Paper No. 1

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AURIS HEALTH, INC.
Petitioner,

v.

INTUITIVE SURGICAL OPERATIONS, INC.
Patent Owner.

Patent No. 6,491,701

Inter Partes Review No. IPR2019-01532

Petition for *Inter Partes* Review of U.S. Patent No. 6,491,701

TABLE OF CONTENTS

EXHIBIT LIST

Exhibit #	Exhibit Description
1001	U.S. Patent No. 6,491,701 to Tierney et al.
1002	Prosecution History of U.S. Patent No. 6,491,701
1003	Declaration of William Cimino, Ph.D.
1004	U.S. Patent No. 5,624,398 to Smith et al.
1005	European Patent App. Pub. No. 0688538A1 to Viola et al.
1006	U.S. Patent No. 7,118,582 to Wang et al.
1007	Joint Claim Construction Chart (Dkt. 76), filed on Aug. 2, 2019 in *Intuitive Surgical, Inc. et al. v. Auris Health, Inc.*, C.A. No. 18-1359-MN (D. Del.)
1008	Executed Summons (Dkt. 5), filed on Sept. 4, 2018 in *Intuitive Surgical, Inc. et al. v. Auris Health, Inc.*, C.A. No. 18-1359-MN (D. Del.)

Petitioner's Mandatory Notices

A. Real Party in Interest (§42.8(b)(1))

Auris Health, Inc. is a real party in interest pursuant to § 42.8(b)(1). Auris Health, Inc. is a wholly owned subsidiary of Ethicon, Inc., which is a wholly owned subsidiary of Johnson & Johnson. Both Ethicon, Inc. and Johnson & Johnson also are real parties in interest.

B. Other Proceedings (§42.8(b)(2))

1. Patents and Applications

U.S. Patent No. 6,491,701 ("'701 patent") is related to the following U.S. patents and applications:

- U.S. 6,331,181
- U.S. 8,758,352
- U.S. 8,142,447
- U.S. Provisional Application No. 60/116,844
- U.S. Provisional Application No. 60/111,713
- U.S. Application No. 14/065,869

Petitioner is concurrently filing an IPR petition on U.S. Patent No. 8,142,447 in IPR No. IPR2019-01533.

2. Related Litigation

The '701 patent has been asserted in the following litigation:

- *Intuitive Surgical, Inc. v. Auris Health, Inc.*, Action No. 18-1359-MN (D. Del.) (pending).

3. Patent Office Proceedings

The ’701 patent is not subject to any proceedings filed in the Patent Office.

C. Lead and Backup Lead Counsel (§42.8(b)(3))

Lead Counsel is: Ching-Lee Fukuda (Reg. No. 44,334), clfukuda@sidley.com, (212) 839-7364. Back-Up Lead Counsel are: Thomas A. Broughan III (Reg. No. 66,001), tbroughan@sidley.com, (202) 736-8314, Sharon Lee, sharon.lee@sidley.com, (202) 736-8510) and Ketan Patel, ketan.patel@sidley.com, (212) 839-5854.[1]

D. Service Information (§42.8(b)(4))

Service on Petitioner may be made by e-mail (at the email addresses above & SidleyAurisTeam@sidley.com). Petitioner’s mail or hand delivery address is: Sidley Austin LLP, 1501 K Street, N.W., Washington, D.C. 20005. The fax number for lead and backup lead counsel is (202) 736-8711.

[1] Petitioner will file motions for Sharon Lee and Ketan Patel to appear *pro hac vice* according to the Board’s orders and rules.

I. INTRODUCTION

Claims 1, 7, 8, 11, 16, and 25 of the ’701 patent (the “Challenged Claims”) are directed toward a well-known arrangement for coupling robotic surgical tools with manipulator structures that articulate those tools. The tool includes a plurality of spools that are coupled by cables to articulable joints in the surgical instrument (*e.g.*, end effectors) at the opposed end of the tool. Accordingly, rotation of the spools causes movement in the joints. The movement of the spools is controlled by engaged rotatable bodies in the manipulator structure that rotate in response to an operator’s inputs.

This type of structure for coupling and manipulating robotic surgical tools with manipulator structures was well-known before the priority date of the ’701 patent. For example, U.S. 5,624,398 to Smith (“Smith,” Ex. 1004), which was not considered during prosecution of the ’701 patent, discloses “endoscopic robotic arms which are coupled to servo motors using tendons and pulleys.” Ex. 1004, 3:21-23. The robot arm movements are “operable by servo motors” and “controlled by an encoder worn by a surgeon.” Ex. 1004, 3:18-20, 3:34-36.

Smith discloses all of the elements of the Challenged Claims, including those the Examiner identified as the reasons for allowing the Claims. For example, with respect to claim 1, although the Examiner allowed the claim because “[n]one of the prior art of record teaches or fairly suggests a minimally invasive surgical instrument…including at least three spools angularly displaceably mounted on the support base and having axes which are parallel and spaced apart relative to each other" (Ex. 1002, 363-64), Smith expressly discloses these elements, as explained below. Likewise, for claim 25, the Examiner allowed the claim because the prior art of record did not teach or fairly suggest "including a drive assembly having a plurality of actuator bodies and an instrument comprising a first plurality of movable engaging bodies wherein the instrument is removably coupleable t[o] the drive assembly" (Ex. 1002, 364), but Smith expressly discloses these elements, as explained below.

Accordingly, Petitioner respectfully requests that the Board institute *inter partes* review of the Challenged Claims.

II. REGULATORY INFORMATION

A. Certification Petitioner May Contest the '701 Patent (§ 42.104(a))

Petitioner certifies that the '701 patent is available for *inter partes* review ("IPR"), and that Petitioner is not barred or estopped from requesting an IPR of the '701 patent claims. Neither Petitioner, nor any party in privity with Petitioner, has filed a civil action challenging the validity of any claim of the '701 patent. The '701 patent has not been the subject of a prior IPR by Petitioner or its privy.

Petitioner certifies this IPR petition is timely filed, as it was filed less than one year after September 4, 2018, the date Petitioner was first served with a complaint alleging infringement of the ’701 patent. *See* 35 U.S.C. § 315(b); Ex. 1008.

B. Identification of Challenged Claims (§ 42.104(b))

Claims 1, 7, 8, 11, 16, and 25 are unpatentable based on the following art and ground.

Ground	35 U.S.C. §	Claims	Prior Art Reference
1	102	1, 7, 8, 11, 16, 25	U.S. Patent No. 5,624,398 (“Smith,” Ex. 1004)

Petitioner’s positions are supported by the Declaration of Dr. William Cimino (Ex. 1003), an expert in robotic surgical systems who has over 20 years of experience in the field. Ex. 1003, ¶¶2-6, Appx. A.

C. Fee for *Inter Partes* Review (§ 42.15(a))

The Director is authorized to charge the fee specified by § 42.15(a) to Deposit Account No. 50-1597.

III. BACKGROUND

A. Background Technology

By December 1998, robotic systems were well known in the art. Ex. 1003, ¶45. “[R]obotics often involves electro-mechanically activated articulate members emulating human arms and hands which are operated by an encoding device responsive to the articulation of human arms and hands of a[] practitioner.” Ex.

1004, 1:60-64. Servo motors, which respond to signals from the encoding device, typically moved these robotic articulate members. Ex. 1004, 2:3-7.

Robotic surgical systems were also well-known in the art. Ex. 1001, 1:37-39; Ex. 1004, 1:7-8; Ex. 1003, ¶46. In such systems, typically the surgeon operates a master controller that remotely controls the motion of surgical instruments at the surgical site. Ex. 1001, 1:36-38. These systems also used "servo motors [that] move a manipulator or 'slave' supporting the surgical instrument based on the surgeon's manipulation of the hand input devices." Ex. 1001, 1:48-50; *see also* Ex. 1004, 4:8-29. These surgical instruments—such as tissue graspers, needle drivers, electrosurgical cautery probes, cutters, dissectors—could be attached and detached from the surgical system, so that they may be interchanged during a procedure. Ex. 1001, 1:50-57, 2:9-12; Ex. 1004, 15:10-16, 18:59-65, 19:1-5.

The use of a pulley and cable system to articulate remote surgical instruments was also well-known in the art. Ex. 1004, 3:21-26, 3:31-33; Ex. 1005, 1:53-2:9, 2:25-33 ("A plurality of cable sets are each configured to control the movement of a respective one of the movable fingers and opposable thumb….A plurality of pulley assemblies each corresponding to a respective one of the plurality of cable sets reduce the input signal."); Ex. 1006, 18:29-33 ("Rotation of the first hollow tube 712 results in the linear motion of the leads 352, 254 and the articulation of the articulable portion 301 of the instrument 300 in one plane of motion.”). Using servo motors to engage and move pulleys was also known. Ex. 1004, 4:16-29; Ex. 1003, ¶47.

B. Summary of the ’701 Patent

The ’701 patent is directed to a robotic surgical system that purports to improve techniques for switching tools during a procedure. Ex. 1001, 1:32-36, 2:51-52. According to the ’701, the introduction of more and more different surgical tools that can be used with a robotic system created certain challenges. Ex. 1001, 2:32-48; *see also id.*, 2:9-12 (“As a result, a number of surgical instruments will often be attached and detached from a single instrument holder of a manipulator during an operation.”). For example, “differences between the tool structures (and the interaction between the tool and the other components of the robotic system) become more pronounced.” Ex. 1001, 2:33-36. As a result, when tools are switched out, “the time involved in reconfiguring the robotic system to take advantage of a different tool, and to perfect the master controller’s effective control over the degrees of motion of the tool may add significantly to the total tool change delay.” Ex. 1001, 2:42-48. Accordingly, the ’701 purports to overcome these problems by (i) providing “improved engagement structures for coupling robotic surgical tools with manipulator structures,” and (ii) including a memory mounted on the tool that can provide the robotic system with various information (*e.g.*, compatibility, tool-type). Ex. 1001, Abstract, 2:62-3:25.

The Challenged Claims are directed to the former alleged improvement. As illustrated by Figure 4 below (annotated), the '701 describes a tool 54 that includes a proximal housing 108 (in red), rigid shaft 102 (in brown) having a proximal end 104 (in yellow) and distal end 106 (in green), and a surgical end effector 112 (in purple) coupled to the shaft by a joint 114 that preferably provides at least two degrees of freedom:

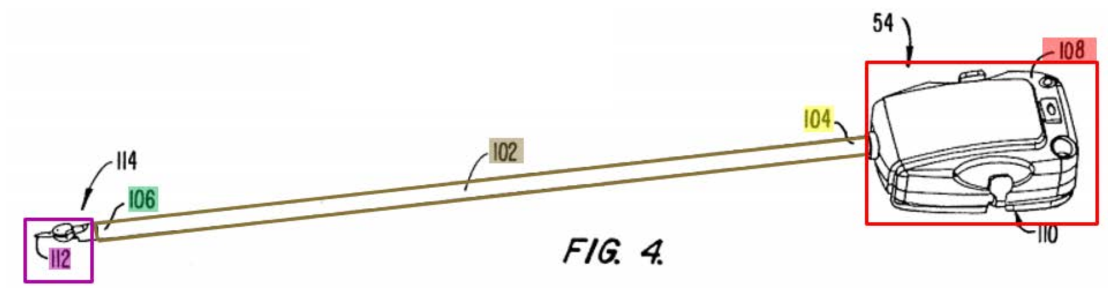

FIG. 4.

Ex. 1001, 9:29-36, Fig. 4. The tool's proximal housing 108 includes an interface 110 that includes driven elements 118:

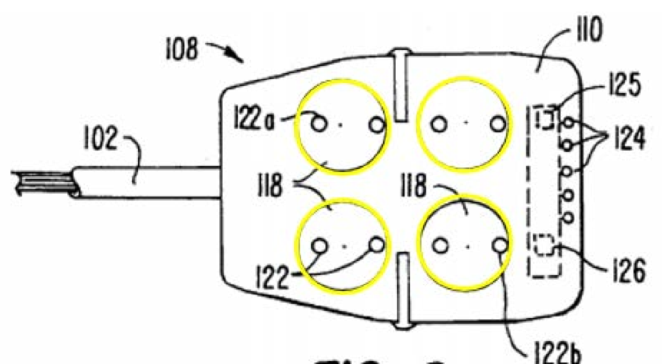

FIG. 6.

Ex. 1001, 9:31-33, 10:33-36, Fig. 6. Driven elements 118 are coupled to the end effector using cables that can effect rotation of the end effector about fixed axes, such as axes A1, A2, and A3 in Figure 5A:

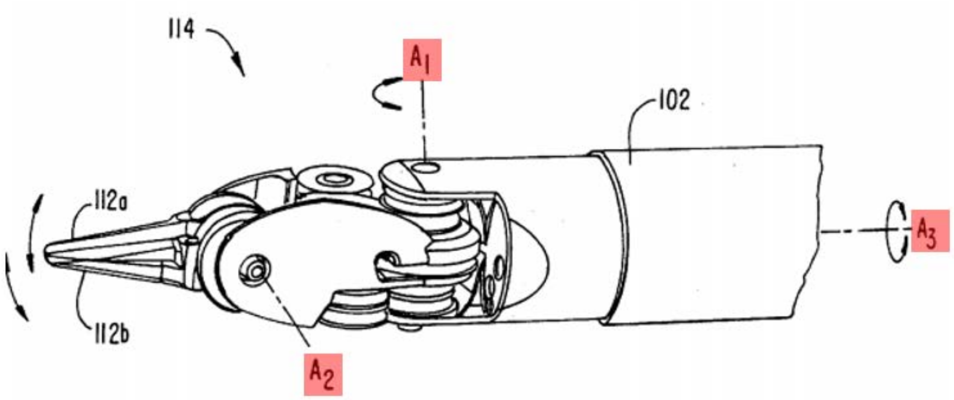

FIG. 5A.

Ex. 1001, 9:42-50, Fig. 5A; *see also id*., 5:23-26, Fig. 4A, 8:25-31, 9:37-41.

Driven elements 118 are coupled to a tool holder of the manipulator of the robotic surgical system via an adapter 128. Ex. 1001, 5:26-28, 10:32-36, 11:24-27, 17:16-25, Figs. 14A-14C. Adapter 128 includes rotatable bodies 134 that "are configured to accurately align the driven elements 118 of the tool with the drive elements of the holder." Ex. 1001, 11:24-27; *see also id.*, 5:29-32, Figs. 7A-7E. The manipulator's drive motors engage the driven elements 118 of the tool to articulate the end effector 112. Ex. 1001, 4:49-60 ("A tool drive motor is coupled to the tool holder so as to drivingly engage the tool drive system and articulate the joint….The processor has programming that effects a desired movement of the end effector by transmitting drive signals to the tool drive motors of the manipulator."); *see also id*., 8:25-31. *See also* Ex. 1003, ¶¶32-35.

C. Summary of the ’701 Patent’s Prosecution History

The ’701 patent issued from Application No. 09/759,542, filed on January 12, 2001. During prosecution, the Examiner rejected the then-pending claims as being anticipated by U.S. Patent No. 5,792,135 (“Madhani”). Ex. 1002, 173. The Examiner determined Madhani discloses “an articulated surgical instrument 12 for performing minimally invasive surgery which includes a tubular support member 24 having a proximal end and a distal end attached to a wrist joint 16 angularly displaceable about two axes. Work members 20a and 20b are mounted to respective driven capstans 18a and 18b which are driven by cables C1-C4. Spools 70, 72, 74 and 76 act intermediate capstans 18a & 18b and idler pulley 82. Distal end of tubular support member 24 is positioned in a support base 28a.” Ex. 1002, 173-74.

In response, Patent Owner (“PO”) argued the Examiner failed to show Madhani discloses a surgical instrument having the combination of “an end effector mounting formation positioned at the working end of [a] shaft and a support base positioned on an opposed end of the shaft; and at least three spools angularly displaceably mounted on the support base,” as required by pending claim 33 (issued claim 1). Ex. 1002, 341.

PO also argued the Examiner failed to show Madhani discloses a surgical instrument having the combination of “the instrument being removably coupleable to the drive assembly when the instrument is operatively mounted to the surgical system so that the plurality of actuator bodies engage with corresponding ones of the plurality of interface bodies," as required by pending claim 31 (issued claim 25). Ex. 1002, 341 (emphasis original). Finally, PO argued Madhani does not qualify as prior art because it and the '701 application are assigned to the same entity. Ex. 1002, 342.

The Examiner then allowed the claims. Ex. 1002, 362. For pending claim 33 (issued claim 1), the Examiner stated in his Reasons for Allowance that "[n]one of the prior art of record teaches or fairly suggests a minimally invasive surgical instrument as recited by claim 33 and particularly including at least three spools angularly displaceably mounted on the support base and having axes which are parallel and spaced apart relative to each other." Ex. 1002, 363-64. For pending claim 51 (issued claim 25), the Examiner stated the prior art of record did not teach or fairly suggest "including a drive assembly having a plurality of actuator bodies and an instrument comprising a first plurality of movable engaging bodies wherein the instrument is removably coupleable t[o] the drive assembly." Ex. 1002, 364. *See also* Ex. 1003, ¶¶36-44.

D. Person of Ordinary Skill in the Art

A person of ordinary skill in the art ("POSA") would have been a person with a good working knowledge of robotics and medical devices such as robotic surgical systems. That knowledge would have been gained by an undergraduate education in electrical engineering, mechanical engineering, robotics, biomedical engineering, or a related field of study, along with about two years of experience in academia or industry studying or developing robotics or medical devices such as robotic surgical systems. Ex. 1003, ¶31. This description is approximate; varying combinations of education and practical experience also would be sufficient. *Id.*

IV. CLAIM CONSTRUCTION

Claims "shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by [a POSA] and the prosecution history pertaining to the patent." 37 C.F.R. § 42.100(b); *see Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). Claim construction requires consideration of "the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art." *Phillips*, 415 F.3d at 1314; *Microsoft Corp. v. Proxyconn, Inc.*, 789 F.3d 1292, 1298 (Fed. Cir. 2015). The specification is "usually" dispositive and "the single best guide to the meaning of a disputed term." *Phillips*, 415 F.3d at 1315.

Petitioner proposes constructions for several terms below. However, because the teachings of the prior art references are squarely within the scope of the Challenged Claims even under Petitioner's narrower constructions, the Board likely will not need to adopt specific constructions to resolve any dispute. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (claim terms need only be construed to the extent necessary to resolve the case).

A. "end effector" (All Challenged Claims)

Consistent with the '701's specification, "end effector" should be interpreted as a device at the end of a surgical instrument for manipulating (cutting, grasping, or otherwise acting on) body tissue.[2] Ex. 1003, ¶¶55-56. The specification describes "end effector" as "for ***grasping tissues*** in the jaws of a forceps or the like." Ex. 1001, 8:22-24[3]. The examples of end effectors that the '701 patent provides are also all devices that manipulate tissue. *See, e.g.*, Ex. 1001, 9:66-10:3 (end effector examples include, "Potts scissor" and "15 degree scalpel"), 10:19-31 (end effector examples include "DeBakey forceps," "microforceps," "Potts scissors," "clip applier," "scalpel," and "electrocautery probe"), Figs. 4, 5A-5H; Ex. 1003, ¶57.

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[2] In district court, PO proposed construing "end effector" as "device at the end of an instrument, designed to interact with the environment." Ex. 1007, 2.

[3] All emphases added unless otherwise indicated.

B. "angularly displaceable about at least two axes" (claims 1, 7, 8, 11, and 16)

The term "angularly displaceable about at least two axes" should be interpreted as rotatable about at least two fixed axes.[4] Ex. 1003, ¶¶58-60. Although the '701's specification does not use the term "angularly displaceable," it does equate angular movement to rotational movement. *See, e.g.*, Ex. 1001, 11:12-18 ("[R]otatable bodies are free ***to rotate without angular limitation***….[T]abs…laterally engage detents on the floating plates so as to limit ***angular rotation*** of the rotatable bodies about their axes."). Moreover, when describing the movement of the end effector tool, the '701 describes that movement as rotational about fixed axes. *See, e.g.*, *id*. 8:1-7 ("The parallelogram arrangement constrains ***rotation to pivoting about an axis 64a***….[T]ool 54 further ***rotates about an axis 64b***…."), 8:19-22 ("Motors 70 are further coupled to tool 54 so as to ***rotate the tool about axis 66***…."), 9:46-50 ("[D]riven elements 118 can effect ***rotation of the end effector about the axis of shaft 102 (A3)***…."); *see also id*., 9:33-61, 9:66-10:11.

[4] In district court, PO proposed that the plain and ordinary meaning of "angularly displaceable about at least two axes" should apply. Ex. 1007, 3.

C. "pivotal movement" (claims 1, 7, 8, 11, and 16)

Consistent with the specification, the term "pivotal movement" should be interpreted as rotational movement around a fixed axis.[5] Ex. 1003, ¶¶61-62. In the context of movement, the '701 patent uses the term "pivot" twice and both times uses that term to describe rotating about an axis: "The parallelogram arrangement constrains ***rotation to pivoting about an axis 64a***, sometimes called the pitch axis. The links supporting the parallelogram linkage are ***pivotally mounted*** to set-up joints 56 ***so that tool 54 further rotates about an axis 64b***, sometimes called the yaw axis." Ex. 1001, 8:1-6.

D. "joint(s)" (claims 7 and 25)

Consistent with the intrinsic evidence, the term "joint(s)" should be interpreted as parts connecting two structures that allows movement.[6] Ex. 1003, ¶¶63-65. The '701 patent describes "joints" as parts that connect two structures. *See, e.g.*, Ex. 1001, 4:41-43 ("A distal surgical end effector is coupled to the shaft ***by at least one joint***."), 7:63-8:1 ("linkage 62 includes rigid links ***coupled together***

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[5] In district court, PO proposed that the plain and ordinary meaning of "pivotal movement" should apply. Ex. 1007, 3.

[6] In district court, PO proposed that the plain and ordinary meaning of "joint(s)" should apply. Ex. 1007, 4.

by rotational joints in a parallelogram arrangement"), 9:33-36 (A surgical end effector 112 is coupled to shaft 102 ***by a wrist joint 114***….").

Moreover, the '701 patent explains that joints allow movement. *See, e.g.*, Ex. 1001, 7:63-8:1 ("linkage 62 includes rigid links coupled together by ***rotational joints*** in a parallelogram arrangement ***so that tool 54 rotates around a point in space 64***"), 8:35-44 ("***[V]ertically sliding joints 82…are used to position*** manipulator 58 along the vertical or Z axis***….[R]otary joints 84…are used to horizontally position*** manipulators 58 in the X-Y plane….[A]nother series of ***rotary joints 84….rotationally orients*** the manipulators."), 8:58-63 ("[T]he processor can further accurately determine end effector position and orientation, as well as how to ***effect movement*** in a desired orientation ***by articulating one or more the driven joints***."), 9:33-36 ("A surgical end effector 112 is coupled to shaft 102 by ***wrist joint 114 providing at least 1 degree of freedom, and ideally provided at least 2 degrees of freedom***.").

E. "at least three spools…to which opposed ends of the elongate elements are connected" (claims 1, 7, 8, 11, and 16)

The claim term "at least three spools…to which opposed ends of the elongate element are connected" should be interpreted as requiring each of the three spools to have two opposed ends of an elongate element connected to it.[7] Ex. 1003, ¶¶66-69. This interpretation is supported by Figure 4B, which depicts the drive system. Ex. 1001, 5:64-65. Figure 4B illustrates at least three spools (driven element 118) each having both ends of the same cable connected to the same spool (as shown in red):

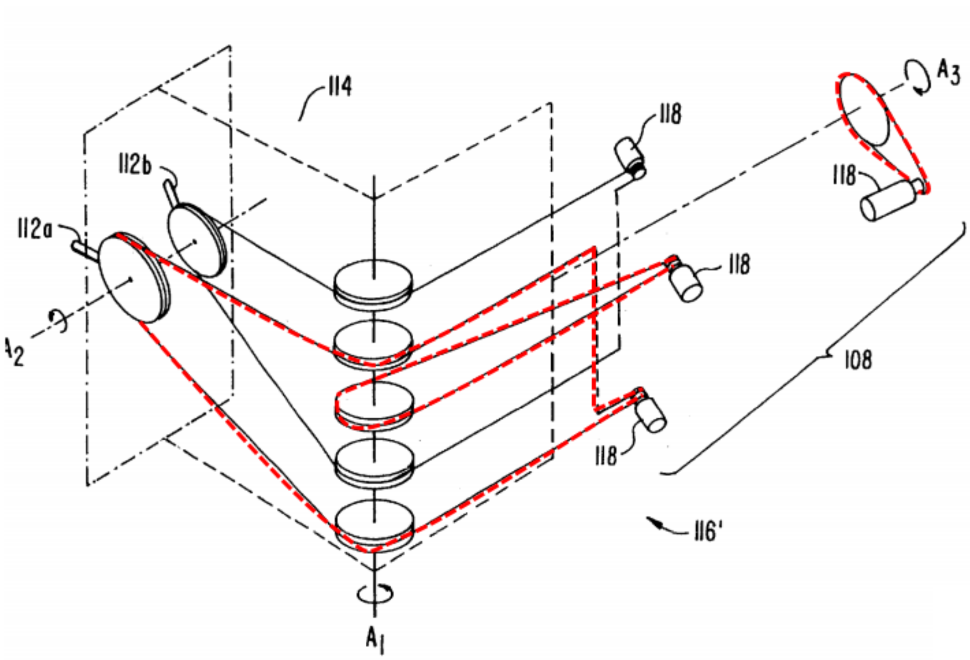


FIG. 4B.

Ex. 1001, Fig. 4B; Ex. 1003, ¶¶68-69.

[7] In district court, PO proposed that the plain and ordinary meaning of "at least three spools…to which opposed ends of the elongate element are connected" should apply. Ex. 1007, 5.

V. ANALYSIS OF THE PATENTABILITY OF THE CLAIMS

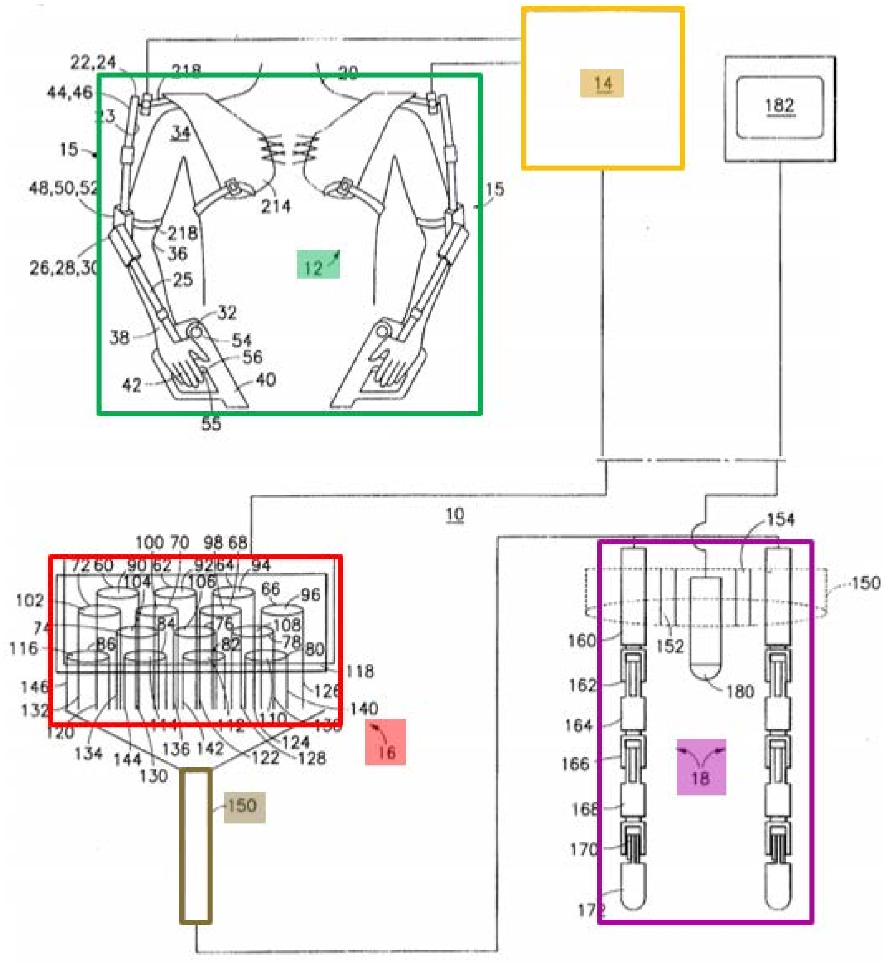
A. Ground 1: Anticipation Based on Smith

1. Summary of Smith

Smith issued on April 29, 1997, which is more than one year before December 8, 1998—the ’701 patent’s earliest claimed priority date.[8] Smith is therefore prior art under at least pre-AIA 35 U.S.C. § 102(b). Ex. 1003, ¶70.

Smith is directed to a robotic surgical system that includes an exoskeleton encoder 12 worn by a practitioner (in green), control circuit 14 (in orange), a servo system 16 comprising engaged servo motors and pulleys (in red), and a pair of remote robot arms 18 (in purple) at the distal end of a multi-lumen tube 150. Ex. 1004, 6:46-7:2, Fig. 1; *see also id.*, Abstract, 3:60-63.

[8] For purposes of this Petition, Petitioner assumes the ’701 patent’s priority date is December 8, 1998.



Ex. 1004, Fig. 1 (Figs. 1A and 1B combined). An end effector (*e.g.*, grippers, cutters, dissectors, bioptomes) is mounted to the end of each robot arm. Ex. 1004, 4:40-41, 18:59-65, Figs. 23, 26-27. *See also* Ex. 1003, ¶71.

The encoder is worn by the practitioner and has rotational and flexional joints for each of the practitioner's shoulders, elbows, and wrists, along with a pistol grip for the practitioner's hands. Ex. 1004, 6:49-55. The encoders have transducers that register the practitioner's rotational and flexional movements in the shoulders, elbows, and wrists, and gripping movements of the practitioner's hands. Ex. 1004, 6:55-59. The transducers are coupled to a control circuit that provides outputs to an array of 14 servo motors, which are coupled respectively to pulleys. Ex. 1004, 5:59-64, 7:31-36. Figure 22 (annotated below) depicts pulleys arranged in a tray (in yellow) that are detachably connected to trays that house the servo motor arrays (in blue). Ex. 1004, 7:26-31. The splined shafts of the servo motors engage the receiving bores of the pulleys. Ex. 1004, 14:53-57. The splined shafts and the receiving bores are self-aligning. Ex. 1004, 14:56-57.

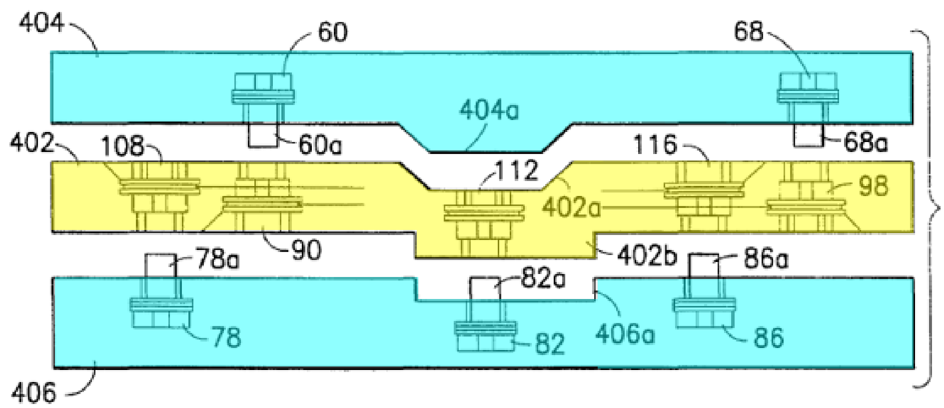


FIG. 22

Ex. 1004, Fig. 22. *See also* Ex. 1003, ¶¶72-73.

Figure 23 (annotated below) depicts the resulting assembly with the pulley tray and servo motor trays sandwiched together as servo system 16 on one end (in red) of the multi-lumen tube 150 (in brown) and the robot arms 18 (in purple) on the opposed, distal end of the tube:

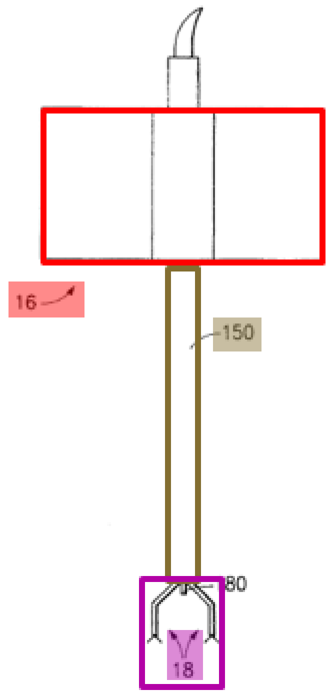


FIG. 23

Ex. 1004, 6:17-18, 14:57-67; Ex. 1003, ¶74.

The pulleys are each connected to a tendon loop, such that there is one tendon loop per servo motor. Ex. 1004, 6:62-67. The tendon loops are fed through a multi-lumen tube to the remote robot arms at the distal end of the tube. Ex. 1004, 6:67-7:2, 14:41-44, Fig. 34; Ex. 1003, ¶75.

Each of the remote robot arms has three rotational joints and three flexional joints and a gripper, such that the 14 tendon loops are each connected to one of the joints and the gripper on each robot arm. Ex. 1004, 7:3-9. Smith's arrangement accordingly allows movement of the practitioner's arms to be replicated in the robot arms. Ex. 1004, 8:51-57, 18:26-31; Ex. 1003, ¶76.

Like the ’701 patent, Smith is concerned with providing a system where different end effectors can be quickly interchanged during a procedure. *See, e.g.*, Ex. 1004, 4:18-23 (“…All of the pulleys are mounted on all of the [servo] shafts simultaneously and quickly by coupling the tray-like housing to the servo motor housing and are similarly quickly disconnectable from the servo motors.”), 19:1-5 (“[T]he end effectors may be interchanged during the source of a procedure by detaching the pulley 22, tray/multilumen tube/robot arms assembly from the servo motor arrays.”). Accordingly, in Smith’s system, different types of remote arms (*e.g.*, robot arms with grippers or with one gripper and one cutter) may be used with the same encoder. Ex. 1004, 15:17-21. “The self-aligning feature of the servo system permits rapid coupling and uncoupling of the servo motors and the pulleys so that different types of robot arms can be used with the same encoder during a single endoscopic procedure.” Ex. 1004, 15:21-25; *see also id*., 19:1-5 (“[T]he end effectors may be interchanged during the course of a procedure by detaching the pulley 22, tray/multilumen tube/robot arms assembly from the servo motor arrays.”). *See also* Ex. 1003, ¶¶77-78.

In addition, parts of Smith’s system may be reusable while others are disposable. Ex. 1004, 15:10-12; *see also id*., 3:46-49 (“It is yet another object of the invention to provide a coupling mechanism whereby robotic endoscopic instrument arms may be coupled to an encoder so that the instrument arms are disposable and the encoder is reusable."). Smith explains that the encoder, control circuit, and servo motors may be reusable, while the parts that will be in contact with human fluids—pulleys, tendons, multi-lumen tube and robot arms—may be disposed of. Ex. 1004, 15:12-16; Ex. 1003, ¶79.

2. Smith Anticipates Claims 1, 7, 8, 11, 16, and 25

a) Claim 1

(1) "A minimally invasive surgical instrument comprising"

To the extent the preamble is limiting, Smith discloses "*[a] minimally invasive surgical instrument*." Ex. 1003, ¶¶81-84. Smith discloses that its system is an "endoscopic robotic ***surgical*** tool." *See, e.g.*, Ex. 1004, 1:6-8 ("The invention relates to endoscopic surgical tools and methods…."), 3:14-17 ("robotic endosurgical tools"), 5:52-53, Fig. 1. Smith explains that endoscopic surgery "involves one or more incisions made by trocars where trocar tubes are left in place so that endoscopic surgical tools may be inserted through the tubes." Ex. 1004, 1:12-15. As was well-known at the time, endoscopic surgery is a minimally invasive procedure requiring smaller incisions than traditional open surgery. *See* Ex. 1004, 1:29-31 (explaining advantages of endoscopic surgery include that it is "***less invasive***"), 2:50-54 (contrasting endoscopic surgery to traditional open surgery, which requires "a large incision"), 3:1-6 ("***endoscopic instruments are*** relatively ***tiny***"), 3:14-17 ("It is another object of the invention to provide ***robotic***

endosurgical tools which are small enough to extend through trocar tubes but which provide a surgeon with substantially all of the articulation available in open surgery."); Ex. 1006, 1:43-46 ("***Minimally invasive procedures*** are conducted by ***inserting surgical instruments and an endoscope through small incision*** in the skin of the patient."); Ex. 1003, ¶82.

Smith discloses an assembly comprising a pulley tray, multi-lumen tube and robot arms that may be attached and detached to servo motor arrays. Ex. 1004, 19:1-5 ("[T]he ***end effectors may be interchanged during the course of a procedure by detaching the pulley 22[] tray/multilumen tube/robot arms assembly from the servo motor arrays***."); *see also id*., 15:21-25 ("The self-aligning feature of the servo system permits rapid coupling and uncoupling of the servo motors and the pulleys so that different types of robot arms can be used with the same encoder during a single endoscopic procedure."). An end effector (*e.g.*, grippers, cutters, dissectors, bioptomes), for use during a surgical procedure, is mounted to the end of each robot arm. Ex. 1004, 4:40-41, 8:5-7, 18:59-65.

Accordingly, Smith discloses "*a minimally invasive surgical instrument*" (*e.g.*, assembly comprising a pulley tray, multi-lumen tube, robot arms to which surgical end effectors are mounted for performing endoscopic surgery). Ex. 1003, ¶84.

(2) "a shaft having a working end"

Smith discloses "*a shaft having a working end*." Ex. 1003, ¶¶85-86. For example, Smith discloses that its endoscopic robotic surgical tool includes "***a multilumen tube***" and that the distal end of the multilumen tube is mounted with "robotic endoscopic instrument arms and an endoscopic camera." Ex. 1004, 3:50-55, 4:30-31 ("The robotic instrument preferably comprises ***two arms mounted at the distal end of a multi-lumen tube***."), 20:23-24 ("FIGS. 1, 23 and 34 show the ***distal end of the multi-lumen tube 150 with the two robot arms 18*** extending therefrom."), Figs. 1B, 23, 34. The robotic arms can "mimic human arms having movements for shoulder rotation, shoulder flexion, upper arm rotation, elbow flexion, lower arm rotation and wrist flexion." Ex. 1004, 4:30-40. "In addition, grippers are mounted at the distal end of the robotic arms to provide a limited hand movement." Ex. 1004, 4:40-41.

Accordingly, Smith discloses "*a shaft*" (*e.g.*, multilumen tube) "*having a working end*" (*e.g.*, distal end at which an endoscopic camera and movable robotic arms may be mounted). Ex. 1003, ¶86.

(3) "an end effector mounting formation positioned at the working end of the shaft and arranged to be angularly displaceable about at least two axes"

Smith discloses "*an end effector mounting formation positioned at the working end of the shaft and arranged to be angularly displaceable about at least two axes*." Ex. 1003, ¶¶87-95.

Smith discloses that robotic arms are mounted to the distal end of its multi-lumen tube and that grippers or other "end effectors" are mounted to the distal end of the robotic arms. Ex. 1004, 4:30-31 ("The robotic instrument preferably comprises ***two arms mounted at the distal end of a multi-lumen tube***."), 4:40-41 ("In addition, ***grippers are mounted at the distal end of the robotic arms*** to provide a limited hand movement."), 8:5-7 ("The ***grippers at the ends of the robot arms may be cutters or other types of end effectors*** and the robot arms may be provided with removable, replaceable end effectors."). 18:59-67 ("While the robotic arms described above have been shown with gripper end effectors, it will be appreciated that the arms could be provided with ***any type of end effector such as a cutter, dissector, bioptome***, etc. Moreover, it will be further appreciated that the ***end effectors could easily be provided with cautery capability***…."), Figs. 26-27, 34.

Smith's grippers and other end effectors (*e.g.*, cutters, dissectors, bioptomes) disclose the claimed "*end effector*" under either Petitioner's or PO's proposed construction of the term. As discussed above (Section IV.A), "*end effector*" should be interpreted as a device at the end of a surgical instrument for manipulating (cutting, grasping, or otherwise acting on) body tissue. Smith's disclosed end effectors, which are mounted at the distal end of the robot arms, are designed to manipulate bodily tissue by gripping (*e.g.*, grippers) and/or cutting and grasping (*e.g.*, cutter, dissector, bioptome, end effector with cautery capability) bodily tissue. Ex. 1004, 1:47-54 (describing known "end effectors," such as "forceps" with "grippers" for "obtaining tissue samples"), 8:5-7 ("grippers at the ends of the robot arms may be cutters or other types of end effectors"), 18:59-67 (types of end effectors include "cutter, dissector, bioptome, etc."), Ex. 1003, ¶88. Accordingly, Smith discloses "*end effectors*" under Petitioner's proposed construction. *Id*.

Because Smith discloses "*end effectors*" under Petitioner's proposed construction, it also discloses "*end effectors*" under PO's broader construction of a "device at the end of an instrument, designed to interact with the environment." Ex. 1003, ¶89. For example, as discussed above, Smith discloses grippers, cutters, dissectors, and bioptomes—all of which are designed to interact with the environment (*e.g.*, tissue). Smith further discloses that other types of devices that can be used with its system include those that provide "suction and/or irrigation capabilities," both of which would also interact with the bodily environment by either removing elements (via suction) from or irrigating the body lumen. Ex. 1004, 18:65-67; Ex. 1003, ¶89.

Accordingly, Smith discloses "*an end effector mounting formation*" (*e.g.*, robot arms to which grippers or other end effectors are mounted on their distal ends) "*positioned at the working end of the shaft*" (*e.g.*, at the distal end of the multi-lumen tube). Ex. 1003, ¶90.

Smith further discloses that its "*end effector mounting formation*" is "*arranged to be angularly displaceable about at least two axes*" under either Petitioner's or PO's proposed construction of "*angularly displaceable about at least two axes*." As discussed above (Section IV.B), "*angularly displaceable about at least two axes*" should be interpreted as rotatable about at least two fixed axes. Smith explains that each of its robot arms include three rotational joints and three flexional joints and that the rotational joints and flexional joints rotate about fixed perpendicular axes:

> Each robot arm generally includes a shoulder 600, an elbow 602, a wrist 604, and a pair of grippers 172 (172a, 172b). ***The shoulder 600, elbow 602 and wrist 604 each have a rotational joint 160, 164, 168 and a flexional joint 162, 166, 170. The axis of rotation of each rotational joint is always perpendicular to the axis of flexion of the corresponding flexional joint***, regardless of their rotational or flexional position. There are, therefore, three rotational joints and three flexional joints. The presently preferred joints are configured as

> alternating socket and clevis members. A clevis is mounted for rotation in a socket and a socket is mounted for flexion in a clevis.

Ex. 1004, 16:10-23; *see also id*., 4:30-41 (explaining that each robotic arm has rotational and flexional joints corresponding to shoulder, elbow, and wrist of the practitioner), 5:10-18.

For example, Figure 25 (below) depicts a side view of a robot arm having wrist, elbow, and shoulder joints, and Figure 26 (below) depicts the same robot arm "but rotated 90^{o} about the shoulder axis" (annotated in red) (Ex. 1004, 6:21-24):

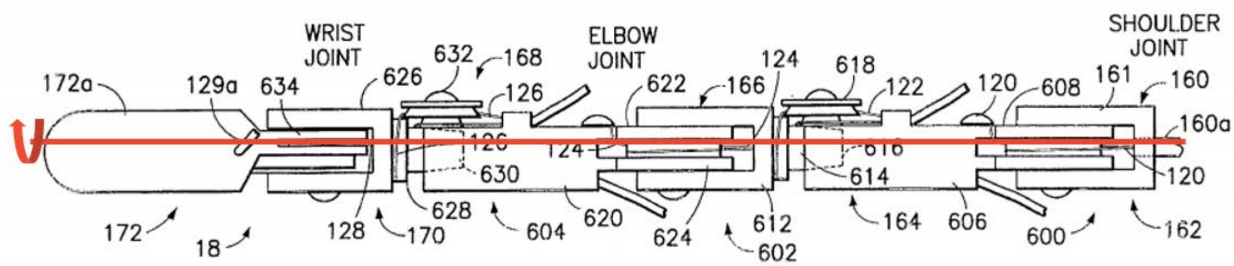


FIG. 25

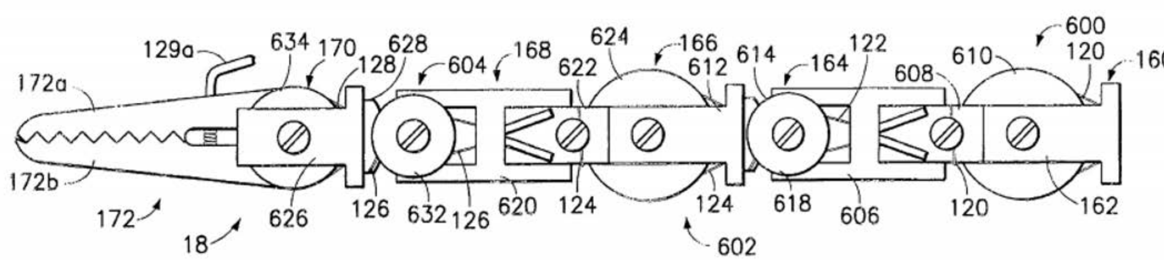


FIG. 26

Ex. 1004, Figs. 25-26; *see also id*., 6:48-51 ("An elbow rotation pulley 618 is mounted on the elbow socket 606 and is rotatable about an axis perpendicular to the axis of rotation of the elbow clevis 612."), 17:1-4 ("A wrist rotation pulley 632 is mounted on the wrist socket 620 and is rotatable about an axis perpendicular to the axis of rotation of the wrist clevis 626."); Ex. 1003, ¶92.

In addition, each of the joints has a flexion pulley that "is rotatable about an axis which is perpendicular to the axis of the [joint's] rotation." Ex. 1004, 16:35-39 (shoulder), 16:58-61 (elbow), 17:9-12 (wrist). For example, Figure 27 (below) depicts the same robot arm as in Figures 25 and 26, but with, for example, the shoulder flexion joint rotated about the red-depicted axis, which is perpendicular to the axis of the shoulder rotation:

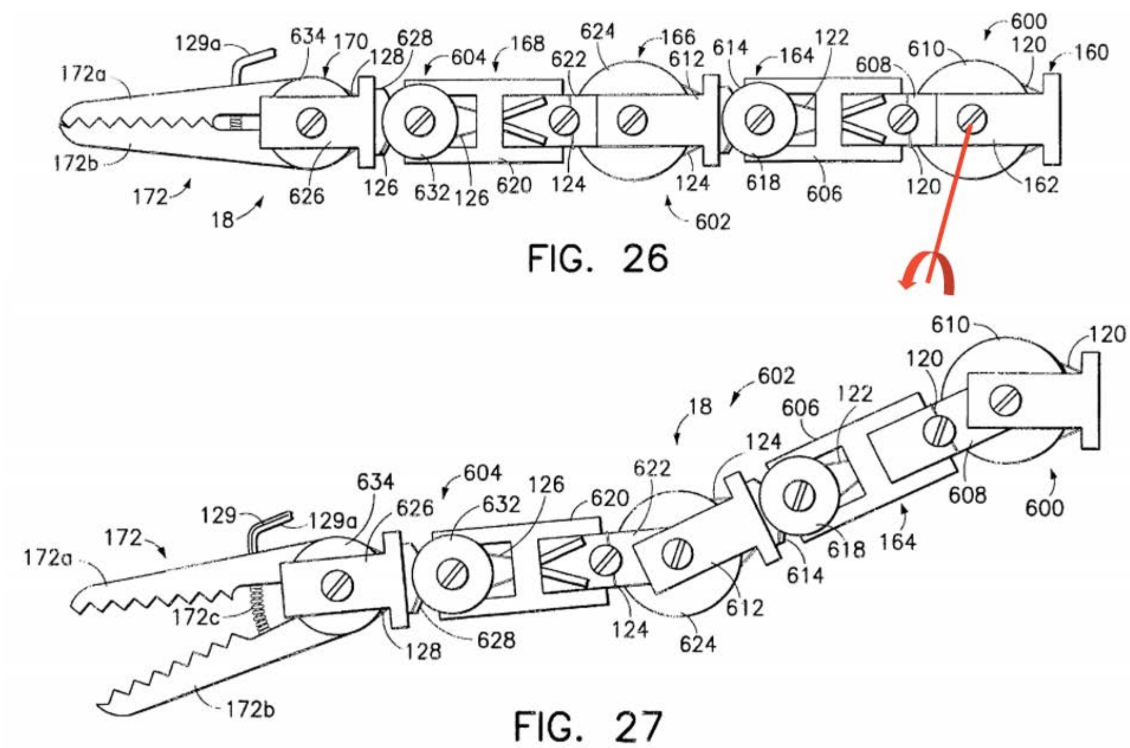


FIG. 26

FIG. 27

Ex. 1004, Figs. 26-27, 6:25-26; Ex. 1003, ¶93.

Accordingly, <u>Smith</u> discloses "*an end effector mounting formation*" (*e.g.*, robotic arms to which grippers or other end effectors are mounted on their distal ends) "*arranged to be angularly displaceable about at least two axes*" (*e.g.*, rotational and flexional joints of each robot arm's shoulder, elbow, and wrist are rotatable around perpendicular axes). Ex. 1003, ¶95. Because Smith discloses "*angularly displaceable about at least two axes*" under Petitioner's proposed construction, it also discloses "*angularly displaceable about at least two axes*" under PO's broader "plain and ordinary meaning" construction. Ex. 1003, ¶94.

(4) "elongate elements connected to the end effector mounting formation to cause selective pivotal movement of the end effector mounting formation about the axes in response to selective pulling of the elongate elements"

Smith discloses "*elongate elements connected to the end effector mounting formation to cause selective pivotal movement of the end effector mounting formation about the axes in response to selective pulling of the elongate elements*." Ex. 1003, ¶¶96-103.

As discussed above (Section IV.C), the claim term "*pivotal movement*" should be interpreted as rotational movement around a fixed axis. And, as explained above (Section V.A.2.a).(3)), each of Smith's robot arms includes three rotational joints and three flexional joints that rotate about fixed perpendicular axes. *See, e.g.*, 4:30-41, 5:10-18, 6:21-26, 16:10-23 ("The shoulder 600, elbow 602 and wrist 604 each have a rotational joint 160, 164, 168 and a flexional joint 162, 166, 170. ***The axis of rotation of each rotational joint is always***

perpendicular to the axis of flexion of the corresponding flexional joint, regardless of their rotational or flexional position.”), 16:35-39, 16:48-51, 16:58-61, 17:1-4, 17:9-12, Figs. 25-27. Accordingly, each of the rotation and flexional joints of Smith’s robotic arms make “*pivotal movement(s)*” under Petitioner’s proposed construction. Ex. 1003, ¶97. Because Smith discloses “*pivotal movement*” under Petitioner’s proposed construction, it also discloses “*pivotal movement*” under PO’s broader “plain and ordinary meaning” construction. *Id*.

Smith further explains that the pivotal movement of those joints and the mounted end effectors are driven by pulleys and connected tendons. For example, Smith explains that tendons couple the pulleys with the joints in the remote robotic arms. *See, e.g.*, Ex. 1004, Abstract (“***Tendons are coupled to the pulleys*** of the servo motors ***and are fed through the multi-lumen tube to the joints of the two arms***.”), 4:30-41 (“…Each arm has rotational and flexional joints corresponding to the shoulder, elbow, and wrist of the practitioner. ***Tendons are coupled to the pulleys*** of the servo motors ***and are fed through the multi-lumen tube to the joints of the two arms***. The endoscopic robotic arms preferably mimic human arms having movements for shoulder rotation, shoulder flexion, upper arm rotation, elbow flexion, lower arm rotation, and wrist flexion.”), 5:16-19 (rotational and flexional joints are “***pulley driven***”), 5:40-43 (“The ***tendons*** are preferably encased by individual coiled sheaths and ***are threaded around the robot arms*** so as to avoid interference with each other and with movement of the robot arms."), 6:67-7:2 ("The ***tendons are fed through a multi-lumen tube 150 to the remote robot arms 18*** which are mounted at the distal end of the tube."); *see also id*., 7:60-63, 16:39-44, 16:51-53, 16:61-64, 17:4-6, 17:12-14.

Smith further explains that the tendons cause rotational and flexional movements of the robotic arm joints:

> Each robot arm is provided with three rotational joints 160, 164, 168 and three flexional joints 162, 166, 170, and the distal end of each robot is provided with a gripper 172. Thus, ***the fourteen tendon loops 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, are each coupled to a respective one of the seven joints and the gripper on each arm***. However, as discussed in more detail below, ***the shoulder rotational joint 160 may be controlled by*** a torsion tube rather than ***a tendon loop***, and the gripper 172 may be controlled by a tendon pull-wire rather than a tendon loop. Moreover, while each tendon is preferably encased in a coil sheath, ***the shoulder flexional joint may be controlled by a tendon*** which is not sheathed since the path taken by the tendon is a relatively straight line through the multilumen tube and the tendon does not bend through a path as the other joints are flexed.

Ex. 1004, 7:3-19; *see also, id.*, 3:21-26 ("It is another object of the invention to provide endoscopic robotic arms which are coupled to servo motors using tendons and pulleys. It is another object of the invention to provide ***endoscopic robotic***

arms which are flexional and rotational through the movement of tendons."), 18:26-31 ("From the foregoing and the description of the servo system above, those skilled in the art will appreciate that ***rotation of the tendon loop 122 at the servo system end results in rotation of the clevis in the robot arm. This design allows a rotation of the rotational joints up to about 270º***."). *See also* Ex. 1003, ¶¶98-99.

The robot arms at the distal end of the multi-lumen tube move in response to and based on movements by the practitioner operating the system. *See, e.g.*, Ex. 1004, Abstract ("Each [robot] arm has rotational and flexional joints corresponding to the shoulder, elbow, and wrist of the practitioner."), 4:30-33 (same), 4:37-41, 8:51-57 ("When the control circuit 14 is activated, movement of the practitioner's arms 34, 36, 38 is replicated in the robot arms 18. When the practitioner grips one of the pistol grips 40, the gripper 172 on a corresponding robot arm 18 is closed. Thus, the tool 10 provides the practitioner 20 with a virtual presence of two arms and hands and vision at the surgical site."), 16:9-14 ("The robot arms approximate the geometry of the encoder which approximates the geometry of the arms of the practitioner."), 20:65-21:15. The practitioner wears an encoder with transducers that "register rotational and flexional movements of the shoulders 34, elbows 36, and wrists 38 as well as gripping movement of the hands 42 of the practitioner." Ex. 1004, 6:49-59. "The transducers are all coupled to a control circuit 14 which in turn provides outputs to an array of fourteen servo motors…[that] are coupled respectively to pulleys...which in turn are coupled to tendon loops." Ex. 1004, 6:59-7:2. Accordingly, the servo motors and pulleys rotate based on the practitioner's movements and *selectively* pull the tendons causing rotational and/or flexional movement in the robot arms. Ex. 1004, 4:8-29 ("The servo system includes a series of servo motors to move to positions correlating to the potentiometer positions which correspond to the position of the arm of the practitioner wearing the encoder. The servo motors are mounted in an interface housing with the rotational axes of their shafts parallel….According to the presently preferred embodiment, for each arm, seven servo motors and corresponding pulleys are provided for responding to flexion and rotation at the shoulder, elbow and wrist of each arm in addition to gripping at each hand."), 18:26-31 ("[T]hose skilled in the art will appreciate that rotation of the tendon loop 122 at the servo system end results in rotation of the clevis in the robot arm. This design allows a rotation of the rotational joints up to about 270º."); *see also id.*, Abstract ("[T]he encoder encodes flexion and rotation at the shoulder, elbow and wrist of each arm in addition to gripping at each hand. The encoding device is coupled to a circuit which operates a servo system."); Ex. 1003, ¶¶100-102.

Accordingly, Smith discloses "*elongate elements connected to the end effector mounting formation*" (*e.g.*, tendon loops connected to robot arm joints) "*to* *cause selective pivotal movement of the end effector mounting formation about the axes*" (*e.g.*, to cause selective rotational and flexional movement of the robot arm joints based on the practitioner's movement) "*in response to selective pulling of the elongate elements*" (*e.g.*, when the servo motors and pulleys are selectively pulling on the tendon loop based on the practitioner's movement). Ex. 1003, ¶103.

(5) "a support base positioned on an opposed end of the shaft"

Smith discloses "*a support base positioned on an opposed end of the shaft*." Ex. 1003, ¶¶104-10. For example, Smith discloses a "tray-like housing" that supports and houses the pulleys:

> [T]he servo system 16 is seen to include ***a disposable aluminum or injection molded plastic pulley tray*** 402 and an upper and lower array of servo motors 404, 406. ***The pulley tray 402 contains fourteen pulleys…supported by bearings (not shown)***. Seven pulleys…are engaged by the upper servo motor array 402 and seven pulleys…are engaged by the lower servo motor array 406. ***The pulleys sit in bushing*** and are sandwiched between the upper and lower servo motors.

Ex. 1004, 14:8-18; *see also id.*, 4:16-17 ("***A series of pulleys corresponding to the number of servo motors are arranged in a single tray-like housing.***"), 7:26-31 ("The ***pulleys*** 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116 ***are preferably arranged in a tray 118*** which is detachable from the array of servo motors 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86"); Ex. 1003, ¶104.

Smith further explains that the pulley tray is on the proximal end of the multi-lumen tube, while the robotic arms and attached end effectors are on the distal end of the multi-lumen tube. *See, e.g.*, Ex. 1004, 8:39-42 ("The assistant couples the pulley tray 118 to the array of servo motors…and inserts the distal end of the multi-lumen tube 150 through a trocar tube (not shown) and locates the robot arms 18 in the vicinity of the surgical site."), Fig. 1. Figure 23 of Smith illustrates "[t]he sandwiched assembly of servo motor arrays and pulley tray is…locked together" on one end (*opposed end*) (in red) of the multi-lumen tube 150 (in brown) and the robot arms having end effectors (in purple) on the other end (*working end*) of the multi-lumen tube 150:

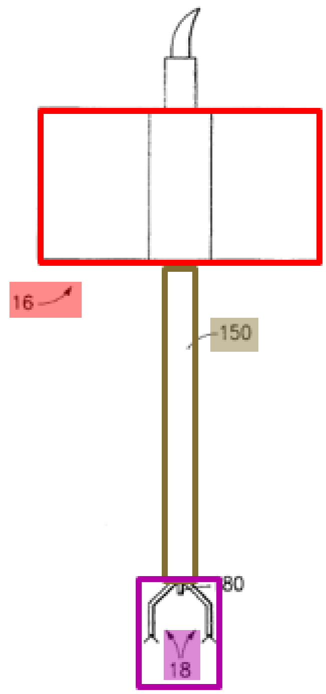


FIG. 23

Ex. 1004, Fig. 23, 6:17-18 ("FIG. 23 is a plan view of an assembled servo motor tray, multilumen tube, and robot arms."), 14:64-67 ("The sandwiched assembly of servo motor arrays and pulley tray is then locked together to provide the assembly as shown in FIG. 23."); Ex. 1003, ¶¶105-06.

Smith's pulley tray is analogous to the support base of the '701 patent's surgical tool. As depicted in Figures 4 and 6 below, the '701 patent's surgical tool 54 comprises a "proximal housing 108" (in red)—located on the opposed end of shaft 102 from end effector 112—that includes an interface 110 containing driven elements 118 (spools). Ex. 1001, 9:29-33, 10:32-36.

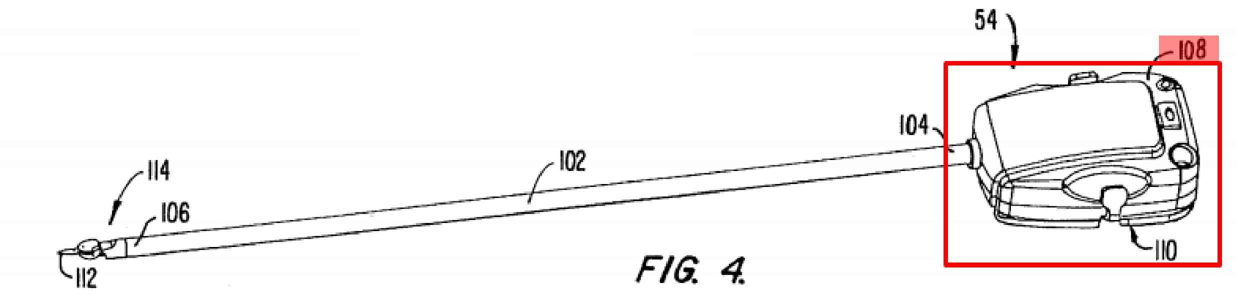


FIG. 4.

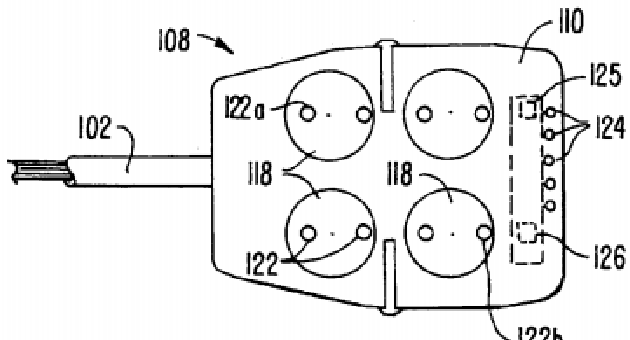


FIG. 6.

Like the ’701 patent’s “proximal housing 108” that supports driven elements 118, Smith’s pulley tray likewise supports pulleys, as explained above. Ex. 1003, ¶¶107-09.

Accordingly, Smith discloses *“a support base”* (*e.g.*, pulley tray supporting pulleys) “*positioned on an opposed end of the shaft*” (*e.g.*, positioned on the multi-lumen tube on the opposite side of the robot arms and end effector). Ex. 1003, ¶110.

(6) "at least three spools angularly displaceably mounted on the support base and to which opposed ends of the elongate elements are connected so that selective angular displacement of the spools causes the selective pulling of the elongate elements"

Smith discloses "*at least three spools angularly displaceably mounted on the support base and to which opposed ends of the elongate elements are connected so that selective angular displacement of the spools causes the selective pulling of the elongate elements*." Ex. 1003, ¶¶111-22.

Smith discloses that its pulley tray, which is assembled with servo arrays, holds 14 pulleys:

> [T]he servo system 16 is seen to include a disposable aluminum or injection molded plastic pulley tray 402 and an upper and lower array of servo motors 404, 406. ***The pulley tray 402 contains fourteen pulleys***…supported by bearings (not shown). Seven pulleys…are engaged by the upper servo motor array 402 and seven pulleys…are engaged by the lower servo motor array 406. The pulleys sit in bushing and are sandwiched between the upper and lower servo motors.

Ex. 1004, 14:8-18; *see also id.*, 4:16-17, 4:27-29 ("Fourteen servo motors and corresponding pulleys are provided for a pair of arms and hands."), 7:26-31 ("The pulleys 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116 are preferably arranged in a tray 118, which is detachable from the array of servo motors 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86").

Smith also discloses that the servo motors, with which these pulleys engage, rotate. Ex. 1004, 4:12-15 (servo motors have "rotational shaft[s]" and the "rotational axes of their shafts [are] parallel"), 7:60-63 ("[T]he servo system need not utilize ***rotary motors with pulleys and cables***, but may use other drive means…."), 16:1-4 ("rotations of the servo motor"). Because the pulleys are engaged with the servo motors, when the servo motors rotate, the pulleys rotate as well. Ex. 1003, ¶¶111-12.

Accordingly, Smith discloses "*at least three spools*" (*e.g.*, 14 pulleys) "*angularly displaceably mounted on the support base*" (*e.g.*, mounted in a tray housing for engagement and rotation with corresponding servo motors). Ex. 1003, ¶113.

As discussed above (Section IV.E), "*at least three spools…to which opposed ends of the elongate element are connected*" should be interpreted as requiring each of the at least three spools to have two opposed ends of an elongate element connected to it. Smith discloses that a "tendon loop" is connected to each of its pulleys. *See*, *e.g.*, Ex. 1004, 6:62-7:2 ("The servo motors are coupled respectively to pulleys…which in turn are coupled to tendon loops…, i.e., one tendon loop per motor. The tendons are fed through a multi-lumen tube 150 to the remote robot arms 18 which are mounted at the distal end of the tube 150."), 15:32-36 ("tendons described above are 'endless loops'"); *see also id*., 4:33-36; Ex. 1003, ¶114-15.

Smith further discloses that the opposed ends of each tendon loop are connected to its respective pulley. For example, as depicted in Figures 17 and 18 below, "[t]endons, e.g. 138 are attached to the pulleys, e.g. 108, by threading ***the ends of the tendon*** around the groove 108*f* in the pulley wheel, through the radial slot 108*g* and around the tendon locking screw 109….The locking screw 109 is then tightened against the tendon 136." Ex. 1004, 14:35-40, Figs. 17-18; *see also id.*, 5:4-7 ("A tendon is attached to a pulley by threading ***its ends*** through the radial slot and around the axial screw. Tightening the axial screw secures the tendon to the pulley.").

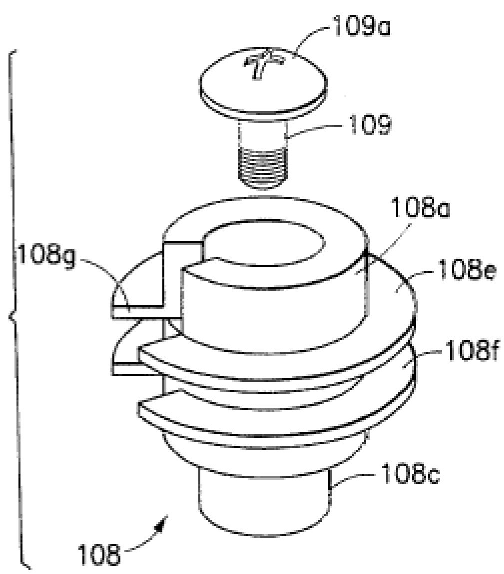


FIG. 17

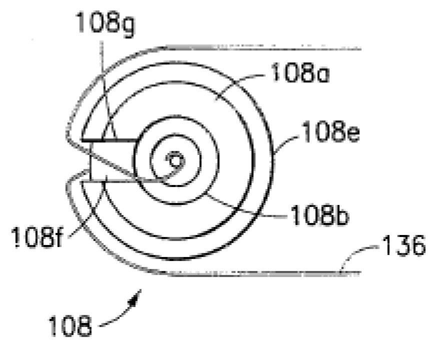


FIG. 18

Accordingly, Smith explains that both ends of each tendon are attached to a pulley around the tightened locking screw. Ex. 1003, ¶116. That both ends of Smith's tendon loops are connected to their respective pulleys is further supported by Smith's disclosure that tendons extend to the robot arms at the distal end of the multi-lumen tube and return back to the pulley tray: "A shoulder flexion tendon 120 is wrapped around the shoulder flexion pulley 610 and around the stem 608 of the elbow socket 606 as described in more detail below. The tendon 120 extends proximally through the bore 160a in the shoulder rotational joint 160 ***back to the pulley tray*** described above." Ex. 1004, 16:39-44, Figs. 25-27; Ex. 1003, ¶117.

In addition, Smith distinguishes between a single pullwire arrangement—where a single wire controls movement—and a tendon loop arrangement—where the tendons extend to the robot arms at the distal end of the multi-lumen tube and loop back to the pulleys. Ex. 1004, 7:9-13 ("gripper 172 may be controlled by a tendon pull-wire rather than a tendon loop"), 15:31-36 ("In addition, while the tendons described above are 'endless loops', the tendon which controls the gripper 172 is preferably a single pull wire…."), 18:54-57, 19:8-11. For example, Figure 34 (annotated below) illustrates that tendon loops that go back to the pulley tray are used for the robot arms (example in red), but single pull-wires may be used for the grippers (example in blue):

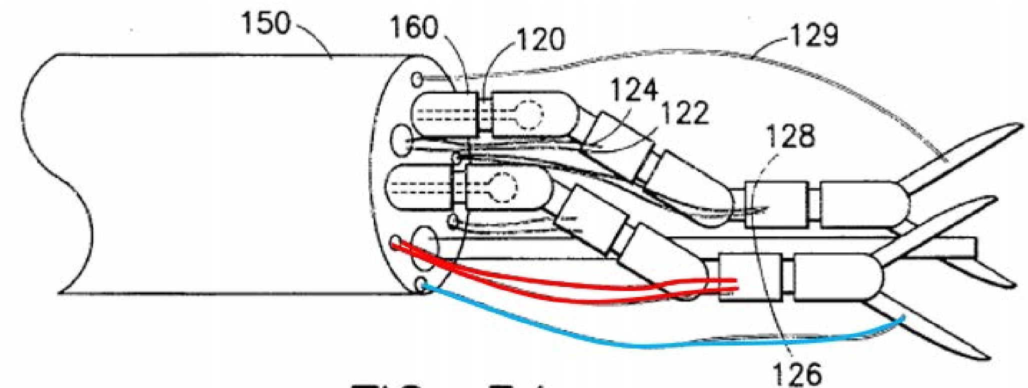


FIG. 34

Ex. 1004, Fig. 34, 18:49-57; Ex. 1003, ¶¶117-19.

As discussed above (Section IV.E), Figure 4B of the ’701 patent discloses at least three spools (driven element 118) that each have both ends of the same cable connected to the same spool (as shown in red):

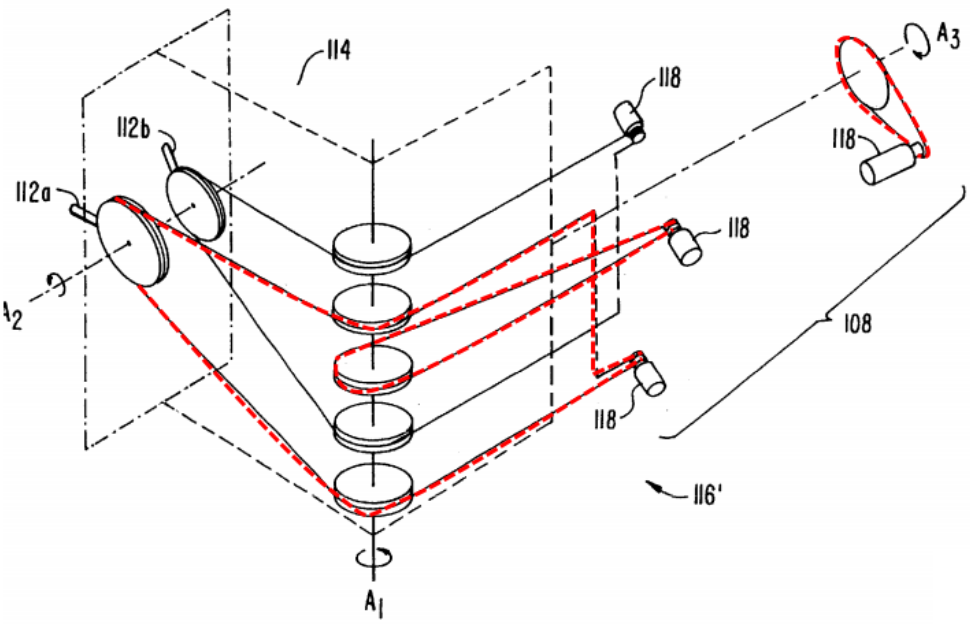


FIG. 4B.

Thus, even if "*at least three spools…to which opposed ends of the elongate element are connected*" is not limited to having two opposed ends of an elongate element connected to each of the at least three spools, it must at least cover that arrangement. Accordingly, Smith discloses "*at least three spools…to which opposed ends of the elongate elements are connected*" under any construction of that term. Ex. 1003, ¶¶120-21.

And, as explained above (Section V.A.2.a).(4)), movement by the practitioner is translated into rotation of the servo motors and, therefore, the pulleys, which rotation causes selective pulling of the tendons that cause the robot arms to move according to the practitioner's movements. Ex. 1003, ¶122.

(7) "the spools having axes which are parallel and spaced apart relative to each other"

Smith discloses "*the spools having axes which are parallel and spaced apart relative to each other*." Ex. 1003, ¶¶123-24. For example, Smith explains that the servo motors, which align with the pulleys, have parallel rotation axes:

> The servo motors are mounted in an interface housing ***with rotational axes of their shafts parallel***. The rotational shaft of each servo motor is provided with a quick connecting end. A series of pulleys corresponding to the number of servo motors are arranged in a single tray-like housing. ***Each pulley is provided with a self-aligning socket designed to mate with a corresponding servo motor shaft***.

Ex. 1004, 4:12-19. Because these servo motors having parallel rotational axes align with the pulleys, the pulleys also have parallel rotational axes. Ex. 1003, ¶123. This is further illustrated by Figure 22 of Smith (annotated below), which depicts pulley tray 402 (highlighted in yellow) having pulleys that are spaced apart relative to each other and that have parallel rotational axes along the y-axis (depicted with red lines):

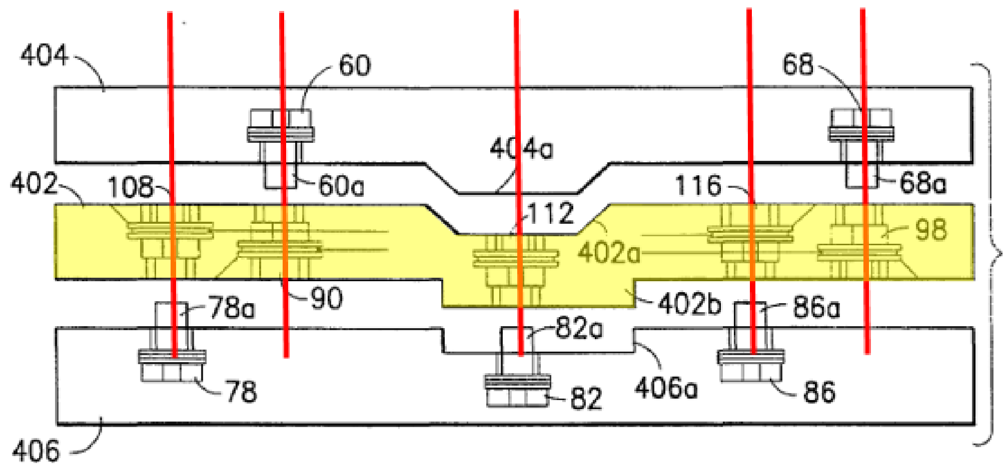


FIG. 22

See also Ex. 1004, 14:48-67, Figs. 13-14; Ex. 1003, ¶124.

b) Claim 7

Claim 7 depends from claim 1 and specifies "*[t]he surgical instrument of claim 1, wherein the instrument includes at least one joint disposed adjacent the shaft working end, and the at least one joint is coupled to at least one of the elongate elements, said at least [one]*[9] *elongate element being housed within the shaft.*"

As explained above (Section V.A.2.a)), Smith discloses "*[t]he surgical instrument of claim 1*." Smith further discloses "*wherein the instrument includes*

[9] A POSA would have understood that the omission of "one" here was a typographical error in view of claim 7's earlier recitation of "at least one of the elongate elements." Ex. 1003, ¶125 n.3.

at least one joint disposed adjacent the shaft working end, and the at least one joint is coupled to at least one of the elongate elements, said at least [one] elongate element being housed within the shaft." Ex. 1003, ¶¶125-135.

Smith discloses that each of its robot arms, which are mounted at the distal end of the multi-lumen tube, has three rotational joints and three flexional joints:

> Each robot arm generally includes a shoulder 600, an elbow 602, a wrist 604, and a pair of grippers 172 (172a, 172b). ***The shoulder 600, elbow 602 and wrist 604 each have a rotational joint 160, 164, 168 and a flexional joint 162, 166, 170.*** The axis of rotation of each rotational joint is always perpendicular to the axis of flexion of the corresponding flexional joint, regardless of their rotational or flexional position. ***There are, therefore, three rotational joints and three flexional joints***.

Ex. 1004, 16:10-23; *see also id*., 4:30-41, 5:10-18. Each of these joints are, therefore, adjacent to the distal end ("*working end*") of the multi-lumen tube. Ex. 1003, ¶¶127-28.

As discussed above (Section IV.D), "*joint(s)*" should be interpreted as parts connecting two structures that allows movement. Smith's disclosed joints connect two structures to allow rotational and flexional movement and, thus, disclose "*joint(s)*" under Petitioner's proposed construction. Because Smith discloses "*joint(s)*" under Petitioner's proposed construction, it also discloses "*joint(s)*" under PO's broader "plain and ordinary meaning" construction. Ex. 1003, ¶¶129-33.

For example, Smith explains that the three rotational joints and three flexional joints in the robot arms "are configured as alternating socket and clevis members. A clevis is mounted for rotation in a socket and a socket is mounted for flexion in a clevis." Ex. 1004, 16:20-23. Figure 25 (below) depicts how each of the joints is formed:

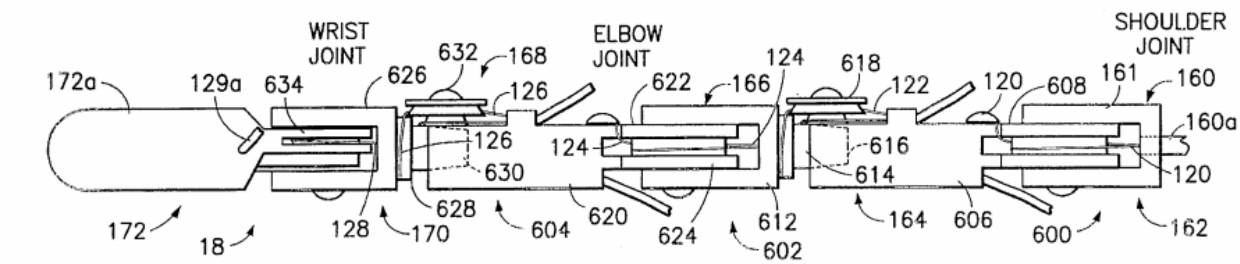


FIG. 25

Ex. 1004, Fig. 25; *see also id.*, Figs. 26-27. "[S]houlder rotational joint 160" is formed by "a cylindrical bore 160*a* which extends into the shoulder clevis 161." Ex. 1004, 16:29-31. "[S]houlder flexional joint 162…is formed by mounting an elbow socket 606 in the shoulder clevis 161." Ex. 1004, 16:32-34. Similarly, the "elbow rotational joint 164…is formed by the elbow socket 606 and an elbow clevis 612 having a stem 614 which is rotationally mounted in the cylindrical bore 616 of the elbow socket 606." Ex. 1004, 16:45-48. The "elbow flexional joint 166…is formed by mounting a wrist socket 620 in the elbow clevis 612." Ex.

1004, 16:54-56. The "wrist rotational joint 168…is formed by the wrist socket 620 and a wrist clevis 626 having a stem 628 which is rotationally mounted in the cylindrical bore 630 of the wrist socket 620." Ex. 1004, 16:65-7:1. And "wrist flexional joint…is formed by mounting a pair of grippers 172 between the arms of the wrist clevis 626." Ex. 1004, 17:7-9.

Each of the joints in the robot arms is coupled to a tendon loop: "[T]he ***fourteen tendon loops…are each coupled to a respective one of the seven joints*** and the gripper on each arm." Ex. 1004, 6:62-7:9. And the tendons are fed through and, thus, housed within the multi-lumen tube. Ex. 1004, Abstract ("Tendons…are fed through the multi-lumen tube to the joints of the two arms."), 3:21-27, 4:30-41 ("Tendons are coupled to the pulleys of the servo motors and are fed through the multi-lumen tube to the joints of the two arms."), 16:39-17:14, Fig. 34; Ex. 1003, ¶134.

Accordingly, Smith discloses "*wherein the instrument includes at least one joint disposed adjacent the shaft working end*" (*e.g.*, each robot arm's three rotational and three flexional joints disposed adjacent to the distal end of the multi-lumen tube) "*and the at least one joint is coupled to at least one of the elongate elements*" (*e.g.*, each joint is coupled to a tendon loop), "*said at least [one] elongate element being housed within the shaft*" (*e.g.*, tendon loops are fed through and housed within the multi-lumen tube). Ex. 1003, ¶135.

c) Claim 8

Claim 8 depends from claim 1 and specifies "*[t]he surgical instrument of claim 1, wherein at least one of the elongate elements includes a flexible cable portion*."

As explained above (Section V.A.2.a)), Smith discloses "*[t]he surgical instrument of claim 1*." Smith further discloses "*wherein at least one of the elongate elements includes a flexible cable portion*." Ex. 1003, ¶¶136-141.

Smith discloses that its tendons, which Smith also refers to as "cables," are flexible. *See, e.g.*, Ex. 1004, 8:43-46 ("The tray of servo motors 16 is located a convenient distance from the surgical site with the ***flexible sheathed tendons*** extending to the multilumen tube which holds the robot arms."), 22:49-52 ("at least some of said drive means are coupled to said first robotic arm by ***flexible tendons***"), 22:57-59 ("at least some of said drive means are coupled to said first and second robotic arms by ***flexible tendons***"); *see also id.*, 7:60-63 ("[T]he servo system need not utilize rotary motors with pulleys and ***cables***, but may use other drive means such as motorized jack screws, hydraulic, or pneumatic drive means."); Ex. 1003, ¶¶138-39.

Moreover, Smith discloses that the tendons are tendon ***loops*** and that the tendons are wrapped around pulleys, both of which would only be possible if at least a portion of the tendons were flexible. *See*, *e.g.*, Ex. 1004, 5:4-6 ("A tendon is attached to a pulley by threading its ends through the radial slot and ***around the axial screw***."), 6:62-67 (explaining pulleys are coupled to "tendon loops"), 16:39-42 (tendon 120 wrapped around pulley 610), 16:51-53 (tendon 122 wrapped around pulley 618), 16:61-64 (tendon 124 wrapped around pulley 624), 17:4-6 (tendon 126 wrapped around pulley 632), 17:13-14 (tendon 128 wrapped around pulley 634), Figs. 25-27; Ex. 1003, ¶¶140-41.

For example, Figure 18 below shows "[t]endons, e.g. 138, are attached to the pulleys, e.g. 108, by threading the ***ends of the tendon around the groove 108f in the pulley wheel***, through the radial slot 108*g* and ***around the tendon locking screw 109***," which is then tightened against the tendon (Ex. 1004, 14:35-40):

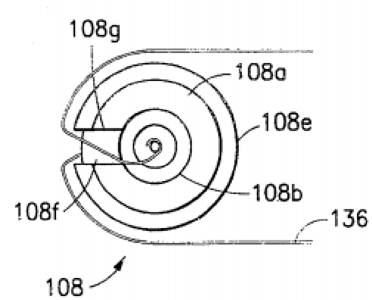


FIG. 18

Ex. 1004, Fig. 18.

d) Claim 11

Claim 11 depends from claim 1 and specifies "*[t]he surgical instrument of claim 1, wherein at least one of said spools spool*[10] *is engageable with a rotatable actuator body of a robotic surgical system, so as to cause a rotation of the spool when the rotatable body of the actuator is rotated in response to the operator inputs*."

As explained above (Section V.A.2.a)), Smith discloses "*[t]he surgical instrument of claim 1*." Smith further discloses "*wherein at least one of said spools is engageable with a rotatable actuator body of a robotic surgical system, so as to cause a rotation of the spool when the rotatable body of the actuator is rotated in response to the operator inputs*." Ex. 1003, ¶¶142-51.

Smith explains that each of its pulleys engages with a servo motor via a self-aligning socket:

> The servo motors are mounted in an interface housing with the rotational axes of their shafts parallel. The rotational shaft of each servo motor is provided with a quick connecting end. A series of pulleys corresponding to the number of servo motors are arranged in a

[10] In the district court litigation, the parties agreed that "wherein at least one of said spools spool is engageable with a rotatable actuator body of a robotic surgical system" should be construed as "wherein at least one of said spools is engageable with a rotatable actuator body of a robotic surgical system." Ex. 1007, 5.

> single tray-like housing***.*** ***Each pulley is provided with a self-aligning socket designed to mate with a corresponding servo motor shaft***.

Ex. 1004, 4:13-20; *see also id*., 7:27-31, 8:39-43. As illustrated in Figure 22 (annotated below), "pulley tray 402 [in yellow] is ***engaged*** by two servo motor arrays 404, 406 [in blue]." Ex. 1004, 14:48-49. The servo system is assembled by placing the pulley tray 402 on top of the lower servo motor array 406 "so that the ***splined shafts of the servo motors engage the shaft receiving bores of the pulleys***," and placing upper servo motor array 404 on top of pulley tray 402 "so that the ***splined shafts of the servo motors engage the shaft receiving bores of the pulleys***" (Ex. 1004, 14:48-64):

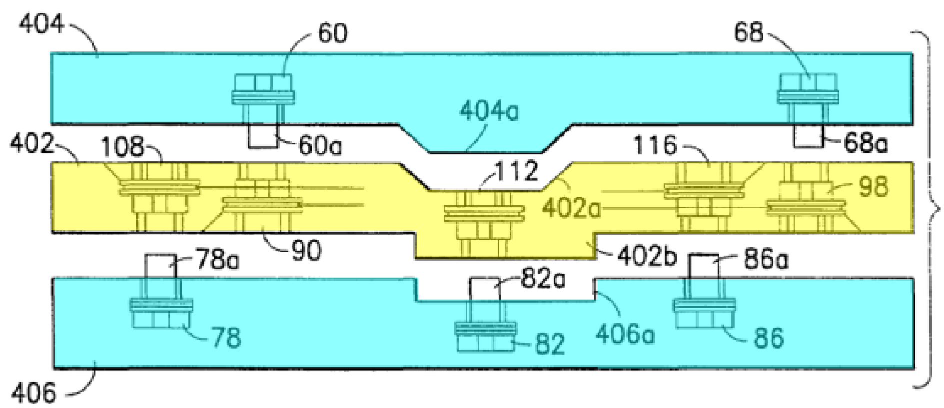


FIG. 22

Ex. 1004, Fig. 22.

These servo motors and pulleys are all parts of Smith's disclosed robotic surgical system. *See, e.g.*, Ex. 1004, Title ("Endoscopic ***Robotic Surgical Tools*** and Methods"), 1:7-8 ("More particularly, the invention relates to endoscopic methods and ***devices having robotic capabilities***."), 3:18-23 ("It is also an object of the invention to provide ***endoscopic tool having articulate robotic arms which are operable by servo motors***. It is another object of the invention to provide ***endoscopic robotic arms which are coupled to servo motors*** using tendons ***and pulleys***."); *see also id.*, 3:11-17.

Smith describes its servo motors as rotary motors that rotate around the axes of their shafts. Ex. 1004, 4:12-15 (servo motors have "rotational shaft[s]" and the "rotational axes of their shafts [are] parallel"), 7:60-63 ("[T]he servo system need not utilize ***rotary motors with pulleys and cables***, but may use other drive means…."), 16:1-4 ("rotations of the servo motor").

Smith further explains that its servo motors move according to the movement of the practitioner operating the robotic system: "The servo system includes a series of servo motors to move to positions correlating to the potentiometer[11] positions which correspond to the position of the arm of the practitioner wearing the encoder." Ex. 1004, 4:10-13; *see also id.*, Abstract (encoder, worn by practitioner, "is coupled to a circuit which operates a servo system"), 3:31-36 ("robotic endoscopic instrument arms…controlled by an encoder worn by a surgeon"), 3:40-42, 4:37-40, 6:46-67 (transducers, which "register

[11] Potentiometers are transducers. Ex. 1004, 10:4-10 ("The transducers are preferably potentiometers…."). Ex. 1003, ¶145 n.5.

rotational and flexional movements" of the practitioner, are "coupled to a control circuit 14 which in turn provides outputs to an array of fourteen servo motors"), 8:51-53 ("When the control circuit 14 is activated, movement of the practitioner's arms 34, 36, 38 is replicated in the robot arms 18."). Thus, when the servo motors rotate in response to the practitioner's movements, the pulleys engaged with those servo motors also rotate. Ex. 1003, ¶¶144-50.

Accordingly, Smith discloses "*wherein at least one of said spools*" (*e.g.*, pulleys 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116) "*is engageable with a rotatable actuator body of a robotic surgical system*" (*e.g.*, connected to servo motors 60, 62, 64, 66, 68 70, 72, 74, 76, 78, 80, 82, 84, 86, which have rotatable shafts, of the endoscopic robotic tool 10) "*so as to cause a rotation of the spool when the rotatable body of the actuator is rotated in response to the operator inputs*" (*e.g.*, the pulleys are rotated when the servo motors, which are engaged with the pulleys, rotate in response to the practitioner's movements). Ex. 1003, ¶151.

e) Claim 16

Claim 16 depends from claim 11 and specifies "*[t]he surgical instrument of claim 11, wherein at least three of the spools are each engageable with a respective rotatable actuator body of a robotic surgical system in substantially the same manner of engagement*."

As explained above (Section V.A.2.d)), Smith discloses "*[t]he surgical instrument of claim 11*." Smith further discloses "*wherein at least three of the spools are each engageable with a respective rotatable actuator body of a robotic surgical system in substantially the same manner of engagement*." Ex. 1003, ¶¶152-55.

All of Smith's fourteen pulleys engage with the fourteen servo motors in the same way. *See, e.g.*, Ex. 1004, 4:17-19 ("***Each pulley is provided with a self-aligning socket designed to mate with a corresponding servo motor shaft***."), 6:62-64 ("***[S]ervo motors*** 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86…***are coupled respectively to pulleys*** 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116…."), 14:13-18 ("***Seven pulleys*** 90, 92, 94, 96, 98, 100, 102 ***are engaged by the upper server motor array 402*** and ***seven pulleys*** 104, 106, 108, 110, 112, 114, 116 ***are engaged by the lower servo motor array 406***. The pulleys sit in bushings and are sandwiched between the upper and lower servo motors."), 14:19-23 ("***[E]ach pulley, e.g. 108, has*** a first cylindrical part 108*a* with a screw receiving bore 108*b*, a second cylindrical part 108*c* with ***a servo motor shaft receiving bore 108d*** and a pulley wheel 108*e* with a grooved rim 108*f*."), 14:48-67 (explaining that "***[e]ach servo motor has a splined shaft…which engages the shaft receiving bore, e.g. 108d, of a respective pulley***"); Ex. 1003, ¶154.

Figure 22 (annotated below) depicts five servo motors (blue) with splined shafts that each engage with a shaft receiving bore of the five pulleys (yellow):

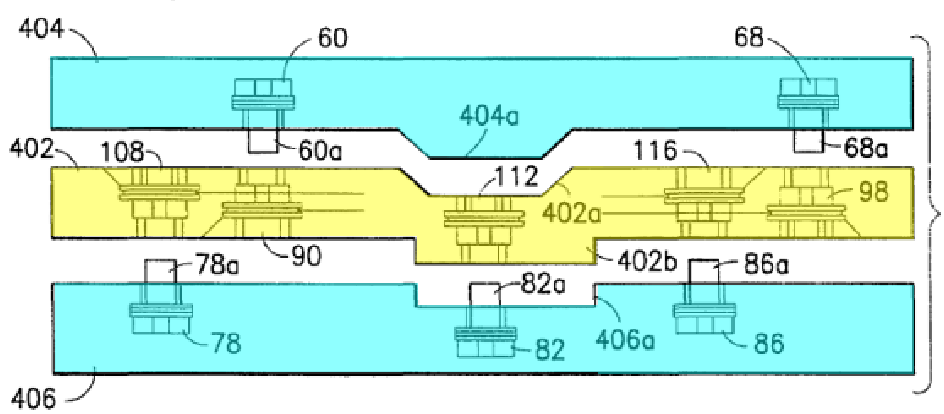


FIG. 22

Ex. 1004, Fig. 22, 14:48-64; Ex. 1003, ¶155.

f) Claim 25

(1) "A surgical instrument for operative mounting to a robotic surgical system, the surgical system having a drive assembly operatively coupled to a control unit operable by inputs from an operator, the drive assembly having a plurality of actuator bodies which are movable in response to operator inputs, the surgical instrument comprising:"

To the extent the preamble is limiting, Smith discloses "*[a] surgical instrument for operative mounting to a robotic surgical system, the surgical system having a drive assembly operatively coupled to a control unit operable by inputs* *from an operator, the drive assembly having a plurality of actuator bodies which are movable in response to operator inputs*." Ex. 1003, ¶¶156-60.

Smith discloses an "endoscopic ***robotic surgical*** tool." *See, e.g.*, Ex. 1004, 1:6-8 ("The invention relates to endoscopic surgical tools and methods…."), 3:14-17 ("robotic endosurgical tools"), 5:52-53, Fig. 1. Smith's system includes an encoder, worn by a practitioner, having ***transducers that "register rotational and flexional movements*** of the shoulders 34, elbows 36, and wrists 38 as well as gripping movement of the hands 42 ***of the practitioner***. The ***transducers are all coupled to a control circuit 14 which in turn provides outputs to an array of fourteen servo motors***….The servo motors are coupled respectively to pulleys…which in turn are coupled to tendon loops…, i.e., one tendon loop per motor. The tendons are fed through a multi-lumen tube 150 to the remote robot arms 18 which are mounted at the distal end of the tube." Ex. 1004, 6:46-7:2, Fig. 1; *see also id*., 4:9-13 ("The servo system includes a series of ***servo motors to move to positions correlating to the potentiometer positions which correspond to the position of the arm of the practitioner wearing the encoder***."), 7:31-36 (control circuit outputs transmitted to servo motors), 8:33-43, 13:1-12 ("In a presently preferred embodiment, the encoder 12 is coupled by wires to the control circuit 14 and the ***output of the control circuit is coupled to the servo system 16*** by wireless transmission."); Ex. 1003, ¶156.

Smith's servo motors move according to and based on the practitioner's movements so that those movements are replicated by the robot arms. Ex. 1004, 4:10-13 ("The servo system includes a series of ***servo motors to move to positions correlating to the potentiometer positions which correspond to the position of the arm of the practitioner wearing the encoder***."), 8:51-53 ("When the control circuit 14 is activated, ***movement of the practitioner's arms 34, 36, 38 is replicated in the robot arms 18***."); *see also id*., 3:31-36 ("robotic endoscopic instrument arm…controlled by an encoder worn by a surgeon"), 3:18-20, 3:40-42, 4:37-40; Ex. 1003, ¶157.

The pulleys are arranged in a single tray-like housing. Ex. 1004, 4:16-17. The servo system is assembled by mounting the pulley tray 402 on top of the lower servo motor array 406 "so that the splined shafts of the servo motors engage the shaft receiving bores of the pulleys," and placing upper servo motor array 404 on top of pulley tray 402 "so that the splined shafts of the servo motors engage the shaft receiving bores of the pulleys." Ex. 1004, 14:48-64; *see also id*., 8:39-43 ("The assistant couples the pulley tray 118 to the array of servo motors…."), 14:8-18; Ex. 1003, ¶158.

Smith further explains that the pulley tray, multi-lumen tube, and robot arms may be an assembly that can be attached and detached from the servo motor array to allow for different types of end effectors to be used during the same procedure.

Ex. 1004, 15:10-25; 19:1-5 ("[T]he end effectors may be interchanged during the course of a procedure by detaching the pulley 22[] tray/multilumen tube/robot arms assembly from the servo motor arrays."); Ex. 1003, ¶159.

Accordingly, Smith discloses "*[a] surgical instrument*" (*e.g.*, assembly of pulley tray, multi-lumen tube, robotic arms, and attached end effectors) "*for operative mounting to a robotic surgical system, the surgical system having a drive assembly*" (*e.g.*, for mounting with endoscopic robotic surgical system, including encoder, control circuit, and transducers, having servo motor array) "*operatively coupled to a control unit operable by inputs from an operator*" (*e.g.*, coupled to control circuit that receives inputs from practitioner movements), "*the drive assembly having a plurality of actuator bodies which are movable in response to operator inputs*" (*e.g.*, servo motor arrays having 14 servo motors that move in response to practitioner's movements). Ex. 1003, ¶160.

(2) "a proximal portion and a distal portion, the proximal portion comprising a first plurality of movable engaging interface bodies"

Smith discloses "*a proximal portion and a distal portion, the proximal portion comprising a first plurality of movable engaging interface bodies*." Ex. 1003, ¶¶161-65. Smith discloses a pulley tray containing 14 pulleys on the proximal side of the multi-lumen tube and robotic arms with grippers (or other end effectors) on the distal end of the multi-lumen tube. Ex. 1004, 6:62-7:2 ("The servo motors are coupled respectively to ***pulleys 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116*** which in turn are coupled to tendon loops….The tendons are fed through a multi-lumen tube 150 to the ***remote robot arms 18 which are mounted at the distal end of the tube***.”), 7:26-30 (“The ***pulleys…are preferably arranged in a tray 118*** which is detachable from the array of servo motors….”), *see also id*., 4:30-41 (“The robotic instrument preferably comprises two arms mounted at the distal end of a multi-lumen tube….In addition, ***grippers are mounted at the distal end of the robotic arms*** to provide a limited hand movement.”), 8:5-7, 18:59-67, 20:23-24; Ex. 1003, ¶161.

Figure 1B annotated below shows the pulley tray 118 (red) on the proximal side of the multi-lumen tube 150 and the robot arms 18 (purple) on the distal end of the multi-lumen tube 150:

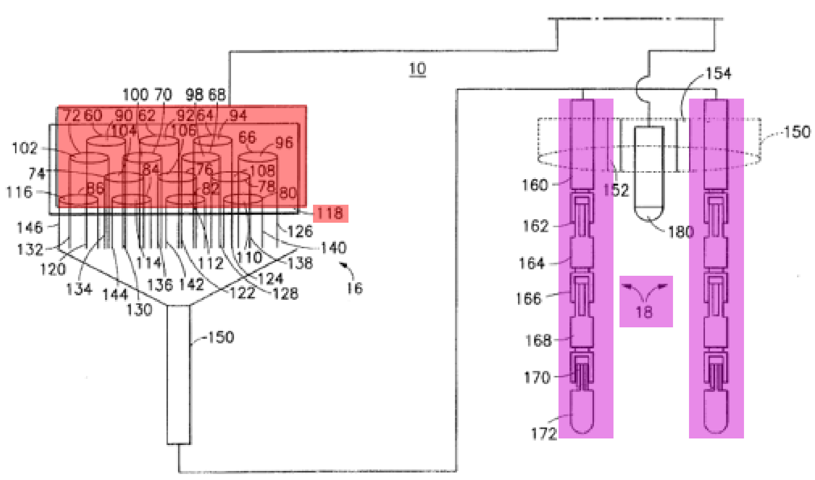


FIG. 1B

Ex. 1004, Fig. 1B, 6:62-7:2; *see also id*., Fig. 23, 14:64-67 Ex. 1003, ¶¶162-63.

As explained above (Section V.A.2.f).(1)), each of Smith's pulleys in the pulley tray engages and, therefore, interfaces with its respective servo motor. *See, e.g.*, Ex. 1004, 1004, 14:48-64 ("the splined shafts of the servo motors ***engage*** the shaft receiving bores of the pulleys"); *see also id*., 8:39-43 ("The assistant couples the pulley tray 118 to the array of servo motors…."), 14:8-18. Each of Smith's pulleys in the pulley tray rotates (and, therefore, movable) when its respective engaged servo motor rotates, as explained above in Section V.A.2.a).(6). Ex. 1003, ¶164.

Accordingly, Smith discloses "*a proximal portion*" (*e.g.*, portion comprising the pulley tray) "*and a distal portion*" (*e.g.*, robot arms with grippers or other end effectors at the distal end of the multi-lumen tube), "*the proximal portion comprising a first plurality of movable engaging interface bodies*" (*e.g.*, 14 pulleys in the pulley tray). Ex. 1003, ¶165.

(3) "at least one distal end effector member"

Smith discloses "*at least one distal end effector member*." Ex. 1003, ¶¶166-68. Smith explains that robotic arms are mounted at the distal end of a multi-lumen tube and that "end effectors" (*e.g.*, gripper, cutter, dissector, bioptome) are "mounted at the distal end of the robotic arms." Ex. 1004, 4:30-41 ("The robotic instrument preferably comprises two arms mounted at the distal end of a multi-lumen tube….In addition, ***grippers are mounted at the distal end of the robotic***

arms to provide a limited hand movement."), 8:5-7 ("The ***grippers at the end of the robot arms may be cutters or other types of end effectors*** and the robot arms may be provided with removable, replaceable ***end effectors***."), 18:59-67 ("While the robotic arms described above have been shown with ***gripper end effectors***, it will be appreciated that the arms could be provided with ***any type of end effector such as a cutter, dissector, bioptome, etc***. Moreover, it will be further appreciated that the ***end effectors could easily be provided with cautery capability***, either monopolar or bipolar. In addition, either the ***end effectors*** or the multilumen tube ***could be provided with suction and/or irrigation capabilities***."); *see also id*., 15:19-25, Figs. 25-26; Ex. 1003, ¶166.

As explained above (Section V.A.2.a).(3)), Smith's grippers and other end effectors (*e.g.*, cutters, dissectors, bioptomes) disclose the claimed "*end effector*" under either Petitioner's or PO's proposed construction of the term. As discussed above (Section IV.A), "*end effector*" should be interpreted as a device at the end of a surgical instrument for manipulating (cutting, grasping, or otherwise acting on) body tissue. Smith's disclosed end effectors, which are mounted at the distal end of the robot arms, are designed to manipulate bodily tissue by gripping (*e.g.*, grippers) and/or cutting and grasping (*e.g.*, cutter, dissector, bioptome, end effector with cautery capability) bodily tissue. Ex. 1004, 1:47-54 (describing known "end effectors," such as "forceps" with "grippers" for "obtaining tissue samples"), 8:5-7 (“grippers at the ends of the robot arms may be cutters or other types of end effectors”), 18:59-67 (types of end effectors include “cutter, dissector, bioptome, etc.”), Ex. 1003, ¶¶88, 167. Accordingly, Smith discloses “*end effectors*” under Petitioner’s proposed construction. *Id*.

Because Smith discloses “*end effectors*” under Petitioner’s proposed construction, it also discloses “*end effectors*” under PO’s broader construction of a “device at the end of an instrument, designed to interact with the environment.” Ex. 1003, ¶¶89, 167. For example, as discussed above, Smith discloses grippers, cutters, dissectors, and bioptomes—all of which are designed to interact with the environment (*e.g.*, tissue). Smith further discloses that other types of end effectors that can be used with its system include those that provide “suction and/or irrigation capabilities,” both of which would also interact with the bodily environment by either removing elements (via suction) from or irrigating the body lumen. Ex. 1004, 18:65-67; Ex. 1003, ¶¶89, 167.

Accordingly, Smith discloses “*at least one distal end effector member*” (*e.g.*, grippers, cutters, dissectors, bioptomes, etc. mounted on the distal end of each of the robotic arms). Ex. 1003, ¶168.

(4) "a plurality of joints, at least one of the joints being coupled to the end effector member, the joints being coupled to the plurality of movable engaging interface bodies by a plurality of drive members"

Smith discloses "*a plurality of joints, at least one of the joints being coupled to the end effector member, the joints being coupled to the plurality of movable engaging interface bodies by a plurality of drive members*." Ex. 1003, ¶¶169-74.

Smith discloses that each of its robot arms has three rotational joints and three flexional joints:

> Each robot arm generally includes a shoulder 600, an elbow 602, a wrist 604, and a pair of grippers 172 (172a, 172b). ***The shoulder 600, elbow 602 and wrist 604 each have a rotational joint 160, 164, 168 and a flexional joint 162, 166, 170.*** The axis of rotation of each rotational joint is always perpendicular to the axis of flexion of the corresponding flexional joint, regardless of their rotational or flexional position. ***There are, therefore, three rotational joints and three flexional joints***.

Ex. 1004, 16:10-23; *see also id*., 4:30-41, 5:10-18. As discussed above (Section IV.D), "*joint(s)*" should be interpreted as parts connecting two structures that allows movement. Smith's disclosed joints connect two structures to allow rotational and flexional movement and, thus, disclose "*joint(s)*" under Petitioner's proposed construction. Because Smith discloses "*joint(s)*" under Petitioner's proposed construction, it also discloses "*joint(s)*" under PO's broader "plain and ordinary meaning" construction. Ex. 1003, ¶¶129-33, 170. For example, Smith explains that the three rotational joints and three flexional joints in the robot arms "are configured as alternating socket and clevis members. A clevis is mounted for rotation in a socket and a socket is mounted for flexion in a clevis." Ex. 1004, 16:20-23. Figure 25 (below) depicts how each of the joints is formed:

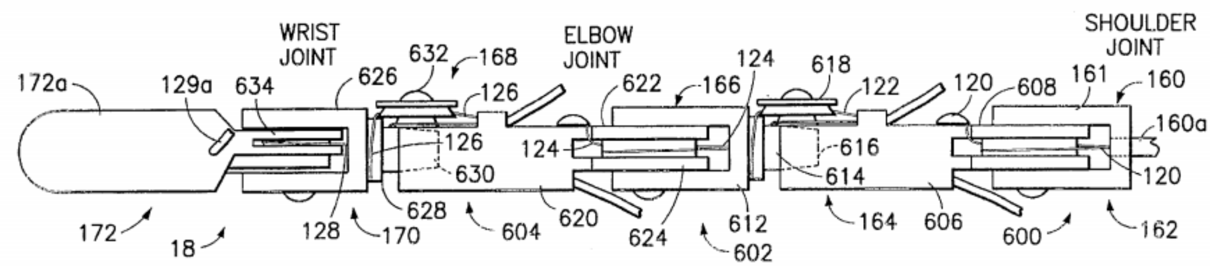


FIG. 25

Ex. 1004, Fig. 25; *see also id.*, Figs. 26-27. "[S]houlder rotational joint 160" is formed by "a cylindrical bore 160*a* which extends into the shoulder clevis 161." Ex. 1004, 16:29-31. "[S]houlder flexional joint 162…is formed by mounting an elbow socket 606 in the shoulder clevis 161." Ex. 1004, 16:32-34. Similarly, the "elbow rotational joint 164…is formed by the elbow socket 606 and an elbow clevis 612 having a stem 614 which is rotationally mounted in the cylindrical bore 616 of the elbow socket 606." Ex. 1004, 16:45-48. The "elbow flexional joint 166…is formed by mounting a wrist socket 620 in the elbow clevis 612." Ex. 1004, 16:54-56. The "wrist rotational joint 168…is formed by the wrist socket 620 and a wrist clevis 626 having a stem 628 which is rotationally mounted in the cylindrical bore 630 of the wrist socket 620." Ex. 1004, 16:65-7:1. And "wrist flexional joint…is formed by mounting a pair of grippers 172 between the arms of the wrist clevis 626." Ex. 1004, 17:7-9.

In addition, as depicted in Figure 25 (above), each of the robot arm's joints is coupled to the end effector 172 (*e.g.*, grippers) that is mounted on the distal end of the robot arms. Ex. 1004, 3:50-55, 4:30-31 ("The robotic instrument preferably comprises ***two arms mounted at the distal end of a multi-lumen tube***.), 4:40-41 ("In addition, ***grippers are mounted at the distal end of the robotic arms*** to provide a limited hand movement."), 16:10-15 ("Each robot arm generally includes a shoulder 600, an elbow 602, a wrist 604, and a pair of grippers 172 (172a, 172b). The shoulder 600, elbow 602 and wrist 604 each have a rotational joint 160, 164, 168 and a flexional joint 162, 166, 170."), 20:23-24, Figs. 1B, 25-27, 34; Ex. 1003, ¶171.

Each of the joints in the robot arms is coupled to a pulley, which engages with servo motors, by tendons:

> The servo motors are coupled respectively to ***pulleys*** 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116 which in turn ***are coupled to tendon loops*** 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, i.e., one tendon loop per motor….Each robot arm is provided with three rotational joints 160, 164, 168 and three flexional joints 162, 166, 170, and the distal end of each robot arm is provided with a gripper 172. Thus, ***the fourteen tendon loops*** 120,

> 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, ***are each coupled to a respective one of the seven joints and the gripper on each arm***.

Ex. 1004, 6:62-7:9; *see also id*., Abstract ("***Tendons are coupled to the pulleys*** of the servo motors and are fed through the multi-lumen tube ***to the joints of the two arms***."), 3:21-27, 4:30-41 ("…Each arm has rotational and flexional joints corresponding to the shoulder, elbow, and wrist of the practitioner. ***Tendons are coupled to the pulleys*** of the servo motors and are fed through the multi-lumen tube ***to the joints of the two arms***."), 16:39-17:14; Ex. 1003, ¶172.

The pulleys and tendons drive the robot arm's joints' rotational and flexional movements. Ex. 1004, 5:16-19 (rotational and flexional joints are "pulley driven"), 7:60-63 ("[T]he servo system need not utilize rotary motors with ***pulleys and cables***, but may use other ***drive means***…."); Ex. 1003, ¶173.

Accordingly, Smith discloses "*a plurality of joints*" (*e.g.*, three rotational and three flexional joints on each robot arm) "*at least one of the joints being coupled to the end effector member*" (*e.g.*, each joint coupled to, for example, grippers), "*the joints being coupled to the plurality of movable engaging interface bodies by a plurality of drive members*" (*e.g.*, each joint coupled to pulleys in the pulley tray by tendons). Ex. 1003, ¶174.

(5) "the instrument being removably coupleable to the drive assembly when the instrument is operatively mounted to the surgical system so that the plurality of actuator bodies engage with corresponding ones of the plurality of interface bodies, and so that movement of the actuator bodies in response to operator inputs produces a corresponding movement of at least one of the joints"

Smith discloses "*the instrument being removably coupleable to the drive assembly when the instrument is operatively mounted to the surgical system so that the plurality of actuator bodies engage with corresponding ones of the plurality of interface bodies, and so that movement of the actuator bodies in response to operator inputs produces a corresponding movement of at least one of the joints*." Ex. 1003, ¶¶175-78.

Smith explains that "the end effectors may be interchanged during the course of a procedure by ***detaching the pulley 22, tray/multilumen tube/robot arms assembly from the servo motor arrays***." Ex. 1004, 19:1-5. In addition, "the encoder, the control circuit, and the servo motors are reusable [while] ***[t]he pulleys, tendons, multi-lumen tube and robot arms*** which will be in contact with human fluids, ***may be uncoupled from the servo motors*** and disposed of, if desired." Ex. 1004, 15:10-16. Accordingly, the pulley tray, multi-lumen tube, and robot arms with end effectors can be removed from the servo motor arrays. Ex. 1003, ¶175.

In addition, Smith's servo system is assembled by placing the pulley tray 402 on top of the lower servo motor array 406 "so that the splined shafts of the servo motors engage the shaft receiving bores of the pulleys," and placing upper servo motor array 404 on top of pulley tray 402 "so that the splined shafts of the servo motors engage the shaft receiving bores of the pulleys." Ex. 1004, 14:48-64; *see also id*., 8:39-43 ("The assistant couples the pulley tray 118 to the array of servo motors…."), 14:8-18. Accordingly, as explained above (Section V.A.2.d)), when the practitioner makes movements, the servo motors—and, therefore, the pulleys—rotate so that the robot arms' joints make movements that correspond to the practitioner's movements. *See, e.g.*, Ex. 1004, Abstract ("[T]he encoder encodes flexion and rotation at the shoulder, elbow and wrist of each arm in addition to gripping at each hand. The encoding device is coupled to a circuit which operates a servo system….The robotic instrument preferably comprises two arms mounted at the distal end of a multi-lumen tube. Each arm has rotational and flexional joints corresponding to the shoulder, elbow, and wrist of the practitioner. Tendons are coupled to the pulleys of the servo motors and are fed through the multi-lumen tube to the joints of the two arms."), 3:18-26 (explaining ***robotic arms are "operable by servo motors," "coupled to servo motors using tendons and pulleys," and "flexional and rotational through the movement of tendons"***), 4:8-12 ("The encoding device is coupled to a circuit which operates a servo system.

The ***servo system includes a series of servo motors to move to positions correlating to the potentiometer positions which correspond to the position of the arm of the practitioner wearing the encoder***.”), 6:62-7:9 (explaining servo motors are coupled to pulleys, which are coupled to tendon loops, which are coupled to a respective one of the seven joints and the gripper on each robot arm), 8:51-57 (“When ***the control circuit 14 is activated, movement of the practitioner's arms 34, 36, 38 is replicated in the robot arms 18***. When the practitioner grips one of the pistol grips 40, the gripper 172 on a corresponding robot arm 18 is closed. Thus, the tool 10 provides the practitioner 20 with a virtual presence of two arms and hands and vision at the surgical site.”); Ex. 1003, ¶¶176-77.

Accordingly, Smith discloses “*the instrument*” (*e.g.*, pulley tray, multi-lumen tube, robot arms with end effectors assembly) “*being removably coupleable to the drive assembly when the instrument is operatively mounted to the surgical system*” (*e.g.*, the assembly capable of being decoupled from the servo motor arrays of the surgical system for disposal or to switch end effectors) “*so that the plurality of actuator bodies engage with corresponding ones of the plurality of interface bodies*” (*e.g.*, the plurality of servo motors engage with corresponding plurality of pulleys), “*and so that movement of the actuator bodies in response to operator inputs produces a corresponding movement of at least one of the joints*” (*e.g.*, practitioner’s movements cause servo motors to make movements, which causes the joints in the robot arms to replicate the practitioner's movements). Ex. 1003, ¶178.

VI. CONCLUSION

For the foregoing reasons, Petitioner respectfully asks the Board to initiate *inter partes* review and find claims 1, 7, 8, 11, 16, and 25 of the '701 patent to be unpatentable.

Dated: August 29, 2019

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CERTIFICATION OF WORD COUNT (37 C.F.R. § 42.24)

I hereby certify that this Petition for *Inter Partes* Review has 13,856 words (as counted by the "Word Count" feature of the Microsoft Word™ word-processing system), exclusive of "a table of contents, a table of authorities, mandatory notices under § 42.8, a certificate of service or word count, or appendix of exhibits or claim listing."

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CERTIFICATE OF SERVICE (37 C.F.R. § 42.6(e)(4))

I hereby certify that the attached Petition for *Inter Partes* Review and supporting materials were served as of the below date by Federal Express on the Patent Owner at the correspondence address indicated for U.S. Patent No. 6,491,701.

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