248062 B1</td>
<td>19-06-2001</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 0067642 A2</td>
<td>16-11-2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1176912 A2</td>
<td>06-02-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 2008207525 A1</td>
<td>18-09-2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2500566 A1</td>
<td>22-04-2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1565111 A2</td>
<td>24-08-2005</td>
</tr>
<tr>
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<td></td>
<td>JP 4429167 B2</td>
<td>10-03-2010</td>
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<td>19-01-2006</td>
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<td></td>
<td>JP 4430645 B2</td>
<td>10-03-2010</td>
</tr>
<tr>
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<td></td>
<td>JP 2006346503 A</td>
<td>28-12-2006</td>
</tr>
<tr>
<td>EP 0623004 B1</td>
<td>02-05-1997</td>
<td>AU 3263993 A</td>
<td>03-08-1993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69310345 D1</td>
<td>05-06-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69310345 T2</td>
<td>20-11-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 9313713 A1</td>
<td>22-07-1993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 3390436 B2</td>
<td>24-03-2003</td>
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<td>JP 7502914 T</td>
<td>30-03-1995</td>
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