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. 8,142,447

Inter Partes Review No. IPR2019-01533

Petition for *Inter Partes* Review of U.S. Patent No. 8,142,447

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EXHIBIT LIST

Exhibit #	Exhibit Description
1001	U.S. Patent No. 8,142,447 to Cooper et al.
1002	Prosecution History of U.S. Patent No. 8,142,447
1003	Declaration of William Cimino, Ph.D.
1004	U.S. Patent No. 5,624,398 to Smith et al.
1005	U.S. Patent No. 5,824,007 to Faraz et al.
1006	"Hybrid Position/Force Control for Coordination of a Two-Arm Robot" by Uchiyama et al, 1987 IEEE International Conference on Robotics and Automation, pp. 1242-47, IEEE 1987
1007	European Patent App. Pub. No. 0688538A1 to Viola et al.
1008	U.S. Patent No. 7,118,582 to Wang et al.
1009	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.)
1010	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. 8,142,447 ("the '447 patent" or "the '447" (Ex.1001)) is related to the following U.S. patents and applications:

- U.S. 6,331,181
- U.S. 6,491,701
- U.S. 7,048,745
- U.S. 7,524,320
- U.S. 8,758,352
- U.S. Provisional Application No. 60/111,713
- U.S. Provisional Application No. 60/116,844
- U.S. Application No. 14/065,869

Petitioner is concurrently filing an *inter partes review* ("IPR") petition on U.S. 8,491,701 in IPR No. IPR2019-01532.

2. Related Litigation

The ’447 patent and U.S. Patent No. 6,491,701 (“the ’701 patent”) have been asserted in the following litigation:

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

U.S. Patent No. 7,048,745 was asserted in the following litigation:

- *Intuitive Surgical, Inc. v. Vital Care Reps, Inc.*, Action No. 06-cv-06971 (N.D. Cal.)

3. Patent Office Proceedings

The ’447 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]

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

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.

I. INTRODUCTION

The ’447 patent is directed to well-known methods for performing surgery on a patient using a robotically controlled surgical instrument. The surgical instrument comprises a proximal portion containing a number of movable or rotatable bodies and a distal portion with an end effector. The instrument couples to a drive assembly on a robotic arm containing a set of actuators or driving elements. In operation, the drive assembly rotates or otherwise manipulates the actuators/driving elements, which in turn rotate or otherwise manipulate the movable/rotatable bodies in the surgical instrument. Through a set of drive members connected to the movable/rotatable bodies, the actuator/driving elements in the drive assembly can control the end effector.

During prosecution, the Examiner differentiated the ’447 claims from the prior art because the “claims require engagable rotatable bodies ***between the instrument and the drive assembly*** of the robotic arm.” Ex.1002, 1338-39.[2] This method for performing surgery, however, was well known before the priority date of the ’447. For example, a near identical device was earlier described in U.S. Patent No. 5,624,398 (“Smith” (Ex.1004)). Smith discloses end effectors “coupled to servo motors using tendons and pulleys.” Ex.1004, 3:21-23. The end effectors are “operable by servo motors” and “controlled by an encoder worn by a surgeon.”

[2] All emphasis added unless otherwise noted.

Ex.1004, 3:18-20, 3:34-36. Smith further describes engagable rotatable bodies between the instrument and the drive assembly. *See*, *e.g.*, Ex.1004, 14:48-49.

Further, robotic arms were not new and have been developed and used since at least the 1970s. *See*, *e.g.*, Ex.1006, 1242. A device similar to the claimed robotic arm was earlier described in numerous references. For example, U.S. Patent No. 5,824,007 ("Faraz" (Ex.1005)) describes a motorized or actuated surgical stand that contains an instrument holder. Ex.1005, 2:56-3:50, 6:23-29.

Smith discloses or renders obvious all of the elements of claims 1-5 (the "Challenged Claims"). To the extent Smith does not teach every limitation of the Challenged Claims, the claims would have been obvious to a person of ordinary skill in the art ("POSA") based on Smith in view of Faraz. Accordingly, Petitioner respectfully requests that the Board institute *inter partes* review of claims 1-5 of the '447.

II. REGULATORY INFORMATION

A. Certification that Petitioner May Contest the '447 (§42.104(a))

Petitioner certifies that the '447 is available for IPR, and that Petitioner is not barred or estopped from requesting an IPR of the '447 claims. Neither Petitioner, nor any party in privity with Petitioner, has filed a civil action challenging the validity of any claim of the '447. The '447 has not been the subject of a prior IPR by Petitioner or a privy of Petitioner.

Petitioner also 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 ’447. *See* 35 U.S.C. §315(b); Ex.1010.

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

Claims 1-5 are unpatentable based on the following art and grounds.

Prior Art Reference	Abbreviation
U.S. Patent No. 5,624,398 to Smith et al.	“Smith” (Ex.1004)
U.S. Patent No. 5,824,007 to Faraz et al.	“Faraz” (Ex.1005)

Ground	35 U.S.C. §	Claims	Prior Art Reference(s)
1	103(a)	1-5	Smith and Faraz

Petitioner’s positions are supported by the Declaration of William Cimino (Ex.1003), an expert in robotic surgical systems who has over 25 years of experience in the field. Ex.1003, ¶¶4-5.

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

The Director is authorized to charge the fee specified by 37 C.F.R. §42.15(a) to Deposit Account No. 50-1597.

III. BACKGROUND

A. Background Technology

By December 1998, robotic surgical systems were known in the art. Ex.1001, 1:37-39; Ex.1004, Abstract. As illustrated below, in robotically assisted surgery, the surgeon operates a master controller to remotely control the motion of surgical instruments that emulate the movements of human arms and hands. Ex.1001, 1:42-44; Ex.1004, 1:60-64.

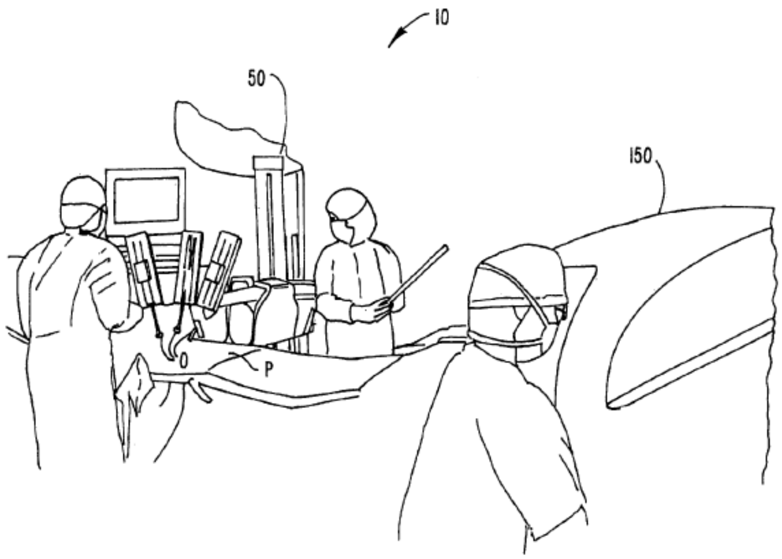
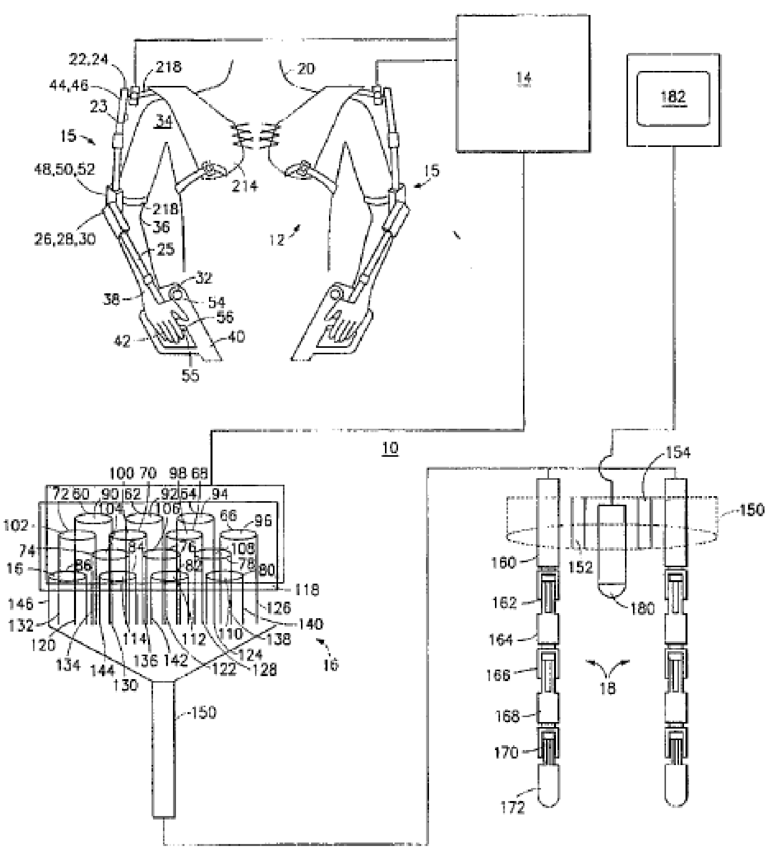


FIG. 1.



This controller will typically include one or more hand input devices such as joysticks, exoskeletal gloves and sleeves, and master manipulators. Ex.1001, 1:49-51; Ex.1004, 1:64-66. The input devices are coupled to the surgical instrument by a servomechanism and can control the surgical instrument based on the surgeon's manipulation of the input device. Ex.1001, 1:53-55; Ex.1004, 1:66-2:12.

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.1007, 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.1008, 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."). In addition, using servo motors to engage and move pulleys was known. Ex.1004, 4:16-29.

B. Summary of the '447 Patent

The '447 is directed to a robotic surgical system that purports to improve techniques for switching tools during a procedure. Ex.1001, 1:37-41, 2:51-53. According to the '447, the introduction of more and more different surgical tools that can be used with a robotic system created certain challenges. Ex.1001, 2:34-

49; *see also id*., 2:12-15. 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, 2:34-38. 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, 2:43-49. Accordingly, the '447 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, 2:63-3:26.

The Challenged Claims are directed to the former alleged improvement. As illustrated by Figure 4 below (annotated), the '447 patent describes a tool 54 that includes a proximal housing 108 (in red), a 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:

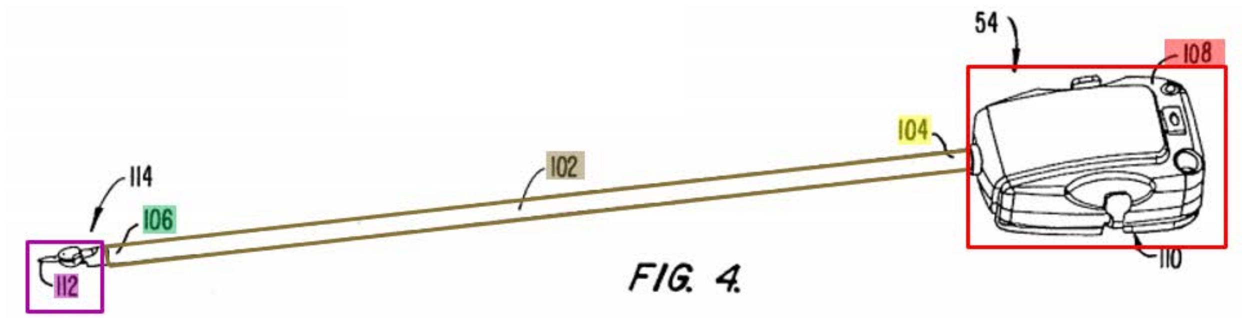


FIG. 4.

Ex.1001, 4:20-25, Fig. 4.

The proximal housing includes an interface 110 with a number of driven elements 118 (in red) that mechanically couple the end effector to a drive assembly.

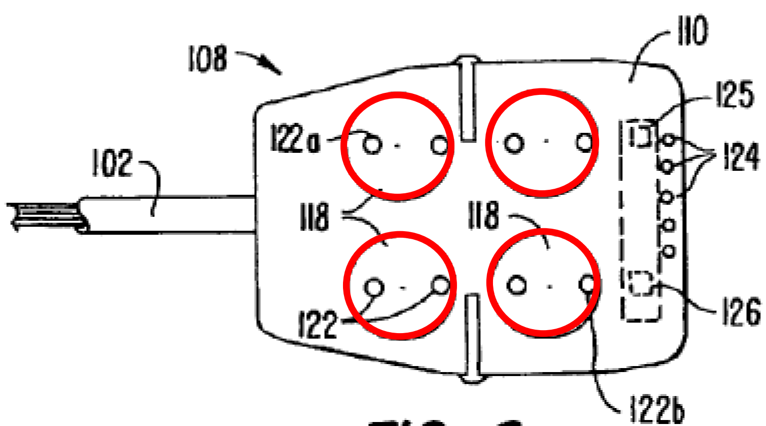


FIG. 6.

The interface can be releasably coupled with an instrument holder on a robotic manipulator arm as shown Figures 2A and 14C (annotated below). Ex.1001, 3:29-36. The holder contains rotatable bodies (in green box) configured to accurately align the driven elements of the instrument with driving elements in the holder. Ex.1001, 11:6-9.

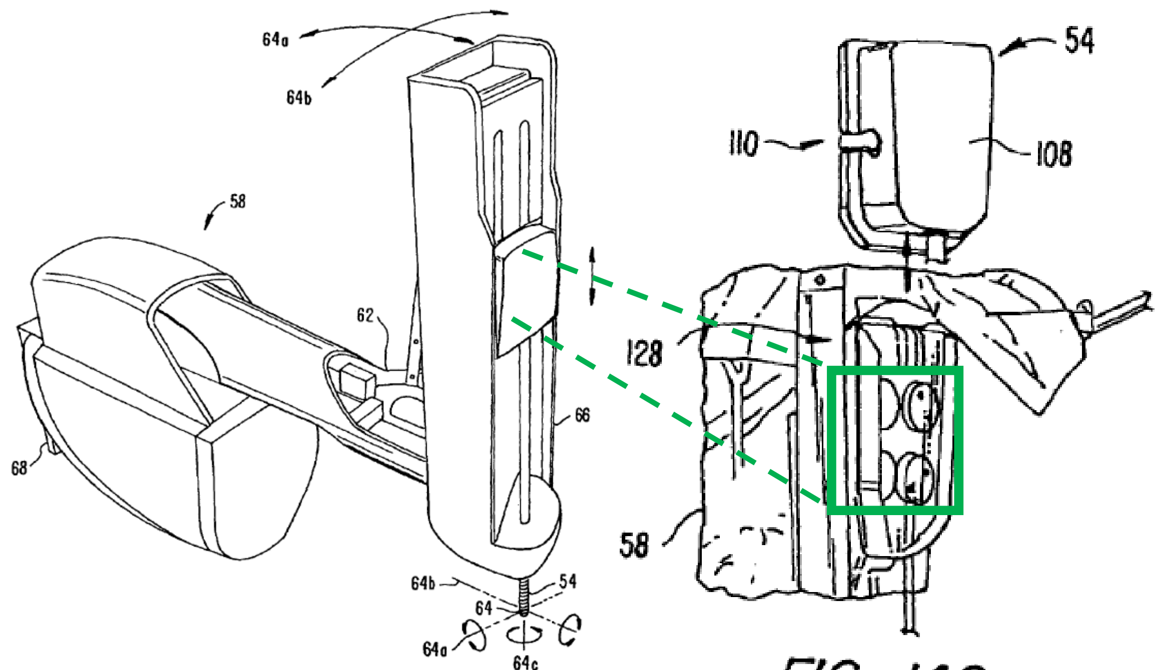


FIG. 2A.

FIG. 14C.

In operation, the driving elements of the probe holder couple with the driven elements of the instrument and, when angularly displaced, can manipulate the end effector via a set of cables connecting the driven elements to the end effector. Ex.1001, Ex.1001, 4:52-57 ("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.*, 18:6-29. In this manner, the end effector can rotate about fixed axes, such as axes A1 (in red), A2 (in green), and A3 (in blue) in Figure 5A:

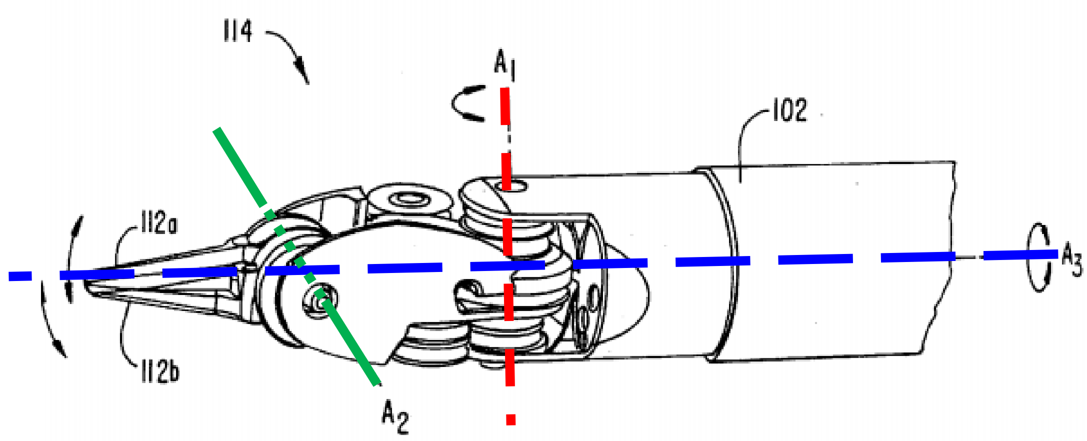


FIG. 5A.

Ex.1001, 9:24-37, Fig. 5A; *see also id*., 5:23-26, Fig. 4A.

C. Prosecution History

The ’447 issued from Application No. 12/407,150 filed on March 19, 2009. The Examiner allowed the claims on July 22, 2011 without any office actions. Ex.1002, 1332. The Examiner found that the prior art did not disclose engagable rotatable bodies between the instrument and the drive assembly of the robotic arm:

> The claims require ***engagable rotatable bodies between the instrument and the drive assembly of the robotic arm, the location and manner in which the movably rotating bodies engage was not found in the prior art***. Closest prior art patents use pulley systems within the surgical robots for movement, wherein each pulley may be considered a movable or rotatable body, however were not found to position the bodies in the manner claimed within the system.

Ex.1002, 1338-39.

Concurrent with allowance, the Examiner amended the claims as follows:

Claim No.	**Original Language**	**Examiner's Amendment**
1	"said distal joint"	"said at least one distal joint"
1	"said drive member"	"said at least one drive member"
1	"the operation"	"operation"
2	"the surgical instrument"	"the instrument"
5	"the at least one end"	"the at least one distal end"

On October 21, 2011, the applicants filed a request for continued examination to identify additional prior art and also to request that the Examiner update (1) the "brief description of the drawings…to reference FIGs. 7F and 7M" and (2) the claims and specification "to reflect the Examiner's amendments as noted in the Notice of Allowability of July 22, 2011." Ex.1002, 1600-02.

On November 10, 2011, the Examiner again allowed the claims citing the same reasoning as the July 22, 2011 Notice of Allowability. Ex.1002, 1849.

D. Person of Ordinary Skill in the Art

A 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 one of ordinary skill in the art 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; *see also 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.

Auris 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" (Claims 1, 2 and 5)

Consistent with the intrinsic evidence, the term "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.[3] The '447 specification describes "end effector" as "for ***grasping tissues*** in the jaws of a forceps or the like." Ex.1001, 8:11-14. In addition, the examples of end effectors that the '447 provides are all instruments that manipulate tissue. *See*, *e.g.*, Ex.1001, 9:52-56 (end effector examples include, "Potts scissor" and "15 degree scalpel"), 10:4-16 (end effector examples include "DeBakey forceps," "microforceps," "Potts scissors," "clip applier," "scalpel," and "electrocautery probe"), Figs. 4, 5A-5H.

B. "angularly displaceable about at least two axes" (claim 2)

The claim term "angularly displaceable about at least two axes" should be interpreted as rotatable about at least two fixed axes.[4] The '447 specification does not use the term "angularly displaceable." The specification does, however, equate angular movement to rotational movement. *See*, *e.g.*, Ex.1001, 10:62-11:1

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[3] In the district court litigation, the Patent Owner ("PO") proposed construing "end effector" more broadly as "device at the end of an instrument, designed to interact with the environment." Ex.1009, 2.

[4] In the district court litigation, PO proposed that the plain and ordinary meaning of "angularly displaceable about at least two axes" should apply. Ex.1009, 3.

(“Rotatable 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 ’447 describes that movement as rotational about fixed axes. *See, e.g.*, Ex.1001, 7:58-62 (“The parallelogram arrangement constrains ***rotation to pivoting about an axis 64a***….[T]ool 54 further ***rotates about an axis 64b***….”), 8:8-11 (“Motors 70 are further coupled to tool 54 so as to ***rotate the tool about axis 66***….”), 9:33-37 (“[D]riven elements 118 can effect ***rotation of the end effector about the axis of shaft 102 (A3)***….”); *see also id*., 9:20-48, 9:52-64.

C. “joint(s)” (claims 1 and 5)

Consistent with the intrinsic evidence, the term “joint(s)” should be interpreted as parts connecting two structures that allows movement.[5] The ’447 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***.”), 7:53-57 (“linkage 62 includes rigid links ***coupled together by rotational joints*** in a parallelogram arrangement”), 9:20-23 (“A surgical end effector 112 is coupled to shaft 102 ***by a wrist joint 114***….”). Moreover, the ’447 explains that joints allow

[5] In the district court litigation, the PO proposed that the plain and ordinary meaning of “joint(s)” should apply. Ex.1009, 4.

movement. *See*, *e.g.*, Ex.1001, 7:53-57 ("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***"), 8:27-33 ("***[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."), 8:46-50 ("[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***."), 9:20-23 ("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***.").

D. Agreed Constructions

In the district court litigation, the parties agreed to the following constructions for claim 3:

Claim Term	**Agreed Construction**
"moves the movable port on disposed"	"moves the movable portion disposed"
"coupling an instrument o a drive assembly"	"coupling an instrument to a drive assembly"
"wherein rotating the first plurality of rotatable bodies moves the movable port on disposed at the distal portion"	"wherein rotating the first plurality of rotatable bodies moves the movable portion disposed at the distal portion"

V. ANALYSIS OF THE PATENTABILITY OF THE CLAIMS

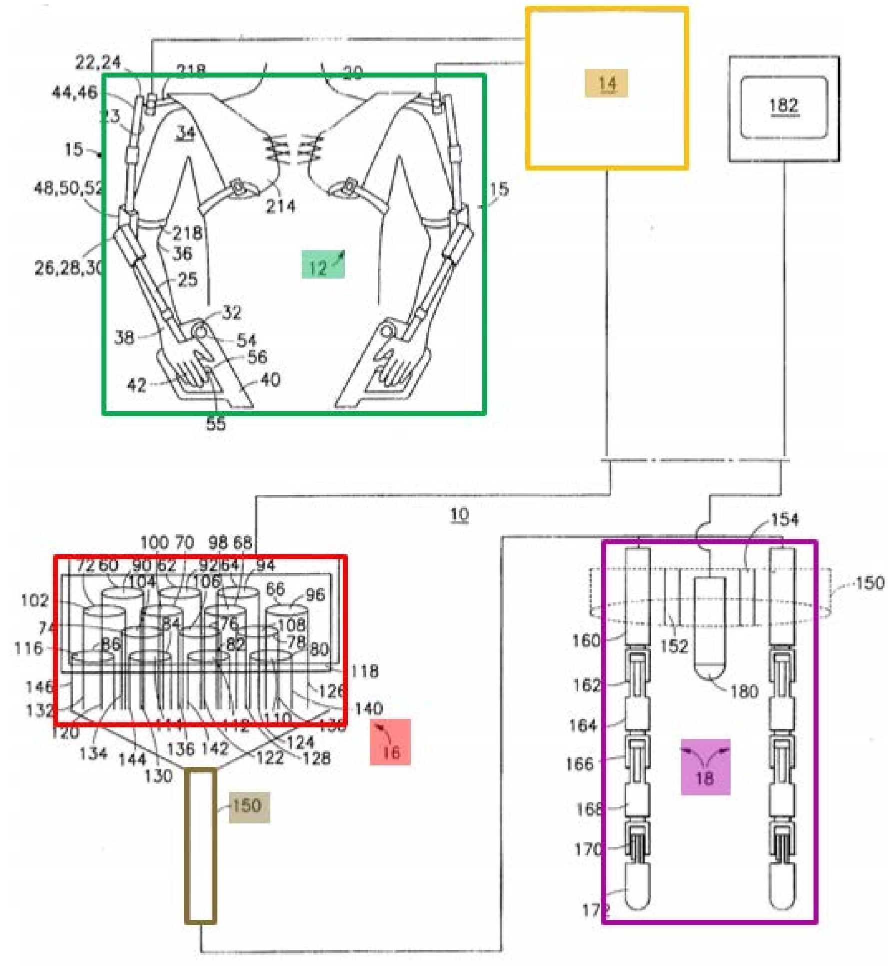
A. Ground 1: Obviousness Based on Smith and Faraz

1. Summary of Smith

Smith was filed on February 8, 1996 and issued on April 29, 1997, which is more than one year before December 8, 1998—the ’447’s earliest claimed priority date. Smith is therefore prior art under at least pre-AIA 35 U.S.C. §102(b).

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 instrument arms 18 (in purple) at the distal end of a multi-lumen tube 150.[6] Ex.1004, 6:46-7:2, Fig. 1; *see also id.*, Abstract, 3:60-63.

[6] Smith uses the terms “robot/robotic arm(s)” to describe a pair of distally mounted remote arms to which end effectors are attached. Ex.1004, 6:67-7:6. Because the ’447 uses the term “robotic manipulator arm” and “robotic arm” to describe support structures to which the surgical instrument can be coupled (*see, e.g.*, Ex.1001, 6:35-51), this Petition refers to Smith’s “robot/robotic arm(s)” as “instrument arm(s).”



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 instrument arm. Ex.1004, 4:40-41, 18:59-65.

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, 6:59-64, 7:31-36. As shown in Figure 22 (annotated below), the pulleys are arranged in a tray (in yellow) and are detachably connected to the 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.

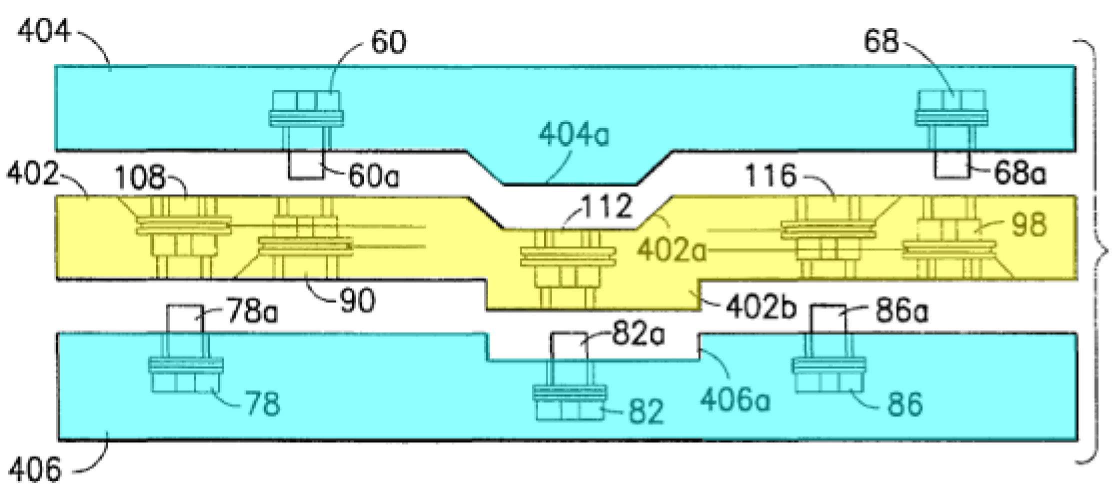


FIG. 22

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 instrument arms 18 (in purple) on the opposed end of the tube:

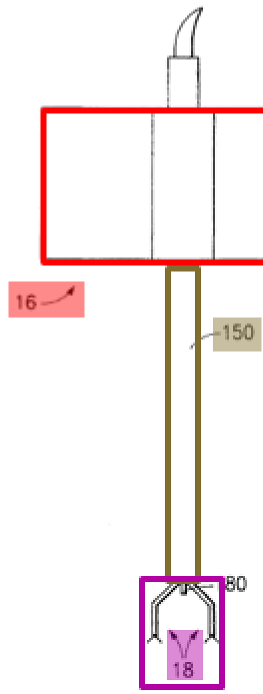


FIG. 23

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 instrument arms. Ex.1004, 6:67-7:2.

Each of the instrument arms has three rotational joints, 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 instrument arm. Ex.1004, 7:3-9. Smith's arrangement accordingly allows movement of the practitioner's arms to be replicated in the instrument arms. Ex.1004, 8:51-57.

Like the '447 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/[instrument] arms assembly from the servo motor arrays."). Accordingly, in Smith's system, different types of instrument arms (*e.g.*, arms with grippers, cutters, etc.) 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 [instrument] arms can be used with the same encoder during a single endoscopic procedure." Ex.1004, 15:21-25; *see also id*., 19:1-5.

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. 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 instrument arms—may be disposed of. Ex.1004, 15:12-16.

2. Summary of Faraz

Faraz was filed on December 3, 1996 and issued on October 20, 1998. Faraz is therefore prior art under at least pre-AIA 35 U.S.C. §102(e).[7]

Faraz is directed to an adjustable surgical stand. Ex.1005, Abstract. Figure 1, reproduced below, depicts the stand, which includes a base 12, a pillar 14, an arm support 16 that can be moved vertically by a power assisted drive, two or more arms 22 with segments 22A connected by two or more joints 30, an implement holding wrist 24, and an implement holder 26 that holds surgical implements 28 in proximity to a patient P. Ex.1005, 2:56-3:50.

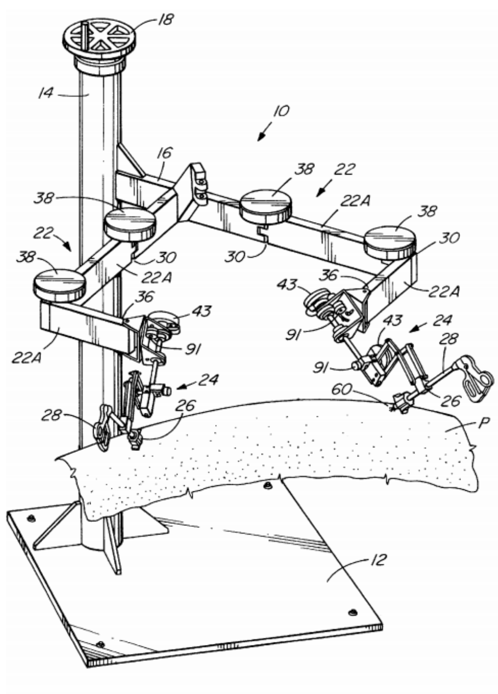


FIG. 1

[7] The '447's earliest effective priority date is December 8, 1998, over a year after Faraz was filed.

Faraz describes during use, the "brakes or 'locks' on arms 22 are released and arms 22 are positioned so that the fixed points 60 of wrists 24 coincide with incisions in the patient being operated on." Ex.1005, 6:8-12. "Surgical implements 28 may be slid into implement holder 26 and into the body of patient P." Ex.1005, 6:14-15. Surgical implements 28 then can be manipulated in three independent directions, and can be locked in place in any or all of the directions. Ex.1005, 6:15-22.

Faraz teaches that its stand "is well adapted for use as a basis for a robotic surgery device" and can be used either "as a passive positioning stand" or as an active stand with an actuated joint controlled by a controller. Ex.1005, 3:41-52, 6:23-24. "The position of a surgical implement 28 can be readily monitored by affixing angular position sensors 91 to each of joints 30, member 40, and at least one of the pivot points of [stand 10]. Furthermore, motors or other actuators could be connected using known means to drive and control the motion of any or all of the joints in stand 10." Ex.1005, 6:23-29.

3. A POSA Would Have Considered Smith and Faraz Together

Smith teaches a robotic surgical system in which a servo motor and pulley assembly of a surgical instrument can be "supported by an adjustable clamping means connected to an operating table or other support." Ex.1004, 8:46-48. Faraz is one reference that describes a type of "other support" to which Smith's surgical instrument may be clamped. Ex.1003, ¶¶82-84. Faraz describes an "adjustable surgical stand" that is "well adapted for use as a basis for a robotic surgery device." Ex.1005, 6:23-24. The basic structure of Faraz's system has many features similar to Smith. Ex.1003, ¶83. Both describe support structures for holding surgical instruments, both teach the use of position sensors for sensing the position of joints and both were developed and filed as U.S. Patent applications in the mid-to-late 1990s. *Id*.

A POSA following his/her ordinary design process would have considered and evaluated techniques used in analogous systems that could improve the performance of the system the POSA was trying to design. Ex.1003, ¶84. A POSA considering Smith would have looked to other references such as Faraz that provide more detail about the types of supports to which a surgical instrument may be adjustably clamped. *Id*. When implementing these features of Smith, the POSA would have refined the features based on Faraz's implementation of analogous features. *Id*. Particularly given the nature of robotics as a field where practitioners successfully modify and adapt robots using known components and concepts, it would have been a routine engineering task for a POSA to adapt Faraz's motorized or actuated robotic arm for use in Smith. *Id*

4. Claims 1-5 Are Obvious in View of Smith and Faraz

As set forth below, Smith and Faraz render all elements in claims 1-5 obvious. Smith teaches most limitations, and Faraz provides additional details on the motorized/actuated robotic arm.

a) Claim 1

(1) "A method for performing robotic surgery on a patient, the method comprising"

To the extent the preamble is limiting, Smith discloses this limitation. Ex.1003, ¶¶86-88. Smith describes "methods and devices" for performing robotic surgery on a patient. *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. As explained by Smith, 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. Smith discloses a surgical instrument "compris[ing] two arms mounted at the distal end of a multi-lumen tube." Ex.1004, Abstract. This "surgical instrument is inserted through [a trocar] for purposes of manipulating and/or cutting [an] internal organ." Ex.1004, 1:16-19.

(2) "coupling a surgical instrument to a robotic surgical system"

Smith discloses this limitation. Ex.1003, ¶¶89-95. As illustrated in Figure 23 (annotated below), Smith discloses a surgical instrument comprising a pulley tray located on the proximal end (in red), a multi-lumen tube (in brown), and end effectors on the distal end (in purple) (Ex.1004, 6:17-18):

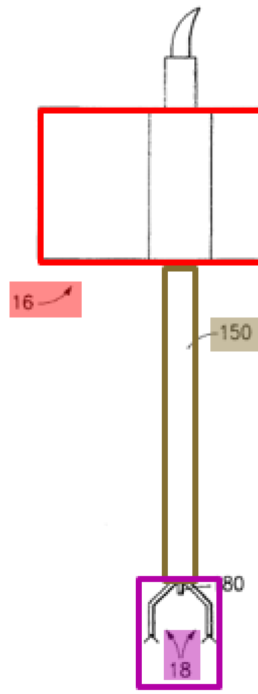


FIG. 23

As discussed above (§V.A.1), Smith describes a robotic surgical system that includes "an exoskeleton encoder 12, a control circuit 14, [and] a servo system 16…." Ex.1004, 6:46-49. Servo system 16 includes "a disposable aluminum or injection molded plastic tray…and an upper and lower array of servo motors…." Ex.1004, 14:8-11. These servo motors allow the instrument to be coupled to the remainder of the surgical system. Ex.1004 15:10-16 ("The encoder, the control circuit, and the servo motors are reusable [while] [t]he pulleys, tendons, multi-lumen tube and [instrument] arms which will be in contact with human fluids, may be uncoupled from the servo motors and disposed of, if desired."), 19:1-5 ("[E]nd effectors may be interchanged during the course of a procedure by detaching the pulley 22, tray/multilumen tube/[instrument] arms assembly from the servo motor arrays.”).

The proximal end of the instrument contains a single tray-like housing in which a “series of pulleys corresponding to the number of servo motors are arranged.” Ex.1004, 4:16-17. “Each pulley is provided with a self-aligning socket designed to mate with a corresponding servo motor shaft. All of the pulleys are mounted on all of the shafts simultaneously and quickly by coupling the tray-like housing to the servo motor housing.” Ex.1004, 4:17-22. As illustrated in Figure 22 (annotated below), “[t]he pulley tray [(in yellow)] 402 is engaged by two servo motor arrays 404, 406.” Ex.1004, 14:48-49.

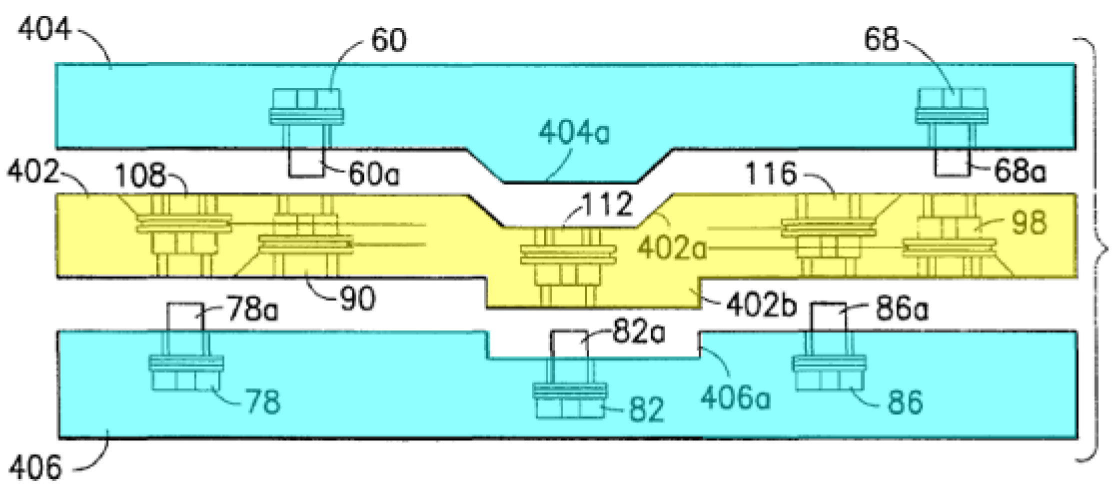


FIG. 22

These servo motors are can “move [the end effectors] to positions correlating to the potentiometer positions which correspond to the position of the arm of the practitioner wearing the encoder." Ex.1004, 4:9-12. Smith further discloses that the encoding device worn by the surgeon "is coupled to a circuit which operates a servo system." Ex.1004, 4:8-9.

Thus, Smith discloses "*coupling a surgical instrument*" (*e.g.*, coupling pulley tray, multilumen tube and instrument arms) "*to a robotic surgical system*" (*e.g.*, servo system, encoder and control circuit). Ex.1003, ¶¶89-95.

(3) "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"

Smith discloses this limitation. Ex.1003, ¶¶96-99. As discussed above (§V.A.4.a.2), Smith discloses a surgical system comprising "an exoskeleton encoder 12, a control circuit 14 [and] a servo system 16…." Ex.1004, 6:46-49. Exoskeletal encoder 12 is worn by the practitioner and has rotational and flexional joints for the practitioner's shoulders, elbows, and wrists, along with a pistol grip for the hands. Ex.1004, 6:49-55. The encoder has transducers that register the practitioner's movements which are then conveyed to a control circuit (*control unit*) "which in turn provides outputs to an array of fourteen servo motors…" Ex.1004, 6:59-64; *see also id.*, 7:31-36. The servo motor array (*drive assembly*) has an upper servo motor array with seven servo motors (*actuator bodies*) and a lower servo motor array also having seven servo motors (*actuator bodies*). Ex.1004, 14:48-56.

The servo motors respond, via the control circuit, to movements of the encoder. *See*, *e.g.*, Ex.1004, Abstract ("The encoding device is coupled to a circuit which operates a servo system."), 2:4-7 ("signals generated by the encoder are then transmitted to a[n instrument] arm which responds to the signals from the encoder…The [instrument] arm is usually moved by servo motors…"), 4:8-10 ("The encoding device is coupled to a circuit which operates a servo system."), 6:55-62 ("[S]even transducers…are provided in each arm of the encoder to register [movements]. The transducers are coupled to a control circuit 14 which in turn provides outputs to an array of fourteen servo motors….").

Accordingly, Smith discloses a surgical system having "*a drive assembly*" (*e.g.*, the servo motor array) "*operatively coupled to a control circuit operable by inputs from an operator*" (*e.g.*, control circuit 14), the drive assembly having "*a plurality of actuator bodies which are movable in response to operator inputs*" (*e.g.*, servo motors which respond to signals from the encoder). Ex.1003, ¶¶96-99.

(4) "the surgical instrument comprising: aproximal [sic] portion and a distal portion, the proximal portion comprising a first plurality of movable engaging interface bodies"

Smith discloses this limitation. Ex.1003, ¶¶100-05. For example, Smith discloses a pulley tray containing 14 pulleys on the proximal side of the multi-lumen tube and instrument 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*** [instrument] ***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*** [instrument] ***arms***…."), 8:5-7, 18:59-67, 20:23-24.

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

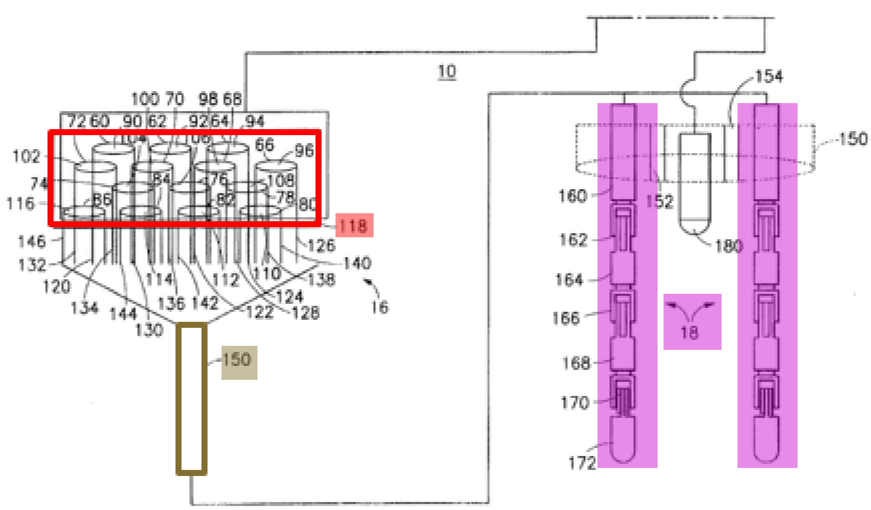


FIG. 1B

Ex.1004, Fig. 1B, 6:62-7:2.

Figure 23 likewise shows pulley tray (as part of servo system 16) (in red) on the proximal portion of the multi-lumen tube 150 (in brown) and the instrument arms and mounted end effectors (in purple) on the distal end of the multi-lumen tube:

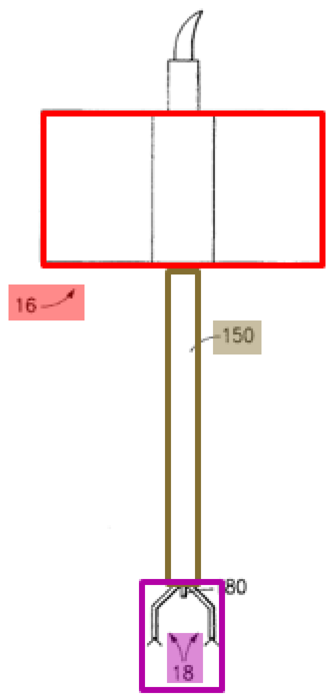


FIG. 23

Ex.1004, Fig. 23, 14:64-67.

As explained above (§V.A.4.a.2), the 14 pulleys in the pulley tray each engage and, therefore, interface with its respective servo motor. *See* Ex.1004, 14:48-64 ("the splined shafts of the servo motors ***engage*** the shaft receiving bores of the pulleys"), 8:39-43 ("The assistant couples the pulley tray 118 to the array of servo motors….”), 14:8-18. Smith’s pulleys rotate when the engaged servo motors rotate and are, thus, movable. Ex.1004, 4:12-15 (servo motors have “rotational shaft[s]” and the “rotational axes of their shafts [are] parallel”), 7:60-63, 16:1-4 (“rotations of the servo motor”).

Accordingly, Smith discloses a “*surgical instrument*” (*e.g.*, pulley tray 118, multi-lumen tube 150 and instrument arms 18) comprising “*a proximal portion*” (*e.g.*, the pulley tray) “*and a distal portion*” (*e.g.*, instrument 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, ¶¶100-05.

(5) “at least one distal end effector member”

Smith discloses this limitation. Ex.1003, ¶¶106-10. For example, Smith explains that instrument arms are mounted at the distal end of a multi-lumen tube and that end effectors (*e.g.*, grippers, cutters, dissectors, bioptomes) are “mounted at the distal end of the [instrument] 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*** [instrument] ***arms*** to provide a limited hand movement.”), 8:5-7 (“The ***grippers at the end of the*** [instrument] ***arms may be cutters or other types of end effectors*** and the [instrument] arms may be provided with removable, replaceable ***end***

effectors.”), 18:59-67 (“While the [instrument] 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.

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 (§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 instrument 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 [instrument] arms may be cutters or other types of end effectors”), 18:59-67; Ex.1003, ¶107. Accordingly, Smith discloses “*end effectors*” under Petitioner’s proposed construction. Ex.1003, ¶¶107-08.

Because Smith discloses "*end effectors*" under Petitioner's proposed construction, it also discloses "*end effectors*" under PO's broader construction—"device at the end of an instrument, designed to interact with the environment." Ex.1003, ¶109. 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, ¶109.

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 instrument arms). Ex.1003, ¶106-10.

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

Smith discloses this limitation. Ex.1003, ¶¶111-17. For example, Smith discloses that each of its instrument arms has three rotational joints and three flexional joints:

> Each [instrument] 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 (§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. For example, Smith explains that the three rotational joints and three flexional joints in the instrument 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:

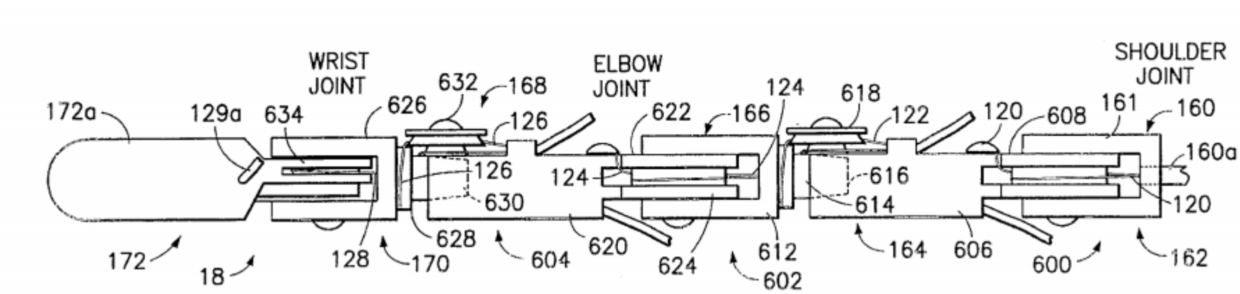


FIG. 25

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 joint of the instrument arms is coupled to the distally mounted end effector (*e.g.*, grippers). 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 [instrument] arms…."), 8:5-7 ("The grippers at the end of the [instrument] arms may be cutters or other types of end effectors and the [instrument] arms may be provided with removable, replaceable end effectors."), 16:10-15 ("Each [instrument] 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.

Each of the joints in the instrument arms is coupled to a pulley in the pulley tray by tendons:

> The servo motors are coupled respectively to ***pulleys***…which in turn ***are coupled to tendon loops***…i.e., one tendon loop per motor….Each [instrument] arm is provided with three rotational joints 160, 164, 168 and three flexional joints 162, 166, 170, and the distal end of each [instrument] arm is provided with a gripper 172. Thus, ***the 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; *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, 16:39-17:14.

The pulleys and tendons drive the rotational and flexional movement of the instrument arms' joints. 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***….").

Accordingly, Smith discloses "*a plurality of joints*" (*e.g.*, three rotational and three flexional joints on each instrument 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, ¶¶111-17.

(7) "the method further comprising: coupling the movable engaging interface bodies to the plurality of actuator bodies"

Smith discloses this limitation. Ex.1003, ¶¶118-28. As discussed above (§V.A.4.a.2), Smith discloses a pulley tray containing 14 pulleys on the proximal side of the multi-lumen tube and instrument arms with grippers (or other end effectors) on the distal end of the multi-lumen tube. Ex.1004, 6:62-64 ("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…."), 7:26-30 ("The ***pulleys…are preferably arranged in a tray 118*** which is detachable from the array of servo motors…."). Smith further describes that these pulleys are coupled to "*the plurality of actuator bodies*" as explained above in §V.A.4.a.2. Ex.1003, ¶¶93-94. Smith explains that each of these pulleys engages with a corresponding servo motor:

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

Ex.1004, 4:12-20; *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*** [in green] ***engage the shaft receiving bores of the pulleys*** [in red]," and placing upper servo motor array 404 on top of pulley tray 402 "so that the ***splined shafts of the servo motors*** [in green] ***engage the shaft receiving bores of the pulleys*** [in red]" (Ex.1004, 14:48-64):

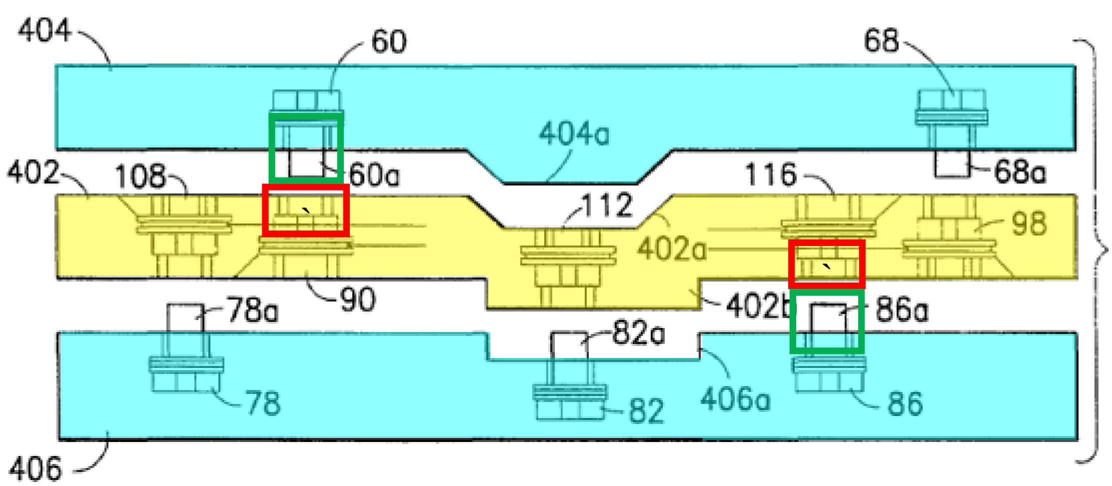


FIG. 22

Ex.1004, Fig. 22.

Accordingly, Smith discloses "*coupling the movable engaging interface bodies*" (*e.g.*, engaging pulleys when the servo motors rotate) "*to the plurality of actuator bodies*" (*e.g.*, servo motors). Ex.1003, ¶¶118-28.

(8) "moving a robotic manipulator arm supporting the instrument in at least one degree of freedom"

Smith renders this limitation obvious in light of Faraz. Ex.1003, ¶¶129-31. As explained above (§V.A.4.a.2), Smith discloses a servo system comprising a pulley tray coupled to a servo motor tray. Ex.1004, 14:8-18; *see also id.*, 4:16-17, 7:26-31. Smith describes that "[t]he 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 [instrument] arms." Ex.1004, 8:43-46. "The servo motor tray ***may be supported by an adjustable clamping means connected to the operating table or other support***." Ex.1004, 8:46-48.

Although Smith does not expressly disclose a "*robotic manipulator arm supporting the instrument in at least one degree of freedom*," a POSA would have found this limitation obvious in light of numerous other references including Faraz. Ex.1003, ¶125; *see also* Ex.1005, 3:44-50, 6:23-29; *see also* Ex.1008, 2:42-52, 3:12-19, 5:20-36. Faraz describes "a stand for assisting a surgeon by holding surgical implements, such as endoscopes, remote manipulators, suturing devices and the like during surgery." Ex.1005, 1:5-7. Faraz's stand "is well adapted for use as a basis for a robotic surgery device" and contains "a surgical instrument holder." Ex.1005, 1:62-7:1, 6:23-24; *see also id.*, 3:12-26. "The position of a surgical [instrument] can be readily monitored by affixing angular position sensors" to a number of joints. Ex.1005, 6:24-27. "Furthermore, motors or other actuators could be connected using known means to drive and control the motion of any or all of the joints in the stand 10." Ex.1005, 6:27-29; *see also id*., 7:33-36.

Smith discloses that during a procedure, an assistant first "incises the patient…with a trocar," "couples the pulley tray…to the array of servo motors…and locates the [instrument] arms 18 in the vicinity of the surgical site." Ex.1004, 8:36-43. Further, Smith states that "[t]he practitioner…may direct the assistant to relocate the [instrument] arms" when necessary. Ex.1004, 8:48-50; *see also id*, 9:6-10. A POSA at the time would have understood that an actuated robotic manipulator arm, such as the arm described by Faraz, would reduce the number of assistants necessary during a procedure and/or reduce the workload of those assistants. Ex.1003, ¶126; *see also* Ex.1005, 6:34-36 ("A support stand, as described, may enable a surgeon to perform surgery with fewer assistants than would be required for the same surgery without such a stand."). Accordingly, a POSA considering Smith's disclosure that "[t]he servo motor tray may be supported by an adjustable clamping means connected to the operating table or other support" would have looked for "other support[s]" that would reduce the number and/or workload of assistants in the operating room. Ex.1003, ¶126.

A POSA considering Smith would have understood that Smith's servo motor tray could be adjustably clamped to the adjustable surgical stand disclosed by

Faraz. Ex.1003, ¶127. Faraz explains that its "surgical support stand compris[es]: a support arm and a wrist projecting from a distal end of the support arm. The wrist comprises: a member pivotally mounted to the support arm for rotation about a first axis, the first axis passing through a fixed point; a surgical instrument holder for holding an axis of a surgical instrument passing through the fixed point; and a linkage connecting the surgical instrument holder to the member." Ex.1005, 1:60-2:1. Faraz further explains that "[a]rms 22 are each pivotally mounted to arm support 16. Preferably each arm 22 comprises two or more arm segments 22A connected by two or more joints 30 which allow the free distal ends 36 of arms 22 to be moved to position surgical implements anywhere within an operating area above patient P." Ex.1005, 3:27-33. Faraz's surgical support stand allows "[s]urgical implement 28 [to] be manipulated in any of three independent directions by respectively: rotating member 40 about its axis; changing the angle of arms 50 to 53 and implement holder 26 relative to member 40; rotating surgical instrument 28 along its longitudinal axis in holder 26; or inserting or withdrawing surgical implement 28 relative to patient P." Ex.1005, 6:15-21.

Faraz further discloses that "[s]tand 10 is well adapted for use as a basis for a robotic surgery device [and that] ***motors or other actuators could be connected using known means to drive and control the motion of any or all of the joints in stand 10***" (*moving a robotic manipulator arm supporting the instrument in at least* *one degree of freedom*). Ex.1005, 6:23-29. Similarly, Faraz explains that its stand can include "an additional ***actuated joint*** at the end of arm 22 (at point D) with a controller to adjust the angle…" Ex.1005, 3:44-50. Accordingly, a POSA would have understood that Faraz discloses a stand with a "*robotic manipulator arm capable of supporting an instrument in at least one degree of freedom*." Ex.1003, ¶¶123-28. A POSA further would have found it obvious to incorporate Faraz's motorized or actuated robot arm into Smith. *Id*.

(9) "moving the actuator bodies in response to operator inputs"

Smith discloses this limitation. Ex.1003, ¶¶129-31. For example, Smith 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 positions which correspond to the position of the arm of the practitioner wearing the encoder." Ex.1004, 4:9-13; *see also id*., Abstract (encoder, worn by practitioner, "is coupled to a circuit which operates a servo system"), 3:31-36, 3:40-42, 4:37-40, 6:46-67 (transducers, which "register 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 [instrument] arms 18.").

Accordingly, Smith discloses "*moving the actuator bodies in response to operator inputs*" (*e.g.*, servo motors respond to the practitioner's movements). Ex.1003, ¶¶129-31.

b) Claim 2

(1) "A method for performing robotic surgery on a patient, the method comprising"

Smith discloses the preamble of claim 2 for the same reasons as the preamble of claim 1. §V.A.4.a.1. Ex.1003, ¶132.

(2) "coupling an instrument to a drive assembly"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.2. Accordingly, Smith discloses "*coupling an instrument*" (pulley tray 118, multilumen tube 150 and instrument arms 18) "*to a drive assembly*" (*e.g.*, servo motor arrays 404, 406). Ex.1003, ¶133.

(3) "the instrument comprising: a shaft having a working end"

Smith discloses this limitation. Ex.1003, ¶¶134-36. 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*** [instrument] ***arms 18*** extending therefrom."), Figs. 1B, 23, 34. The instrument 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 [instrument] arms to provide a limited hand movement." Ex.1004, 4:40-41; *see also id*., 8:5-7.

Accordingly, Smith discloses "*a shaft*" (*e.g.*, multilumen tube) "*having a working end*" (*e.g.*, distal end at which an endoscopic camera and movable instrument arms may be mounted). Ex.1003, ¶¶134-36.

(4) "an end effector mounting formation positioned at the working end, the end effector mounting formation angularly displaceable about at least two axes"

Smith discloses this limitation. Ex.1003, ¶¶137-43. For example, Smith discloses that instrument 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 instrument 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*** [instrument] ***arms*** to provide a limited hand movement."), 8:5-7 ("The ***grippers at the ends of the*** [instrument] ***arms may be cutters or other types of end effectors*** and the [instrument] arms may be provided with removable, replaceable end effectors."). 18:59-67 ("While the [instrument] 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.

As discussed above (§V.A.4.a.5), Smith's grippers and other tools (*e.g.*, cutters, dissectors, bioptomes) disclose the claimed "*end effector*" under either Petitioner's or PO's proposed construction of the term. Accordingly, Smith discloses "*an end effector mounting formation*" (*e.g.*, instrument arms to which grippers or other end effectors are mounted on their distal ends) "*positioned at the working end*" (*e.g.*, at the distal end of the multi-lumen tube). Ex.1003, ¶139.

Smith further discloses that its "*end effector mounting formation*" is "*angularly displaceable about at least two axes*" under either proposed construction of "*angularly displaceable about at least two axes*." As discussed above (§IV.A), "*angularly displaceable about at least two axes*" should be interpreted as rotatable about at least two fixed axes. As discussed above (§V.A.4.a.6), Smith explains that each of its instrument arms include three rotational joints and three flexional joints and that the rotational joints and flexional joints rotate about perpendicular axes:

> Each [instrument] 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 instrument 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 an instrument arm having wrist, elbow, and shoulder joints, and Figure 26 (below) depicts the same arm "but rotated 90^{o} about the shoulder axis" (in red) (Ex.1004, 6:21-24):

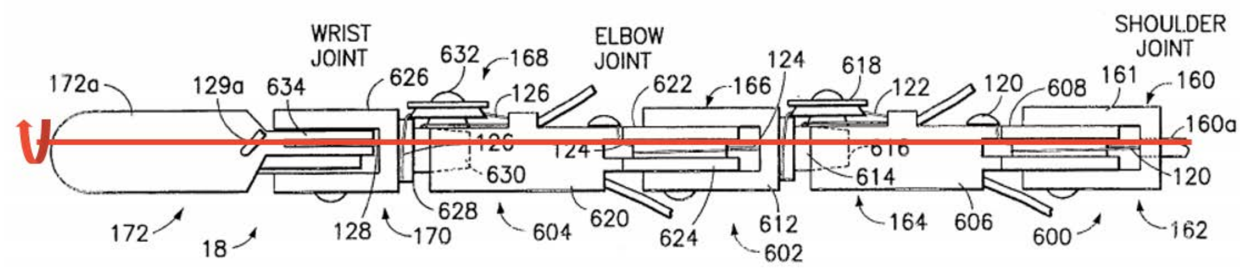


FIG. 25

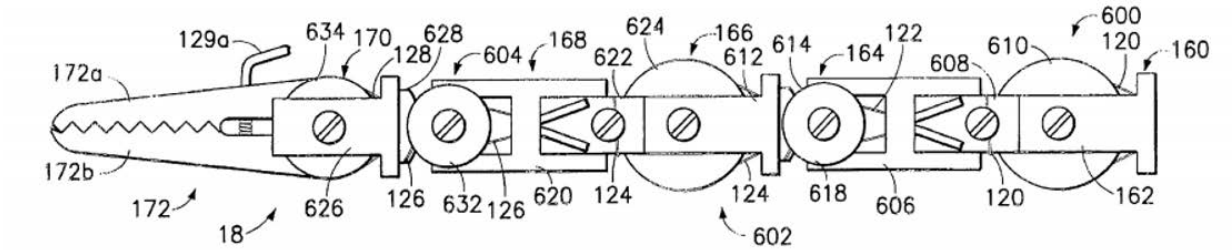


FIG. 26

Ex.1004, Figs. 25-26; *see also id*., 16:48-51 ("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.").

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 instrument 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:

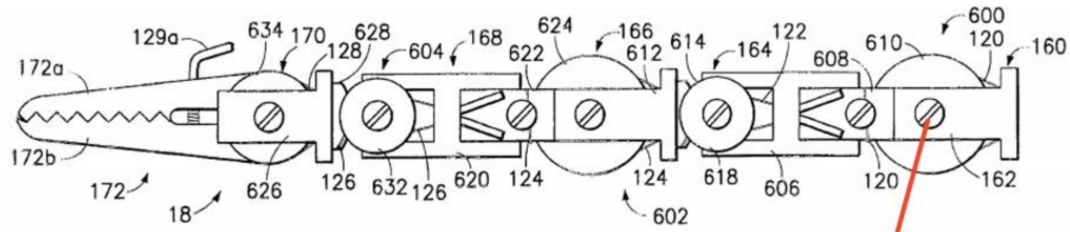


FIG. 26

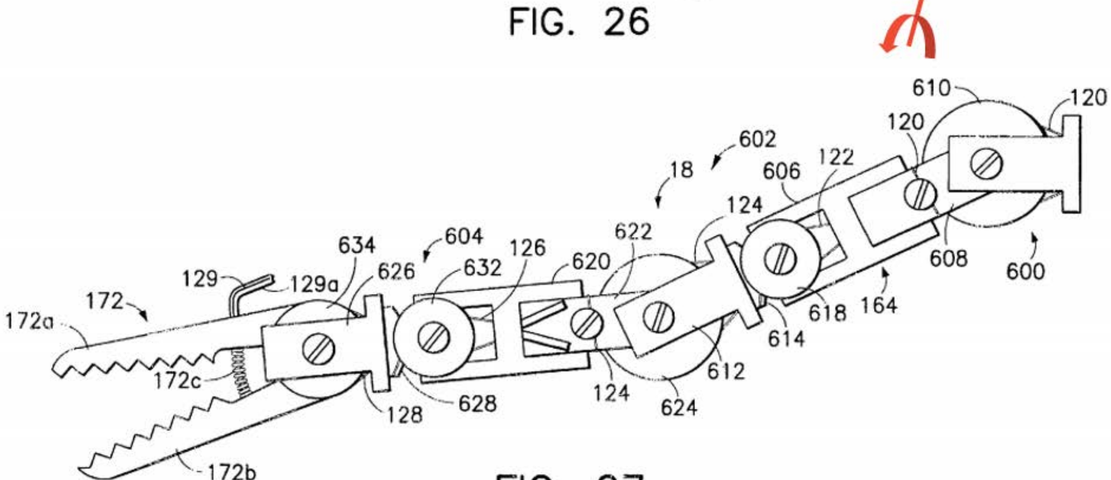


FIG. 27

Ex.1004, Figs. 26-27, 6:25-26; Ex.1003, ¶¶141-42.

Accordingly, <u>Smith</u> discloses "*an end effector mounting formation*" (*e.g.*, instrument arms to which grippers or other end effectors are mounted on their distal ends) "*angularly displaceable about at least two axes*" (*e.g.*, rotational and flexional joints of each instrument arm's shoulder, elbow, and wrist are rotatable around perpendicular axes). Ex.1003, ¶¶137-43. Because <u>Smith</u> 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, ¶140-43.

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

Smith discloses this limitation. Ex.1003, ¶¶144-48. As explained above (§V.A.4.b.4), each of Smith's instrument arms includes three rotational joints and three flexional joints that rotate about perpendicular axes. *See*, *e.g.*, Ex.1004, 4:30-41, 5:10-18, 6:21-26, 16:10-23, 16:35-39, 16:48-51, 16:58-61, 17:1-4, 17:9-12, Figs. 25-27. Smith further teaches that the movement of those joints and the mounted end effectors are driven by pulleys and connected tendons. *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, 5:40-43 ("The ***tendons*** are preferably encased by individual coiled sheaths and ***are threaded around the*** [instrument] ***arms*** so as to avoid interference with each other and with movement of the [instrument] arms."), 6:67-7:2 ("The ***tendons are fed through a multi-lumen tube 150 to the remote*** [instrument] ***arms 18*** which are mounted at the distal end of the tube."); *see also id.*, 16:39-44, 16:51-53, 16:61-64, 17:4-6, 17:12-14.

Smith explains that the rotational and flexional movements of the instrument arms are controlled by the tendons:

> Each [instrument] 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***.

Ex.1004, 7:3-19; *see also, id.*, 3:21-26 ("It is another object of the invention to provide endoscopic [instrument] arms which are coupled to servo motors using tendons and pulleys. It is another object of the invention to provide ***endoscopic*** [instrument] ***arms which are flexional and rotational through the movement of tendons***."), 18:26-31.

The instrument arms at the distal end of the multi-lumen tube move in response to movements by the practitioner operating the system. *See, e.g.*, Ex.1004, Abstract ("Each [instrument] 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 [instrument] arms 18. When the practitioner grips one of the pistol grips 40, the gripper 172 on a corresponding [instrument] 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 [instrument] 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 instrument 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.

Accordingly, Smith discloses "*elongate elements connected to the end effector mounting formation*" (*e.g.*, tendon loops connected to instrument arm joints) "*to cause selective movement of the end effector mounting formation about the axes*" (*e.g.*, to cause selective rotational and flexional movement of the instrument 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, ¶¶144-48.

(6) "a support base positioned on an end of the shaft opposed to the working end"

Smith discloses this limitation. Ex.1003, ¶¶149-54. 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…***.

Ex.1004, 14:8-18; *see also id.*, 4:16-17, 7:26-31.

Smith further explains that the pulley tray is on one end of the multi-lumen tube, while the instrument 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 [instrument] 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 (in red) of the multi-lumen tube 150 (in brown) and the instrument arms having end effectors on the other end (*working end*) of the multi-lumen tube 150 (in purple):

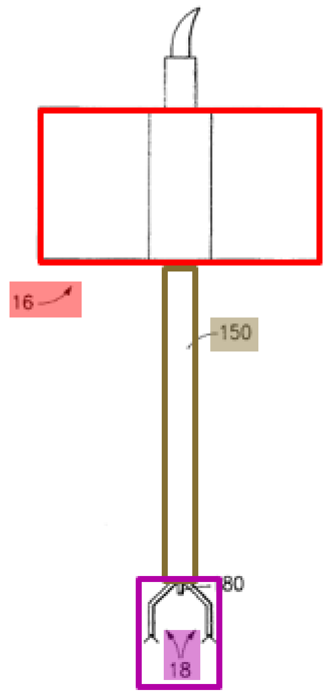


FIG. 23

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

Smith's pulley tray is analogous to the support base of the '447's surgical tool. As depicted in Figures 4 and 6 below, the '447's surgical tool 54 comprises a "proximal housing 108" (in red) that includes an interface 110 containing driven elements 118 (in red). Ex.1001, 9:16-20, 10:17-20.

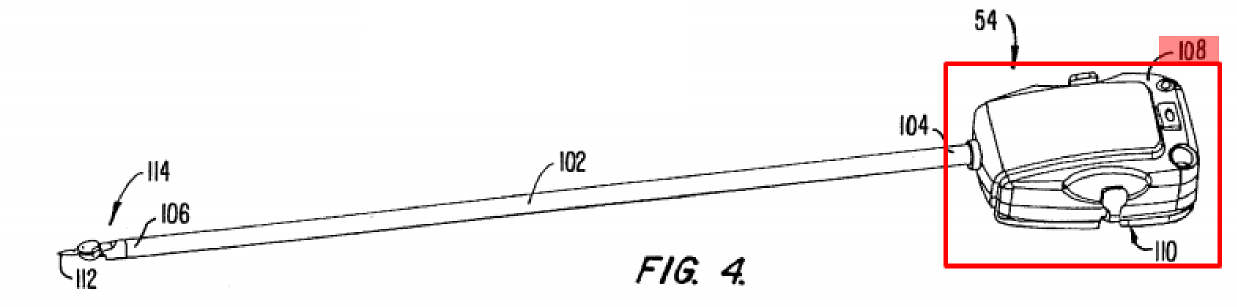


FIG. 4.

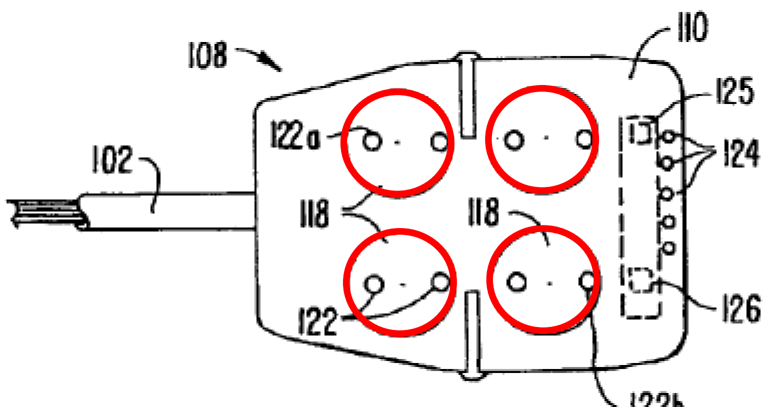


FIG. 6.

Like the '447's "proximal housing 108" that supports driven elements 118, Smith's pulley tray likewise supports pulleys, as explained above.

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 instrument arms and end effector). Ex.1003, ¶¶149-54.

(7) "at least three rotatable driven elements angularly displaceably mounted on the support base and to which opposed ends of the elongate elements are coupled so that selective angular displacement [of] the driven elements causes the selective pulling of the elongate elements"

Smith discloses this limitation. Ex.1003, ¶¶155-63. For example, 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…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 bushings 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…are preferably arranged in a tray 118 which is detachable from the array of servo motors"). 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, ¶157.

Accordingly, Smith discloses "*at least three rotatable driven elements*" (*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, ¶¶156-58.

Smith discloses that a "tendon loop" is coupled 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 [instrument] 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. 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 108f in the pulley wheel, through the radial slot 108g 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.”).

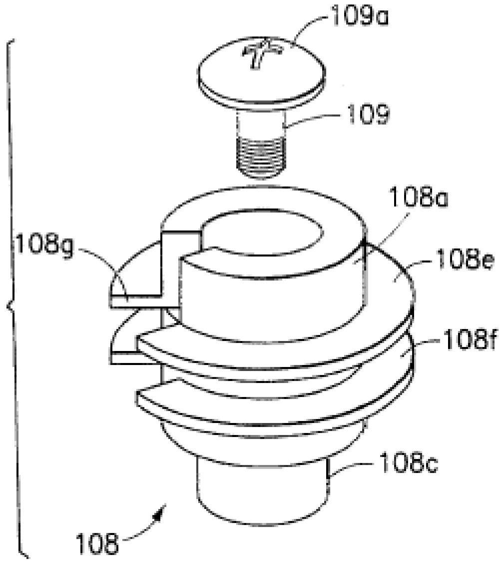


FIG. 17

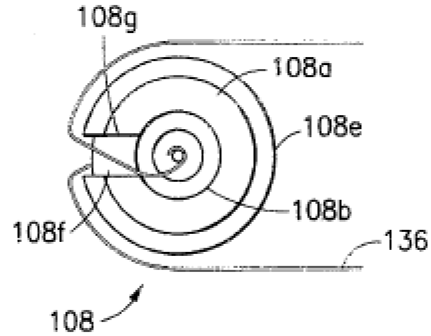


FIG. 18

Accordingly, Smith explains that both ends of each tendon are attached to a pulley around the tightened locking screw. That both ends of Smith’s tendon loops are coupled to their respective pulleys is further supported by Smith’s disclosure that tendons extend to the instrument 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. In addition, Smith describes both a single pullwire arrangement—where a single wire controls movement—and a tendon loop arrangement—where the tendons extend to the instrument 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 tendon loops that go back to the pulley tray for the instrument arms (in red), but also single pull-wires for the grippers (in blue):

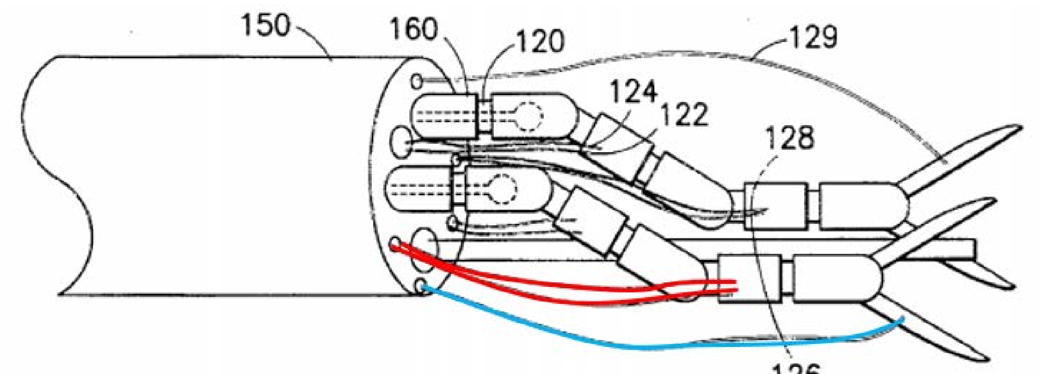


FIG. 34

Ex.1004, Fig. 34, 18:49-57.

As explained above (§V.A.4.b.5), movement by the practitioner is selectively translated into rotation of the servo motors and, therefore, the pulleys, which rotation causes selective pulling of the tendons that cause the instrument arms to move accordingly. Ex.1003, ¶¶144-48.

(8) "the driven elements having axes which are parallel and spaced apart relative to each other"

Smith discloses this limitation. Ex.1003, ¶¶164-67. 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 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 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, ¶165. This is further illustrated by Figure 22 (annotated below), which depicts pulley tray 402 (in yellow) having pulleys with parallel rotational axes along the y-axis (depicted with red lines):

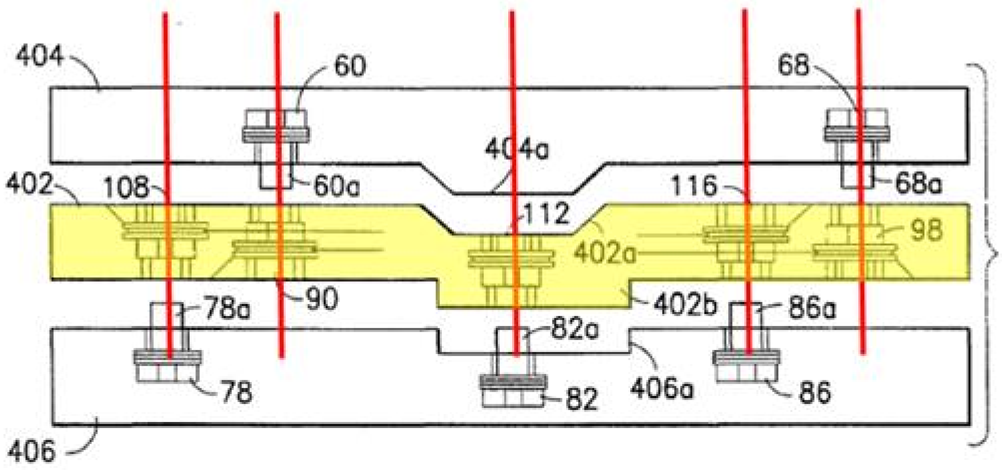


FIG. 22

See also Ex.1004, 14:48-67, Figs. 13-14.

(9) "the method further comprising: driving the at least three rotatable driven elements on the support base with at least three rotatable driving elements disposed on the drive assembly, each of the at least three driven elements sharing a single rotational axis with one of the at least three rotatable driving elements"

Smith discloses "*driving the at least three rotatable driven elements on the support base with at least three rotatable driving elements disposed on the drive assembly, each of the at least three driven elements sharing a single rotational axis with one of the at least three rotatable driving elements.*" Ex.1003, ¶¶168-75.

As discussed above (§V.A.4.b.7), Smith discloses three rotatable driven elements (*e.g.*, pulleys) on the support base (*e.g.*, pulley tray). Smith explains that each of these pulleys engages with a corresponding servo motor:

> 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, 4:12-20; *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):

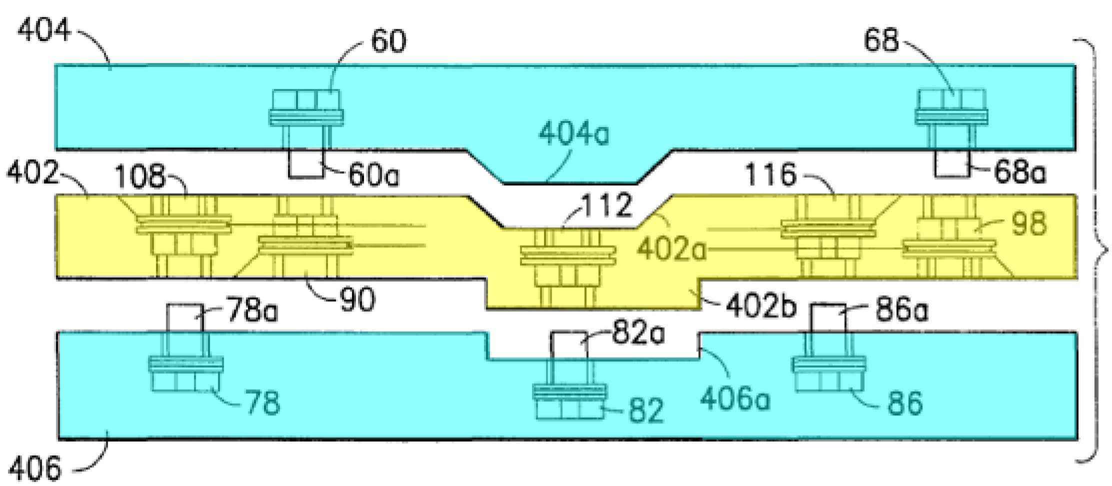


FIG. 22

Ex.1004, Fig. 22.

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"). Ex.1003, ¶171.

Smith further explains that its servo motors selectively 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 positions which correspond to the position of the arm of the practitioner wearing the encoder." Ex.1004, 4:9-13; *see also id.*, Abstract (encoder, worn by practitioner, "is coupled to a circuit which operates a servo system"), 3:31-36, 3:40-42, 4:37-40, 6:46-67 (transducers, which "register 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 [instrument] 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, ¶172.

Accordingly, Smith discloses "*driving the at least three rotatable driven elements on the support base*" (*e.g.*, pulleys on the pulley tray that are engaged when the servo motors rotate) "*with at least three rotatable driving elements disposed on the drive assembly*" (*e.g.*, servo motors in servo motor arrays 404, 406). Ex.1003, ¶¶169-73.

Smith further discloses that each of these servo motors "*shar[es] a single rotational axis*" with one of the pulleys. As described above (§V.A.4.b.8), Smith explains that each of its servo motors aligns with a corresponding pulleys. *See* Ex.1004, 4:12-14, Fig. 22; Ex.1003, ¶174. This is further illustrated by Figure 22 (annotated below), which depicts pulley tray 402 (highlighted in yellow) having pulleys (90, 98, 108, 112, 116) with rotational axes along the y-axis (depicted with red lines) that are shared with a corresponding servo motor in servo motors 404, 406 (highlighted in blue):

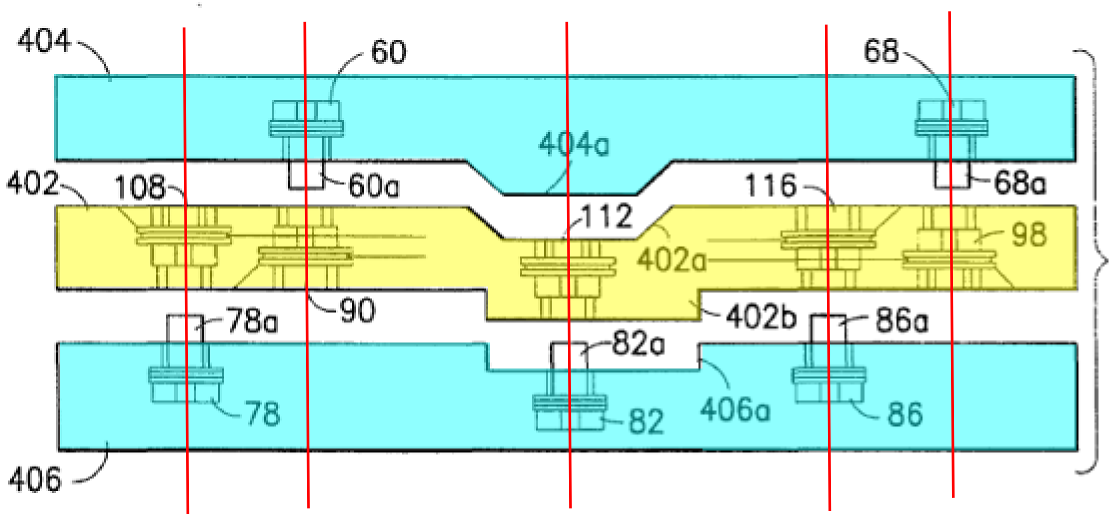


FIG. 22

See also Ex.1004, 14:8-17, 14:48-67, Figs. 13-14.

Accordingly, Smith discloses "*driving the at least three rotatable driven elements on the support base*" (*e.g.*, pulleys) "*with at least three rotatable driving elements disposed on the drive assembly*," (*e.g.*, connected to servo motors of the servo motor array, which each have rotatable shafts) "*each of the at least three driven elements sharing a single rotational axis with one of the at least three rotatable driving elements*" (*e.g.*, each pulley and corresponding servo motor share a single rotational axis). Ex.1003, ¶¶168-75.

(10) "moving a robotic manipulator arm supporting the instrument in at least one degree of freedom."

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.8; Ex.1003, ¶176.

c) Claim 3

(1) "A method for performing robotic surgery on a patient, the method comprising"

Smith discloses the preamble of claim 3 for the same reasons as the preamble of claim 1. §V.A.4.a.1; Ex.1003, ¶177.

(2) "coupling an instrument [t]o a drive assembly"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.2. Accordingly, Smith discloses "*coupling an instrument*" (pulley tray 118, multilumen tube 150 and instrument arms 18) "*[t]o a drive assembly*" (*e.g.*, servo motor arrays 404, 406). Ex.1003, ¶178.

(3) "the instrument having a proximal portion and a distal portion"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.4. Accordingly, Smith discloses "*the instrument having a proximal portion*" (*e.g.*, pulley tray 118) "*and a distal portion*" (*e.g.*, instrument arms 18). Ex.1003, ¶179.

(4) "the proximal portion comprising a first plurality of rotatable bodies"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.4. Accordingly, Smith discloses "*the proximal portion comprising a first plurality of rotatable bodies*" (*e.g.*, 14 pulleys in the pulley tray). Ex.1003, ¶180.

(5) "the drive assembly comprising a second plurality of rotatable bodies"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.3. Accordingly, Smith discloses "*the drive assembly comprising a second plurality of rotatable bodies*" (*e.g.*, servo motor arrays 404, 406 containing servo motors). Ex.1003, ¶181.

(6) "the first plurality of rotatable bodies coupled by drive members to a movable portion disposed at the distal portion"

Smith discloses this element for the same reasons as the corresponding element of claim 2. §V.A.4.b.5. Accordingly, Smith discloses "*the first plurality of rotatable bodies*" (*e.g.*, pulleys in the pulley tray) "*coupled by drive members*" (*e.g.*, tendon loops) "*to a movable portion disposed at the distal portion*" (*e.g.*, instrument arms 18). Ex.1003, ¶182.

(7) "engaging the first plurality of rotatable bodies with the second plurality of rotatable bodies"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.7. Accordingly, Smith discloses "*engaging the first plurality of rotatable bodies*" (*e.g.*, engaging pulleys when the servo motors rotate) "*with the second plurality of rotatable bodies*" (*e.g.*, servo motors). Ex.1003, ¶183.

(8) "rotating the second plurality of rotatable bodies to rotate the first plurality of rotatable bodies, each of the first plurality of rotatable bodies sharing a single rotational axis with one of the second plurality of rotatable bodies, wherein rotating the first plurality of rotatable bodies moves the movable [portion] disposed at the distal portion"

Smith discloses this element for the same reasons as the corresponding element of claim 2. §V.A.4.b.9. Accordingly, Smith discloses "*rotating the second plurality of rotatable bodies*" (*e.g.*, rotating servo motors in response to the practitioner's movements) "*to rotate the first plurality of rotatable bodies*" (*e.g.*, pulleys which are engaged when the servo motors rotate), "*each of the first plurality of rotatable bodies sharing a single rotational axis with one of the second plurality of rotatable bodies*" (*e.g.*, each pulley and corresponding servo motor share a single rotational axis), "*wherein rotating the first plurality of rotatable bodies moves the movable [portion] disposed at the distal portion*" (*e.g.*, when the servo motors and pulleys are selectively pulling on the tendon loop to cause selective rotational and flexional movement of the instrument arm joints). Ex.1003, ¶184.

(9) "moving a robotic manipulator arm supporting the instrument in at least one degree of freedom"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.8; Ex.1003, ¶185.

(10) "inserting the instrument into an aperture on a patient; and manipulating tissue with the distal portion of the instrument."

Smith discloses this limitation. Ex.1003, ¶¶186-88. For example, Smith teaches a "multi-lumen tube 150 [that] is small enough to fit through a trocar tube". Ex.1004, 7:39-41; *see also id*., 3:13-17 ("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."). In operation, Smith describes a method in which an assistant "incises the patient…with a trocar…and inserts the distal end of the multi-lumen tube 150 through [the trocar tube] and locates the [instrument] arms 18 in the vicinity of the surgical site." Ex.1004, 8:36-43. "When the control circuit 14 is activated, movement of the practitioner's arms…is replicated in the [instrument] arms 18. When the practitioner grips one of the pistol grips 40, the gripper 172 on a corresponding [instrument] arm 18 is closed." Ex.1004, 8:51-55; *see also id*., 18:59-65 ("it will be appreciated that the [instrument] arms could be provided with any type of end effector such as a cutter, dissector, bioptome, etc."). In this manner, the practitioner can "perform an endoscopic procedure at a surgical site within a body of a patient". *See*, *e.g.*, Ex.1004, 20:65-67.

Accordingly, Smith discloses "*inserting the instrument into an aperture on a patient*" (*e.g.*, inserting instrument arms 18 and the multi-lumen tube 150 through a trocar tube that created an aperture on a patient) and "*manipulating tissue with the distal portion of the instrument*" (*e.g.*, performing surgery within a body of a patient using a gripper, cutter, dissector, bioptome, etc.). Ex.1003, ¶¶186-88.

d) Claim 4

(1) "A method for performing robotic surgery, comprising:"

Smith discloses the preamble of claim 4 for the same reasons as the preamble of claim 1. §V.A.4.a.1; Ex.1003, ¶189.

(2) "providing an instrument removably couplable to a robotic arm drive assembly"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.2. Thus, Smith discloses "*providing an instrument removably couplable to a robotic arm drive assembly*" (*e.g.*, coupling the pulley tray to the servo motor arrays). Ex.1003, ¶190.

(3) "said instrument comprising proximal and distal portions, said proximal portion comprising a first plurality of movable bodies engagable with a second plurality of corresponding movable bodies on the drive assembly"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.7. Thus, Smith discloses an "*instrument comprising proximal and distal portions*" (*e.g.*, pulley tray 118 and instrument arms 18), "*said proximal portion comprising a first plurality of movable bodies engagable with a* *second plurality of corresponding movable bodies on the drive assembly*" (*e.g.*, pulleys which can be engaged with servo motors in servo motor arrays 404, 406). Ex.1003, ¶191.

(4) "said instrument including at least one distal joint coupled to an end effector member, at least one of said first plurality of movable bodies being coupled to said at least one distal joint by at least one drive member, and said at least one drive member being housed in a shaft portion of said instrument extending between said proximal and distal portions"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.6. Thus, Smith discloses an "*instrument including at least one distal joint*" (*e.g.*, three rotational and three flexional joints on each instrument arm) "*coupled to an end effector member*" (*e.g.*, coupled to, for example, grippers), "*at least one of said first plurality of movable bodies being coupled to said at least one distal joint by at least one drive member*" (*e.g.*, coupled to pulleys in the pulley tray by tendons) and "*said at least one drive member being housed in a shaft portion of said instrument extending between said proximal and distal portions*" (*e.g.*, tendon fed through the multi-lumen tube). Ex.1003, ¶192.

(5) "coupling said instrument to said drive assembly by engaging the first plurality of movable bodies with the second plurality of movable bodies"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.7. Accordingly, Smith discloses "*coupling said instrument* (*e.g.*, pulley tray 118, multilumen tube 150 and instrument arms 18) *to said drive assembly*" (*e.g.*, servo motor trays) "*by engaging the first plurality of movable bodies*" (*e.g.*, pulleys) "*with the second plurality of movable bodies*" (*e.g.*, servo motors). Ex.1003, ¶193.

(6) "controlling operation of said drive assembly from a remote location no that the movable bodies of said drive assembly rotate one or more of the movable bodies of the instrument, thereby causing the at least one distal joint of the instrument to move"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.9. Smith further discloses that, in response to practitioner movements, "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." Ex.1004, 4:9-13; *see also id.*, Abstract (encoder, worn by practitioner, "is coupled to a circuit which operates a servo system"), 3:31-36, 3:40-42, 4:37-40, 6:46-67 (transducers, which "register 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 [instrument] arms 18.").

Smith explains that each of these servo motors engages with a pulley via a self-aligning socket:

> 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, 4:12-20; *see also id*., 7:27-31, 8:39-43. Thus, when the servo motors rotate in response to the practitioner's movements, the pulleys engaged with those servo motors also rotate. Ex.1003, ¶¶194-96.

Further, as explained above (§V.A.4.b.5), Smith describes instrument arms that include three rotational joints and three flexional joints that rotate about perpendicular axes. *See*, *e.g.*, Ex.1004, 4:30-41, 5:10-18, 6:21-26, 16:10-61, 17:1-12, Figs. 25-27. The movement of these joints are driven by pulleys and connected tendons. *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, 5:10-18, 6:21-26, 16:10-61, 17:1-12. Accordingly, the servo motors and pulleys rotate based on the practitioner's movements and selectively pull the tendons causing rotational and/or flexional movement of the joints in the instrument arms. Ex.1004, 4:8-29, 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 [instrument] arm. This design allows a rotation of the rotational joints up to about 270º.").

Thus, Smith discloses "*controlling operation of said drive assembly from a remote location*" (*e.g.*, activating servo motors in response to practitioner inputs) "[s]*o that the movable bodies of said drive assembly rotate one or more of the movable bodies of the instrument,*" (*e.g.*, movement of the pulleys in response to the activation of a corresponding servo motor) *thereby causing the at least one distal joint of the instrument to move*" (*e.g.*, to cause selective rotational and flexional movement of the instrument arm joints based on the practitioner's movement). Ex.1003, ¶¶194-99.

(7) "controlling from the remote location movement in at least one degree of freedom of a robotic manipulator arm supporting the instrument"

Smith discloses this element for the same reasons as the corresponding element of claim 1. §V.A.4.a.8; Ex.1003, ¶200.

(8) "engaging tissue with the end effector member to perform surgery"

Smith discloses this element for the same reasons as the corresponding element of claim 3. §V.A.4.c.10. Accordingly, Smith discloses "*engaging tissue with the end effector member to perform surgery*" (*e.g.*, engaging tissue with gripper, cutter, dissector, bioptome or other end effectors). Ex.1003, ¶201.

(9) "wherein at least one of said first plurality of movable bodies is a rotatable body, at least one of said second plurality of movable bodies is a corresponding rotatable body, and said at least one of said first plurality of movable bodies shares a single rotational axis with said corresponding one of said second plurality of movable bodies when said first and second plurality of movable bodies are operatively engaged"

Smith discloses this element for the same reasons as the corresponding element of claim 2. §V.A.4.b.9; Ex.1003, ¶202.

e) Claim 5

Claim 5 recites the "*method of claim 1, further comprising releasing the instrument from the drive assembly by operating a proximal latch*." As discussed above (§V.A.4.a), Smith renders this limitation obvious in light of Faraz.

Smith further describes that its "pulleys…are preferably arranged in in a tray 118 which is detachable from the array of servo motors…." Ex.1004, 7:26-29; *see also id*., 19:2-5 ("[T]he end effectors may be interchanged during the course of a procedure by detaching the pulley 22, tray/multilumen tube/[instrument] arms assembly from the servo motor arrays."). Smith therefore expressly discloses that some mechanism for releasing the instrument from the drive assembly is necessary to allow the practitioner or assistant to detach the surgical instrument from the servo motor assembly. In light of Smith's disclosure and a POSA's knowledge, it would have, at a minimum, been obvious to "releas[e] the instrument from the drive assembly by operating a proximal latch." Ex.1003, ¶204.

To the extent PO asserts that Smith alone does not disclose or render obvious claim 5, numerous prior art references directed to robotic surgical systems, such as Faraz, disclose the use of a latch or connection mechanism to releasably decouple the instrument from the drive assembly. As discussed above (§V.A.4.a.8), a POSA would have combined Smith with Faraz such that "[t]he servo motor tray may be supported by an adjustable clamping means connected to" an instrument arm. Ex.1004, 8:36-48; Ex.1005, 3:44-50, 6:23-29. Faraz further discloses that "any practical clamping mechanism may be used" to secure the instrument to the implement holder. Ex.1005, 3:12-26. Other references at the time taught similar releasing mechanisms. *See*, *e.g.*, Ex.1008, 12:42-65 ("The instrument 82 may have…a spring biased ball quick disconnect fastener 98…[that] allows instruments…to be coupled to front loading tool driver 82…The quick disconnect 98 has a slot 100 that receives a pin 102 of the front loading driver 82. The pin 102 locks the quick disconnect 98 to the front loading tool driver 100. The

pin 102 can be released by depressing a spring biased lever 104.”). Ex.1003, ¶¶205-06.

Accordingly, a POSA would have understood that the combination of Smith and Faraz renders claim 5 obvious. Ex.1003, ¶¶204-06.

VI. NO SECONDARY CONSIDERATIONS EXIST

As described above, Smith in combination with Faraz renders *prima facie* obvious the Challenged Claims of the ’447. No secondary indicia of non-obviousness exist having a nexus to the putative “invention” of the ’447 contrary to that conclusion. Petitioner reserves its right to respond to any assertion of secondary indicia of non-obviousness advanced by PO. Ex.1003, ¶208.

VII. CONCLUSION

For the reasons set forth above, Petitioner respectfully asks the Board to initiate *inter partes* review and find claims 1-5 of the ’447 to be unpatentable based on the grounds provided herein.

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 13,980 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. 8,142,447.

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