UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AURIS HEALTH, INC.
Petitioner,

v.

INTUITIVE SURGICAL OPERATIONS, INC.
Patent Owner.

Patent No. 6,246,200

Inter Partes Review No. IPR2019-01448

Petition for *Inter Partes* Review of U.S. Patent No. 6,246,200

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Petitioner's Mandatory Notices

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

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

B. Other Proceedings (§42.8(b)(2))

1. Patents and Applications

U.S. Patent No. 6,246,200 ("'200 patent") is not related to any pending applications. It is related to the following issued patents:

- U.S. 6,788,018
- U.S. 6,933,695
- U.S. 6,441,577

2. Related Litigation

The '200 patent has been asserted in the following litigations:

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

3. Patent Office Proceedings

The '200 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 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.[2]

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.

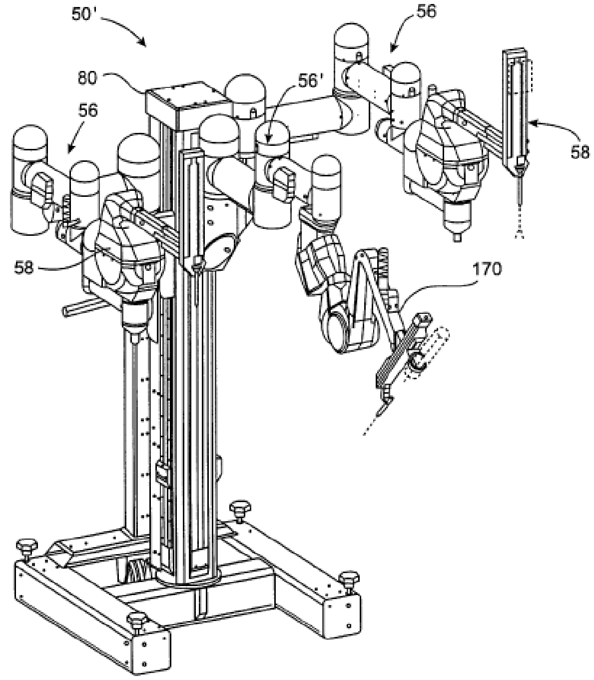
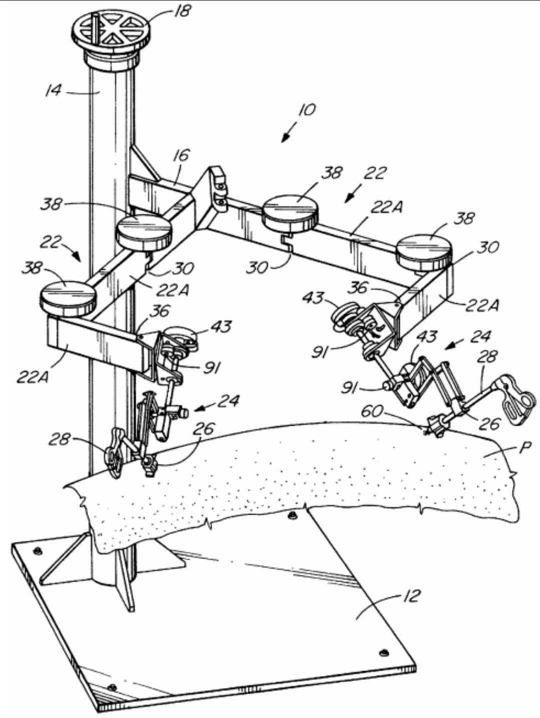
[2] Petitioner will file motions for Sharon Lee and Ketan Patel to appear *pro hac vice* according to the Board's orders and rules.

I. INTRODUCTION

The ’200 patent is directed toward an obvious combination of well-known elements used in robotic surgery. The claimed robotic surgery system includes a base, a surgical end effector (*e.g.*, a surgical implement that manipulates body tissue, such as a suturing device), and a robotic linkage (*e.g.*, robotic arm). The robotic linkage has joints with releasable brakes, and has a sensor system for determining the joints’ position.

This type of robotic surgery system was well-known before the priority date of the ’200 patent. For example, U.S. Patent No. 5,824,007 to Faraz (“Faraz” (Ex.1004)) discloses an “adjustable surgical stand” that is “well adapted for use as a basis for a robotic surgery device.” Faraz’s system includes a “base” and “surgical implements” held at the end of a jointed arm. Faraz explains that the joints are equipped with releasable pneumatic brakes, can be driven by motors, and can be affixed with “position sensors.”

The alleged invention of the ’200 patent bears an uncanny resemblance to Faraz’s device, both depicting, *e.g.*, a base with a central column, robotic arms with joints, and end effectors at the ends of the arms, as shown below:

’200 Patent, Figure 10	Faraz, Figure 1
 FIG. 10	 FIG. 1

Faraz discloses or renders obvious all of the elements of the independent claims, and was not considered during prosecution of the ’200 patent. To the extent Faraz does not teach every limitation of the claims, the claims would have been obvious to a person of ordinary skill in the art (“POSA”) based on Faraz in view of additional references.

Petitioner respectfully requests the Board to institute *inter partes* review of claims 1, 10-12, 14, and 17 of the ’200 patent.

II. Regulatory Information

A. Certification that Petitioner May Contest the ’200 Patent (§ 42.104(a))

Petitioner certifies that the ’200 patent is available for *inter partes* review (IPR), and that Petitioner is not barred or estopped from requesting an IPR of the ’200 patent claims. Neither Petitioner, nor any party in privity with Petitioner, has filed a civil action challenging the validity of any claim of the ’200 patent. The ’200 patent 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 ’200 patent. *See* 35 U.S.C. § 315(b); Ex.1012.

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

Claims 1, 10-12, 14, and 17 are unpatentable based on the following art and grounds.

Prior Art Reference	Abbreviation
U.S. Patent No. 5,824,007 to Faraz	“Faraz” (Ex.1004)
U.S. Patent No. 5,784,542 to Ohm	“Ohm” (Ex.1005)
U.S. Patent No. 5,555,897 to Lathrop	“Lathrop” (Ex.1006)
“Coordinated Control of Two Robot Arms” by Tarn et al, 1986 IEEE International Conference on Robotics and Automation, pp. 1193-1202, IEEE 1986	“Tarn” (Ex.1007)
“Robotically assisted laparoscopic surgery,” by Sackier et al, Surgical Endoscopy (Springer-Verlag	“Sackier” (Ex.1009)

New York Inc. 1994) 8:63-66	

Ground	35 U.S.C. §	Claims	Prior Art Reference(s)
1	103(a)	1, 10-12	Faraz and Ohm
2	103(a)	1, 10-12	Faraz, Ohm, and Sackier
3	103(a)	14, 17	Faraz, Lathrop, and Tarn
4	103(a)	14, 17	Faraz, Lathrop, Tarn, and Sackier

Petitioner's positions are supported by the Declaration of William Cimino (Ex.1003), an expert in telerobotic surgical systems who has over 25 years of experience in the field. Ex.1003, ¶¶2-6.

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

Robotic arms were developed since at least the 1970s. *See, e.g.*, Ex.1008, 1242; Ex.1003, ¶35. In the 1970s and 1980s, researchers worked out detailed kinematic, hardware, and software methods to control the position of an object being handled by multiple robotic arms. Ex.1008, 1242-45. The kinematics included coordinate transformations between a reference coordinate system used by the computer controlling the robot, and the coordinate frame of the end effector in space, so that tasks (*e.g.*, moving an object from point A to point B) could be carried out with specific software instructions to the robot (*e.g.*, drive a particular joint motor a specified amount). *Id.*, 1243-44.

By the early 1990s, numerous researchers had adapted robotic arms for use in surgery. *See, e.g.*, Ex.1005, Abstract, 1:23-40; Ex.1006, Abstract; Ex.1003, ¶36. Robotic surgical arms commonly included multiple joints, to allow a surgeon to place the end effector at a desired position relative to a patient. *See, e.g.*, Ex.1004, 3:27-50; Ex.1005, 17:58-18:22; Fig. 1. The robotic surgical arms also commonly included brakes, to prevent movement of a surgical instrument that was in proximity to, or in contact with, a patient during surgery. *See, e.g.*, Ex.1004, 4:9-11; Ex.1005, 21:47-53; Ex.1006, 6:2-6. In addition, the robotic surgical arms commonly included position sensors to precisely monitor the position of the joints and surgical end effector. *See, e.g.*, Ex.1004, 6:23-29; Ex.1005, 18:28-37.

Those three elements—joints, brakes, and position sensors—were basic components long used to make robotic surgery systems. Ex.1003, ¶37. For that reason, by the mid-1990s researchers were already publishing documents describing various solutions to more intricate problems, such as making robotic surgery systems less bulky and better suited to an operating room environment (Ex.1004, 1:21-55), improving surgical precision with better coupling between joints, force-feedback, and anti-backlash mechanisms (Ex.1005, 1:41-64), and improving ease of operation and safety (Ex.1006, 1:60-2:12).

B. Summary of the '200 Patent

The '200 patent is directed to robotic surgery systems for "aligning the motion and structure of the robotically controlled manipulators and end effectors with both the internal surgical site and each other." Ex.1001, 2:66-3:4.

The '200 patent states that "[r]obotic surgery will generally involve the use of multiple robotic manipulator arms. One or more of the robotic manipulator arms will often support a surgical tool which may be articulated (such as jaws, scissors, [etc.])." Ex.1001, 5:49-56. The robotic manipulator arms can be mounted on a cart. *Id.*, 5:66-6:2. The robotic manipulator arm has joints with potentiometers that measure the joint position. *Id.*, 9:4-6. Using those measurements, a computer determines the position and orientation of the end effector, as well as how to move the end effector in a desired direction by driving the joints. *Id.*, 9:17-22. The arm's joints include brakes that prevent inadvertent movement, for example to avoid "movement if power to the robotic system is lost." *Id.*, 9:51-54; *see* Ex.1003, ¶¶29-31.

In an exemplary embodiment, the brakes at all of the joints supporting a manipulator can be released at the same time by pushing a button, "allowing operating room personnel to position and orient the manipulator freely." Ex.1001, 10:45-49. A surgeon then uses controllers to manipulate tissues using the robotic system, while viewing the surgical site through a display, which the patent acknowledges was "typical" of robotically assisted surgery. *Id.*, 11:39-44, 1:16-18; *see* Ex.1003, ¶¶32-33.

Figure 10, reproduced below, depicts an example of the system. It includes positioning linkages 56 and 56', column 80, and manipulators 58 and 170.

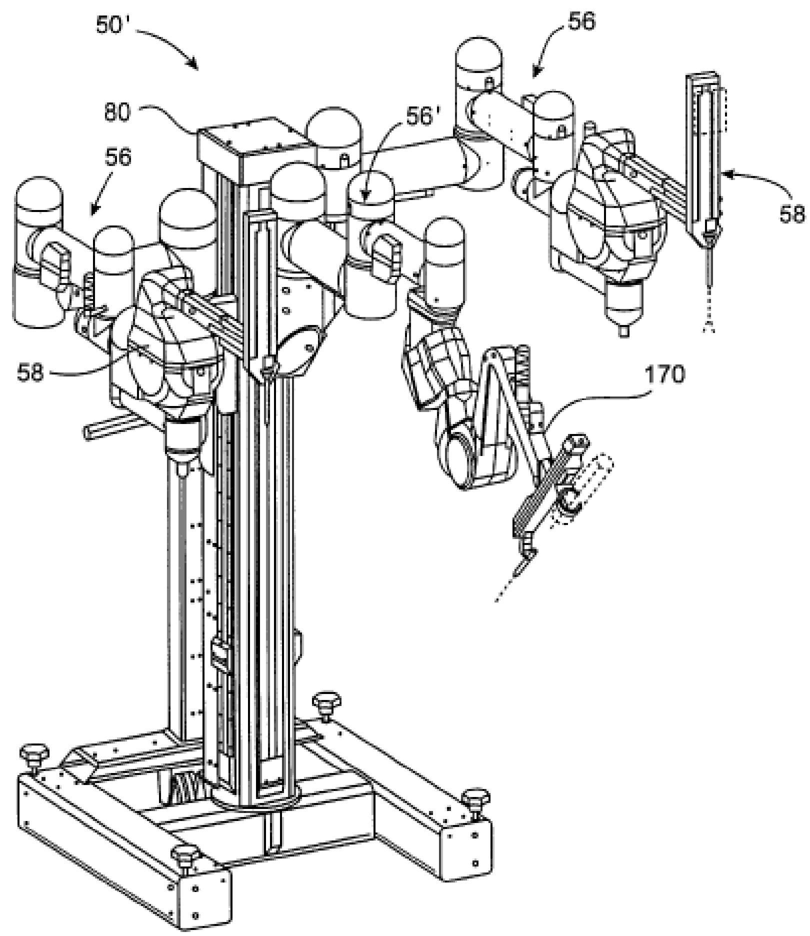


FIG. 10

C. Prosecution History

The '200 patent issued from Application No. 09/368,309, filed on August 3, 1999. During prosecution, the Examiner rejected numerous claims as anticipated and obvious, while allowing other claims and indicating that certain dependent claims would be allowable if rewritten in independent form. Ex.1002, 95-102. In response, the applicant amended claim 1 to specify "a brake system…in which the fixable joints can be manually articulated." *Id.*, 109. The Examiner allowed the claims, stating "the Prior Art fail to teach or suggest any obvious combination of the limitations mentioned above…and further comprising the limitations of a brake system comprising a brake release actuator for releasing the fixable joints to a manually repositionable configuration in which the fixable joints can be manually articulated; the fixable joints including at least two rotational joints accommodating pivotal motion about vertical axes and a vertical sliding joint accommodating translation along the vertical axis, the vertical slide supporting the rotational joints, a slide counterweight supported by the base; and wherein the brake system can release the joints supporting the second manipulator upon actuation of a single actuator." *Id.*, 122.

The Examiner's reasons for allowance appear to refer to elements that are only in dependent claim 22, which is not challenged in this petition. Therefore, the Examiner appears to have either mistakenly allowed the claims challenged in this petition, or incorrectly explained his reasons for allowing them.

D. Person of Ordinary Skill in the Art

A person of ordinary skill in the art 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, ¶28. 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 (citations omitted). The specification is "usually" dispositive and "the single best guide to the meaning of a disputed term." *Phillips*, 415 F.3d at 1315 (citation omitted).

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 any proposed narrower construction, 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. "brake system"

The '200 patent states that linkages supporting surgical instruments "will often maintain a fixed configuration and/or position until a brake system is released." Ex.1001, 3:5-7. The '200 patent states that "[s]uitable brakes may be actuated electrically, pneumatically, hydraulically, or the like, and may be located at the joint axis (as shown) or may [be] coupled to the joint using gears, cables, rigid linkages, or the like." *Id.*, 9:62-67. The '200 patent's claims make clear that the brake system "inhibit[s] articulation of the fixable joints." *Id.*, Claim 1. A POSA would have understood that when the brakes described in the '200 patent were actuated, they would use friction to restrict movement. Thus, the exemplary and alternative brake structures described by the '200 patent encompass brakes that use friction to restrict movement of the fixable joints. Thus, to the extent the term "brake system" needs to be construed for this petition, it should be construed to mean a system that applies friction to restrict movement of the fixable joints.

B. "surgical end effector"

The ’200 patent states that "[i]n traditional minimally invasive surgery, the surgeon then manipulates the tissues using end effectors of the elongate surgical instruments by actuating the instrument's handles while viewing the surgical site on a video monitor." Ex.1001, 1:66-2:3. The ’200 patent also states that "[o]ne or more of the robotic manipulator arms will often support a surgical tool which may be articulated (such as jaws, scissors, graspers, needle holders, micro dissectors, staple appliers, tackers, suction/irrigation tools, clip appliers, or the like) or non-articulated (such as cutting blades, cautery probes, irrigators, catheters, suction orifices, or the like)." *Id.*, 5:50-56. Thus, to the extent the terms "surgical end effector" needs to be construed for this petition, it should be construed to refer to a device at end of a surgical instrument for manipulating (cutting, grasping or otherwise acting on) body tissue. Ex.1003, ¶¶46-48.

V. Analysis of the Patentability of the Claims

A. Ground 1: Faraz and Ohm

1. Summary of Faraz

Faraz was filed on December 3, 1996 and issued on October 20, 1998. Faraz is therefore prior art to the ’200 patent under at least 35 U.S.C. § 102(e).[3]

[3] The ’200 patent's earliest effective priority date is August 4, 1998, which is over a year after Faraz was filed.

Faraz is directed to an adjustable surgical stand. Ex.1004, 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.1004, 2:56-3:50. Each joint is equipped with locking means such as a pneumatic brake 38. *Id.*, 3:59-61.

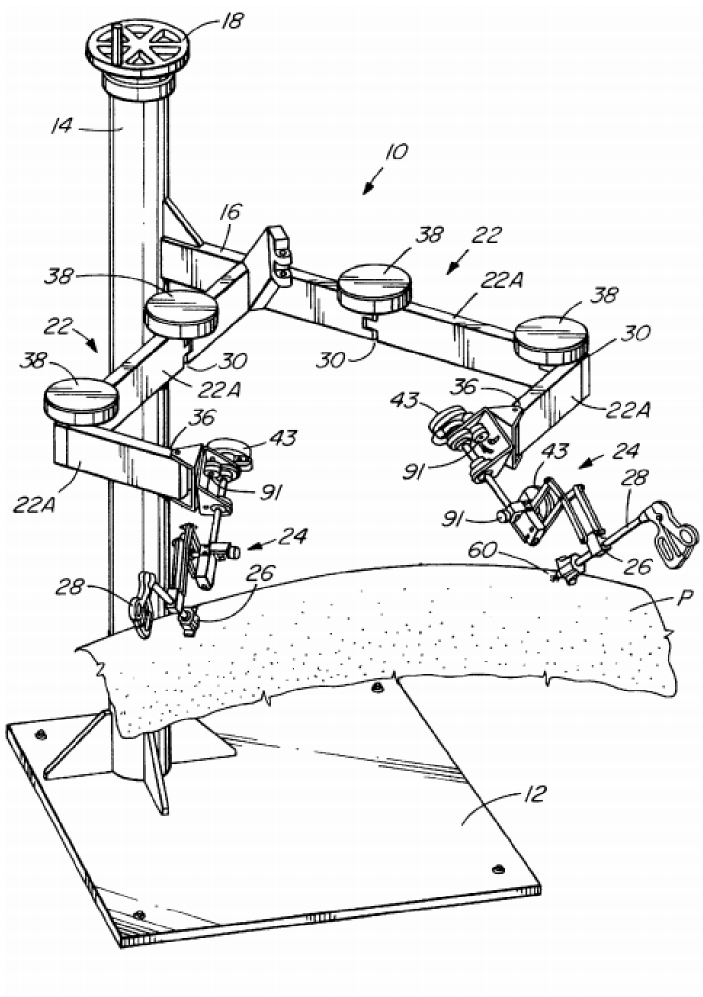


FIG. 1

Faraz describes use of the stand as follows. First, 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." *Id.*, 6:8-12. Then, "locks 38 are applied… to prevent points 60 from moving from the incision points." *Id.*, 6:12-14. Finally, "[s]urgical implements 28 may be slid into implement holder 26 and into the body of patient P." *Id.*, 6:14-15. Surgical implements 28 can be manipulated in three independent directions, and can be locked in place in any or all of the directions. *Id.*, 6:15-22.

Faraz teaches that its stand can be used either "as a passive positioning stand," or as an active stand with an actuated joint controlled by a controller. *Id.*, 3:41-52. Likewise, Faraz teaches that its stand "is well adapted for use as a basis for a robotic surgery device." Ex.1004, 6:23-24; Ex.1003, ¶51. Faraz discloses that "[t]he 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 linkage 25. 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.1004, 6:23-29.

2. Summary of Ohm

Ohm was filed on October 23, 1996 and issued on July 21, 1998. Ohm is therefore prior art to the '200 patent under at least 35 U.S.C. § 102(e).

Ohm is directed to a microsurgical teleoperated robot system. Ex.1005, Abstract. Ohm aimed to improve surgical precision with better coupling between joints, force-feedback, and anti-backlash mechanisms. *Id.*, 1:41-64.

More specifically, Ohm discloses "a low friction, low inertia, six-axis force feedback input device comprising an arm with double-jointed, tendon-driven revolute joints, a decoupled tendon-driven wrist, and a base with encoders and motors." *Id.*, Abstract. "Referring to FIG. 1B, the slave robot manipulator 8' has six degrees of freedom and includes an arm 10' with an end effector 12' coupled to a three-axis wrist joint 14', which is coupled to a forearm 16'." *Id.*, 5:55-58; Fig 1B. The joints are equipped with brakes to fix their position. *Id.*, 21:47-53, 22:11-16.

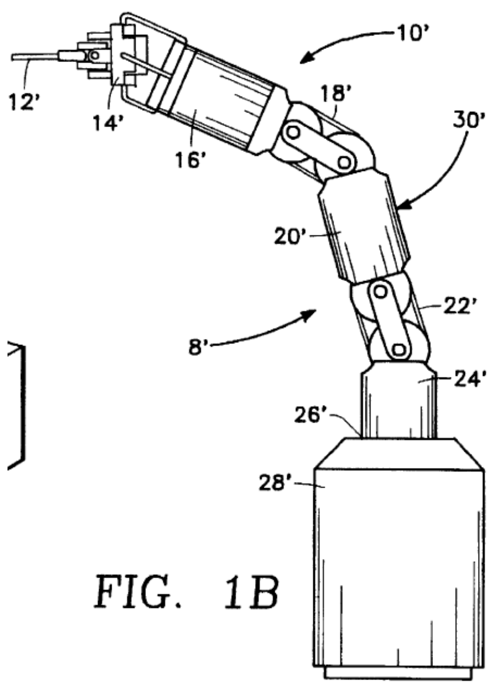


FIG. 1B

The robot has "very precise relative positioning capability[.]" *Id.*, 17:58-18:22. Motors drive each joint. *Id.*, 18:15-22. "Each motor 220' is equipped with an optical encoder (not shown) on its shaft 222' for position sensing," as well as a "Hall effect sensor" that provides "backup motor position information." *Id.*, 18:28-37, 20:14-22. A "servo-control subsystem 300" and "servo-control software module[s]" control joint positions. *Id.*, 20:46-65. The servo-control software "accepts the desired joint positions," "reads the actual joint positions," and "perform[s] joint servo-control for all of the joints based on the reading of the actual joint positions." *Id.*, 20:35-37, 21:8-19, 33:2-19.

Ohm provides great detail about kinematics computations that transform coordinates from a reference frame attached to the robot base, to a coordinate system attached to the robot's tip (and vice versa). Ex.1003, ¶56. Those computations include a "forward kinematics computation" that determines the "tip position and orientation" based on known joint angle positions, and an "inverse kinematics" computation that determines the joint angle positions based on "a desired tip position and orientation." *Id.*, 22:46-50; *see also id.* 22:52-25:3 (explaining detailed mathematics of coordinate system transformations).

3. A POSA Would Have Considered Faraz and Ohm Together

Faraz teaches that its stand can be adapted to be a "robotic surgery system" by "affixing angular position sensors" to the joints and by adding "motors or other actuators [that] could be connected using known means to drive and control the motion of any or all of the joints in stand 10." *Id.* 6:23-29. Ohm is one reference that describes such known means. Ex.1003, ¶¶78-79. The basic structure of Ohm's system has many features that are similar to Faraz. Ex.1003, ¶78. Both contain multi-jointed robotic arms that hold a surgical end effector. *Id.* Both teach use of position sensors for sensing the position of joints. *Id.* Both teach use of brakes to fix the position of joints. *Id.* And both were developed and filed as U.S. Patent applications in the mid to late 1990s. *Id.*

A POSA following his or 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, ¶¶76-77, 79. A POSA considering Faraz would have looked to other references such as Ohm that provide more detail about using the motorized joints and position sensors that Faraz states are used in its robotic surgery stand. Ex.1003, ¶¶79-80. When implementing these features of Faraz, the POSA would have refined the features based on Ohm's implementation of analogous features. Ex.1003, ¶¶80-81. Particularly given the nature of robotics as a field where practitioners are well-versed in successfully modifying and adapting robots using known components and concepts, it would have been a routine engineering task for a POSA to adapt Ohm's motorized joints and position sensors for use in Faraz. Ex.1003, ¶¶75, 80.

4. Claims 1 and 10-12 Are Obvious in View of Faraz and Ohm

As set forth below, Faraz and Ohm teach all the elements in claims 1 and 10-12, rendering those claims obvious. Faraz teaches most limitations, and Ohm provides additional details on motorized joints, position sensors, and coordinate system transformations.

a) Claim 1

(1) "A robotic surgery system comprising:"

Faraz describes "a surgical support stand comprising: a support arm and a wrist projecting from a distal end of the support arm." Ex.1004, 1:58-61. Faraz teaches that its adjustable surgical stand "is well adapted for use as a basis for a ***robotic surgery device***." *Id.*, 6:23-24.[4] Faraz discloses 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." *Id.*, 6:27-29. Faraz explains that "[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." *Id.*, 6:34-36. Thus, to the extent the preamble is limiting, Faraz discloses "*a robotic surgery system.*" Ex.1003, ¶¶97-99.

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[4] All emphases added unless otherwise noted.

(2) "a base"

Faraz discloses that its surgical support stand 10 "has ***a base*** 12 which supports a pillar 14." Ex. 1004, 2:56-59. Faraz's base is circled in green on Faraz's Figure 1 below:

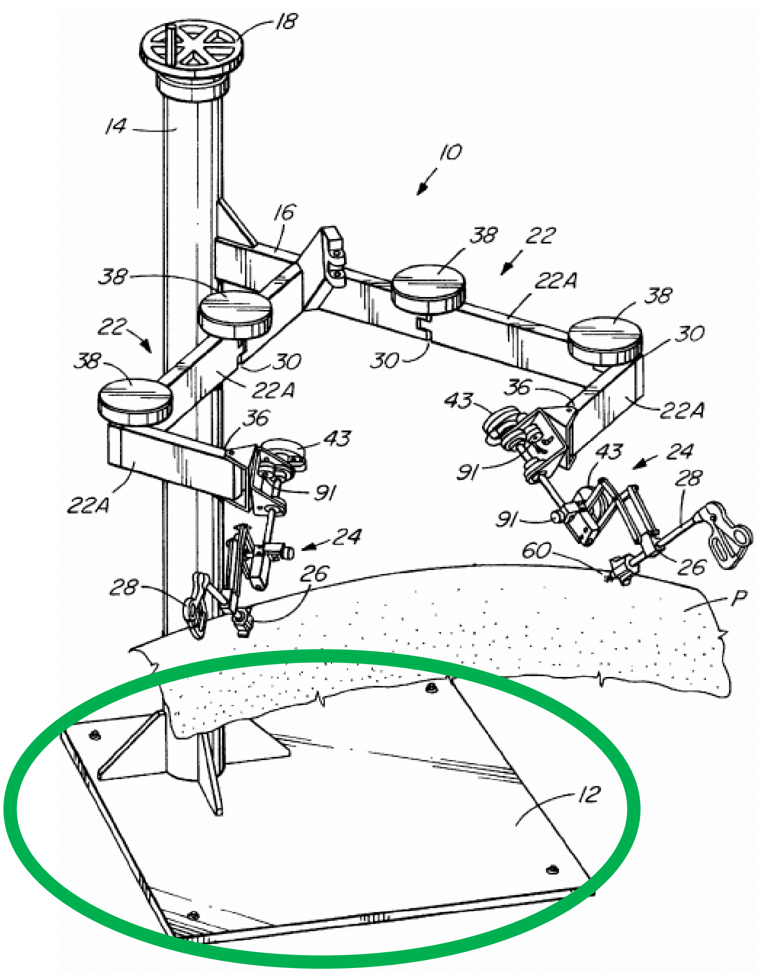


FIG. 1

Ex.1003, ¶100. Thus, Faraz discloses "*a base*."

(3) "a surgical end effector"

Faraz explains that "an implement holding wrist 24 is attached at the end 36 of each arm 22. An implement holder 26 is attached at the distal end of each wrist

24. ***Implement holders 26 are adapted to receive surgical implements 28 such as manipulators, suturing devices*** . . . ." Ex.1004, 3:13-26; *see id.*, 2:56-57. Similarly, Faraz explains that its "invention provides a surgical support stand comprising: a support arm and a wrist projecting from a distal end of the support arm. The wrist comprises… ***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." *Id.*, 1:60-2:1.

Faraz's surgical end effectors are circled in green on Faraz's Figure 1 below:

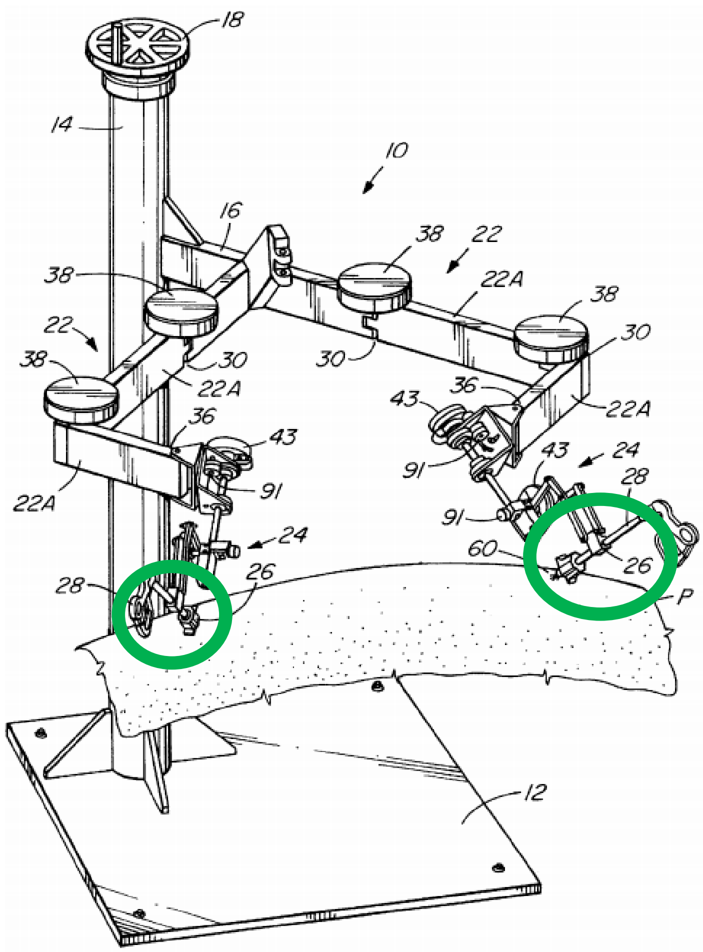


FIG. 1

Ex.1003, ¶¶102-03. In several figures, Faraz discloses that surgical instrument 28 can be scissors. Scissors serve to manipulate (cut or otherwise act on) body tissue. Ex.1003, ¶104.

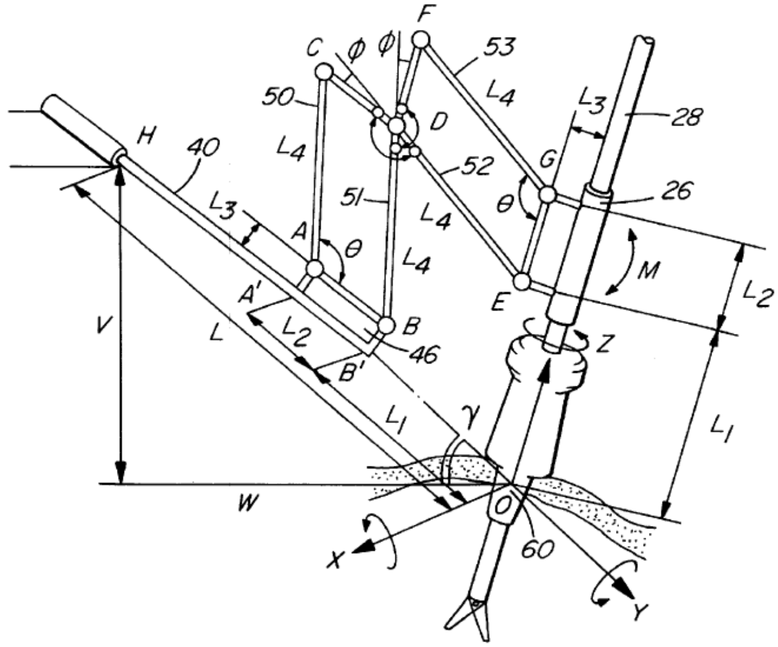


FIG. 2B

Ex.1004, Fig. 2B; *see id.*, Figs 4A and 4B.

Thus, Faraz discloses "*a surgical end effector*."

(4) "a robotic linkage movably supporting the end effector relative to the base, the linkage comprising:"

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.1004, 1:60-2:1. The support arm and wrist are the "*linkage*." Ex.1003, ¶106.

Faraz 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.1004, 3:27-33. Similarly, Faraz explains that its 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." *Id.*, 6:15-21. Faraz thus discloses a "*linkage movably supporting the end effector relative to the base*." Ex,1003, ¶¶107-08.

Faraz further discloses that "[s]tand 10 is well adapted for use as a basis for a ***robotic*** surgery device. 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 linkage 25. 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.1004, 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…" *Id.*, 3:44-50. Faraz thus discloses that its linkage can be "*robotic*." Ex.1003, ¶109.

Faraz's linkages are circled in green on Faraz's Figure 1 below:

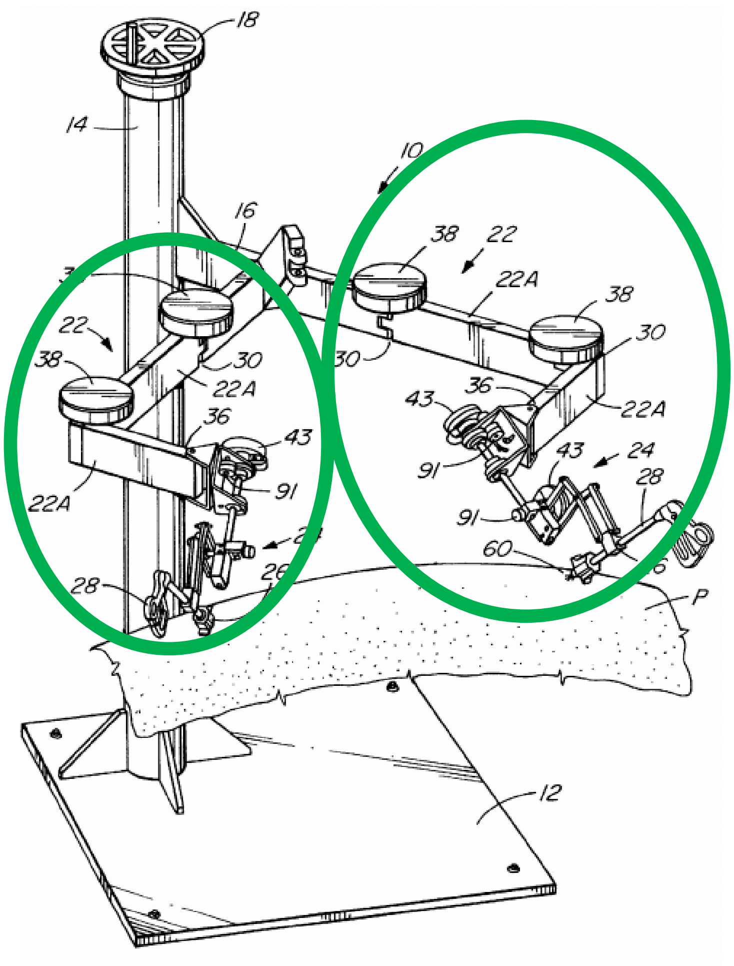


FIG. 1

Ex.1003, ¶110. Faraz thus discloses "*a robotic linkage movably supporting the end effector relative to the base.*"

(5) "a plurality of driven joints coupled to a servomechanism for moving the end effector so as to manipulate tissues"

Plurality of Driven Joints. Faraz's linkages have joints that permit movement of the end effector. Referring to Figure 1, Faraz 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.1004, 3:27-33. These joints are circled in green on Faraz's Figure 1 below:

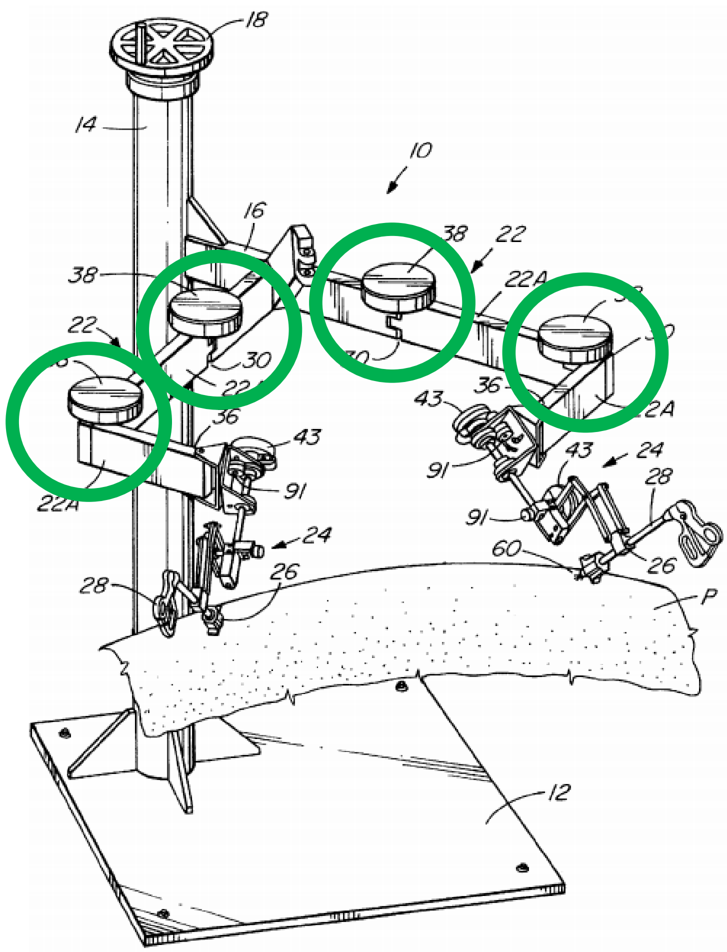


FIG. 1

Ex.1003, ¶¶112-13.

Referring again to Figure 1, Faraz further explains that "[w]rists 24 perform exactly as remote ***spherical joints***. That is, when a surgical instrument 28 is engaged in one of implement holders 26 then wrist 24 does not allow instrument 28 to move relative to a fixed point 60. During surgery fixed point 60 is made coincident with the incision in patient P so that motion of instrument 28 does not stretch or tear the incision." Ex.1004, 4:29-35.

Figure 2A of Faraz shows wrists 24, which include linkages 25. The wrists and linkages include joints, including a spherical joint (comprised of several rotational joints) that allows the wrist to rotate on three-axes. Ex.1003, ¶¶115-16. The rotational joints include "the individual ***pivot joints*** 55 of linkage 25 (which is also shown in FIG. 2A) are identified by the letters A, B, C, D, E, F and G." *Id.*, 4:66-5:22. The joints are circled in green on Faraz's Figure 2A below:

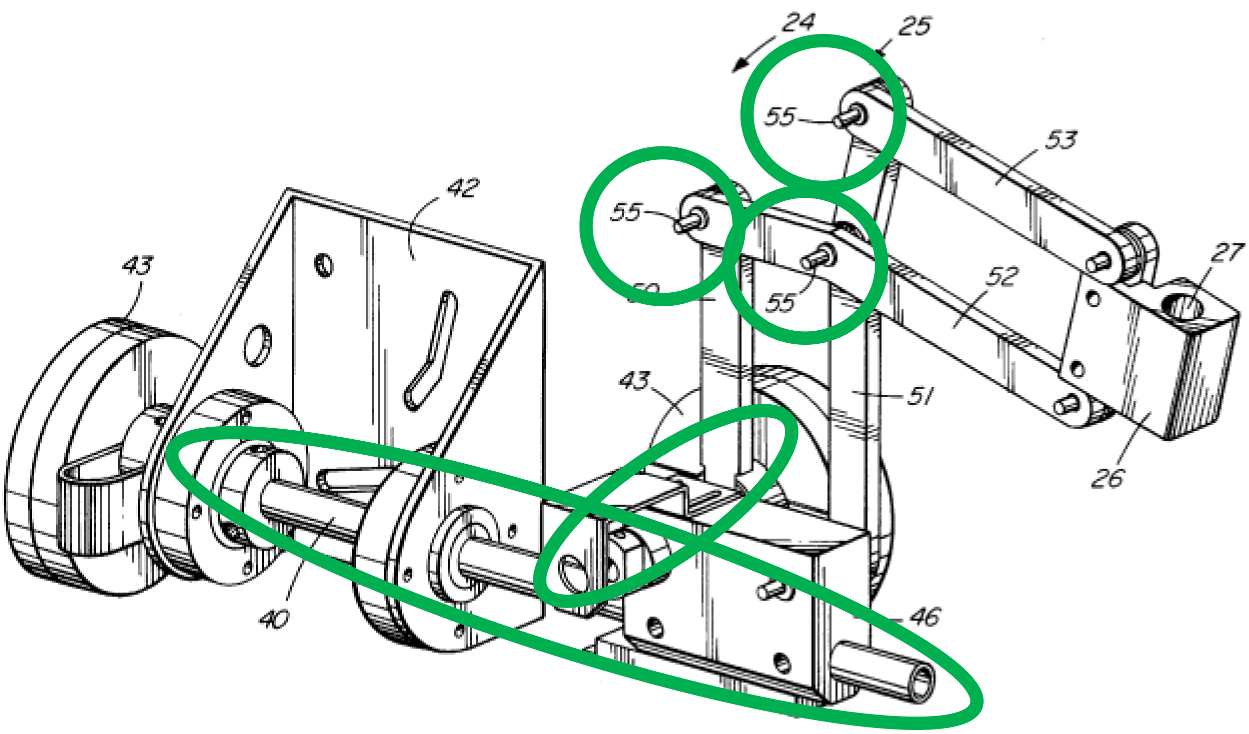


FIG. 2A

Ex.1003, ¶116.

Faraz teaches that a plurality of the joints can be "*driven*." Ex.1003, ¶117. Faraz explains 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."

Ex.1004, 6:23-29. A POSA would further understand that "***any or all of the joints*** in stand 10" (*id.*, 6:23-29), include joints in proximity to the end effector, such as pivot joints 40 and 55 shown in Figure 2A (*id.*, 4:36-39, 4:66-5:7). As explained above, and as depicted in Figure 2A, these joints allow a surgeon to manipulate surgical implements 28 in "three independent directions" while the surgical implements are in "the body of patient P." *Id.*, 6:13-21.

For Moving the End Effector. Faraz's joints are used to move the end effector to manipulate tissues. Ex.1003, ¶118. For instance, Faraz discloses that the "joints 30 [] 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.1004, 3:27-33. Faraz further explains that its surgical support stand allows "surgical 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." *Id.*, 6:15-21.

Coupled to a Servomechanism. The '200 patent uses the term "servomechanism" consistent with its ordinary usage to refer to a motor with control input or feedback that can be used to control the movement of a joint or joints of a robot. Ex.1003, ¶119. For instance, the '200 patent states that in robotically assisted surgery, a surgeon operates a controller that typically includes a hand input device "coupled by a servomechanism to a surgical instrument. More specifically, servo motors articulate the surgical instrument based on the surgeon's manipulation of the hand input devices." Ex. 1001, 1:16-30; *see id.*, 2:4-6. The patent further states that a servomechanism has "a computer processor" that performs coordinate system transformations and calculates positions and orientations of the manipulators, after receiving positions of the joints. *Id.*, 2:10-16, 3:32-36, 4:1-3, 4:65-67. The patent states that the servomechanism is used "for moving the end effector so as to manipulate tissues." *Id.*, 3:51-53.

As Dr. Cimino explains, a POSA would have understood that Faraz's "known means" used to connect motors or other actuators to the joints would include a servomechanism, which was a conventional component of robotic surgery systems, long used to precisely control motors prior to the '200 patent's priority date. Ex.1003, ¶120. Servomechanisms were typically used in robotic surgery systems because they include feedback systems (*e.g.*, using position sensors) that allow for more precise control of the mechanism (*e.g.*, joint). Ex.1003, ¶120. As explained with respect to element 7 below, a POSA would have understood that Faraz's joint sensors would be used with a servomechanism to provide feedback on the joint positions. *See* Ex.1003, ¶¶120, 135-37. Moreover, use of servomechanisms for that purpose in robotic surgery systems is admitted prior art. The ’200 patent describes use of servomechanisms in the Background of the Invention, stating that “[r]obotically assisted minimally invasive surgery instead makes use of a servomechanism to actuate the surgical end effectors of the instruments.” Ex.1001, 2:4-6; *see also id.*, 2:10-16 (describing prior art U.S. Patent No. 5,696,837 as using a servomechanism). Thus, Faraz discloses, or at minimum renders obvious, driven joints that are connected to a servomechanism. Ex.1003, ¶¶121-22.

Combination with Ohm. To the extent Patent Owner asserts that Faraz alone does not disclose or teach this element, numerous prior art references directed to robotic surgical systems, such as Ohm, disclose use of a servomechanism to control motors in the joints of a robot arm. *See* Ex.1005, Fig. 16, 20:46-21:25 (“a second module 316 of ***the servo-control sub-system performs joint servo-control for all the joints*** based on the reading of the actual joint positions.”). A POSA considering Faraz’s disclosure that it uses “known means to drive and control” would have been motivated to look to other references that describe such known means, and Ohm was one such reference. Ex.1003, ¶123. A POSA would have found it obvious to incorporate Ohm’s known means for driving and controlling joints of a robot arm—using a servomechanism connected to motors—into Faraz. *Id.*

Faraz, alone or in combination with Ohm, thus teaches "*a plurality of driven joints coupled to a servomechanism for moving the end effector so as to manipulate tissues*."

(6) "a plurality of releasably fixable joints for pre-configuring the linkage;"

The '200 patent uses the term "*releasably fixable joints*" to refer to joints with releasable brakes, but such joints may or may not be "*driven*." Ex.1003, ¶126. The '200 patent states that "[g]enerally, the arms of cart 50 will include a positioning portion which remains in a fixed configuration while manipulating tissue, and a driven portion which is actively articulated under the direction of Surgeon's console 150. The actively driven portion is herein referred to as a manipulator 58. The fixable portion of the cart linkage structures may be referred to as a positioning linkage and/or a 'set-up joint' 56, 56'." Ex.1001, 7:5-12. Thus, the '200 patent is describing robotic arms that have two different sets of joints, passive positioning joints and active driven joints. Ex.1003, ¶126. Similarly, claim 1 recites a "robotic linkage" comprising "a plurality of driven joints" and "a plurality of releasably fixable joints." By its plain terms, and consistent with the specification, claim 1 allows but does not require that the "*driven joints*" also be "*releasably fixable*."

The '200 patent uses the term "*pre-configuring the linkage*" to include positioning the linkage into alignment with the surgical site. The '200 patent states that "[w]hile the brake is held in a released mode, the linkage allows the operating room personnel to manually move the linkage into alignment with the surgical site." Ex.1001, Abstract. The '200 patent also states that "[t]he robotic manipulator is pre-positioned by manually articulating a linkage…. The positioned manipulator is restrained with a brake system so as to prevent articulation of the linkage." Ex.1001, 4:37-42. The '200 patent further states that "[t]o pre-configure cart 50 to a nominal configuration for a first procedure, first nominal position indicators 180 are aligned on one or more of the rotational joints 84 and sliding joints 82." *Id.*, 14:3-6.

As explained with respect to the previous claim element, Faraz discloses joints that permit movement of the end effector, and that a plurality of the joints may be driven (or not). Faraz teaches that "[e]ach joint 30 is equipped with ***locking means such as a pneumatic brake*** 38. Air pressure can be applied to lock pneumatic brakes 38. ***When brakes 38 are not locked ends 36 of arms 22 may be freely moved***." Ex.1004, 3:59-62. Faraz's "locking means such as a pneumatic brake 38" coupled to each joint make the joints "*releasably fixable*." These brakes are circled in green on Faraz's Figure 1 below:

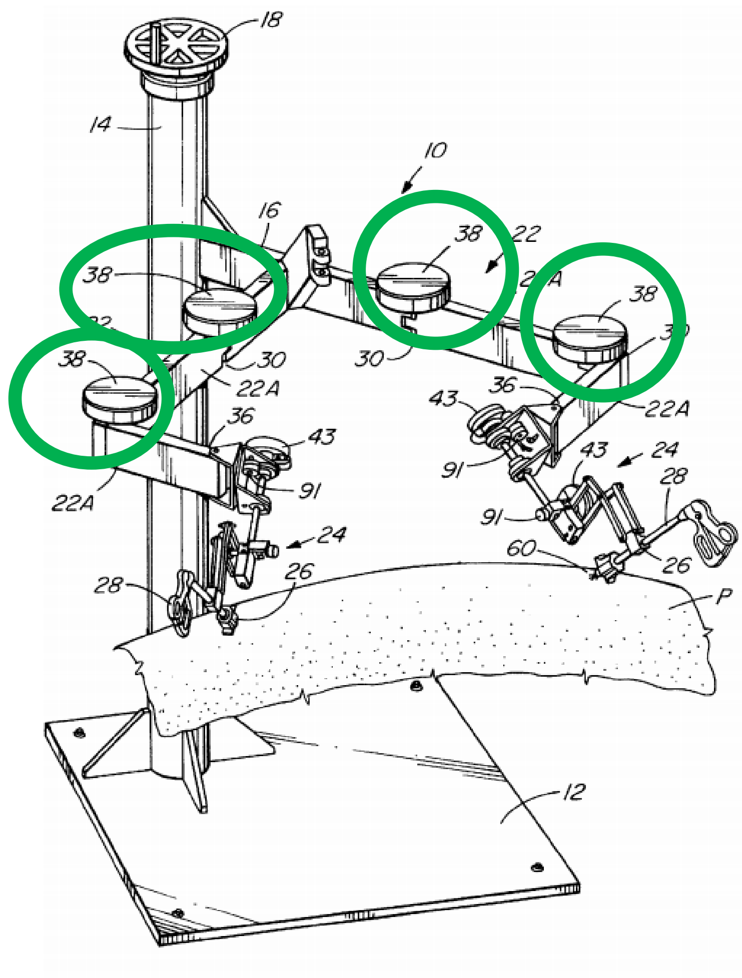


FIG. 1

Ex.1003, ¶¶129-30.

Faraz explains that first, 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***." *Id.*, 6:8-12. Then, "locks 38 are applied… to prevent points 60 from moving from the incision points." *Id.*, 6:12-14. Faraz thus discloses that the "*releasably fixable*" joints are used for "*pre-configuring the linkage*." Ex.1003, ¶¶131-32.

Faraz thus discloses "*a plurality of releasably fixable joints for pre-configuring the linkage*."

(7) "a joint sensor system coupling the fixable joints to the servomechanism, the sensor system generating joint configuration signals; and"

Faraz discloses that "[t]he 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 linkage 25***." Ex.1004, 6:24-27. These position sensors are circled in green on Faraz's Figure 1 below:

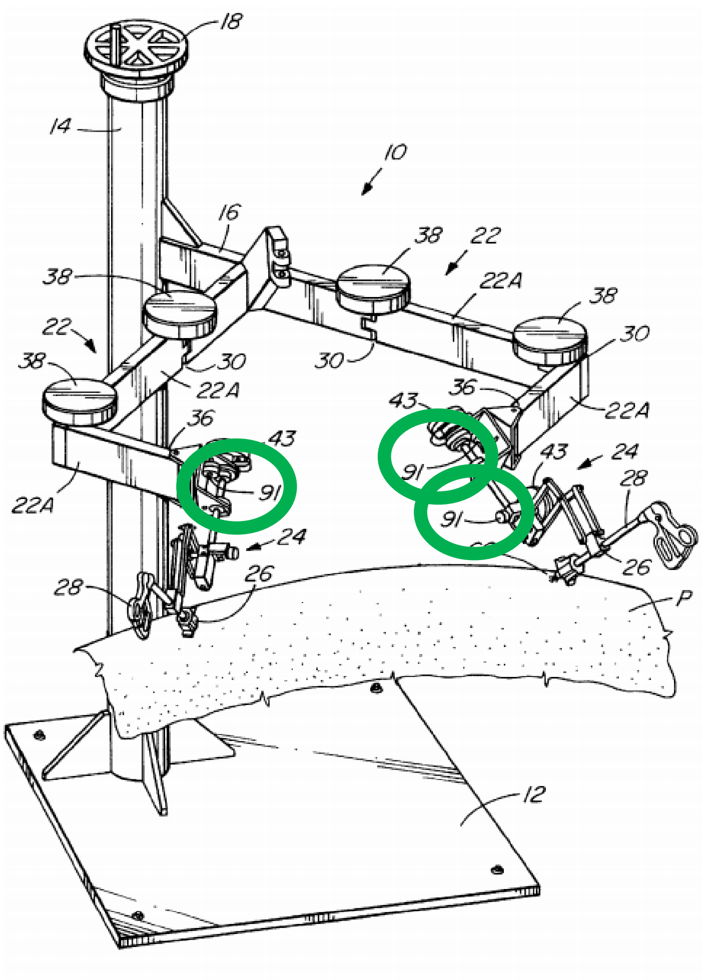


FIG. 1

Ex.1003, ¶¶133-34.

As Dr. Cimino explains, a POSA would have understood that position sensors affixed to joints by definition "*generat[e] joint configuration signals*." Ex.1003, ¶135. A POSA would also have understood that the position sensors would "*coupl[e] the fixable joints to the servomechanism*," because the ordinary use of joint position sensors was to provide feedback to the servomechanism used to control the joint positions. *Id.*, ¶136. The joint position sensor information would have been invariably communicated to a servomechanism that controlled the robotic arm, rather than to (for example) the human operator. *Id.* The servomechanism performed calculations to interpret the joint position information, and (optionally) actuated motors to move the robotic arm, end effector, or portion thereof to a desired position. *Id.* A servomechanism was used for those purposes to relieve the human operator from manually performing those tasks. *Id.*

Patent Owner may contend that Faraz does not provide sufficient details about the position sensors. Any such contention should be rejected for the above reasons. In addition, a POSA would have known the content of numerous references that provided further details about joint position sensors for use in a robotic surgical arm. *See, e.g.*, *LizardTech, Inc. v. Earth Res. Mapping, Inc.*, 424 F.3d 1336, 1345 (Fed. Cir. 2005) (a POSA is presumed to know the content of prior art).

One such reference is Ohm. Ex.1003, ¶¶138-39. Ohm's robotic surgery arm has "very precise relative positioning capability[.]" Ex.1005, 17:58-18:22. Motors drive each joint. *Id.*, 18:15-22. "Each motor 220' is equipped with an optical encoder (not shown) on its shaft 222' for position sensing," as well as a "Hall effect sensor" that provides "backup motor position information." *Id.*, 18:28-37, 20:14-22. A "servo-control subsystem 300" and "servo-control software module[s]" control joint positions. *Id.*, 20:46-65. The servo-control software "accepts the desired joint positions," "reads the actual joint positions," and "perform joint servo-control for all of the joints based on the reading of the actual joint positions." *Id.*, 20:35-37, 21:8-19, 33:2-19.

Figure 16 of Ohm, reproduced below, depicts these operations, including how a "Servo-Control Sub-System" reads joint positions based on "signals from motors" and "encoders" ("*joint configuration signals*"), and "applies the appropriate voltages to the motors to drive the joints to the desired positions" (*id.*, 33:14-17):

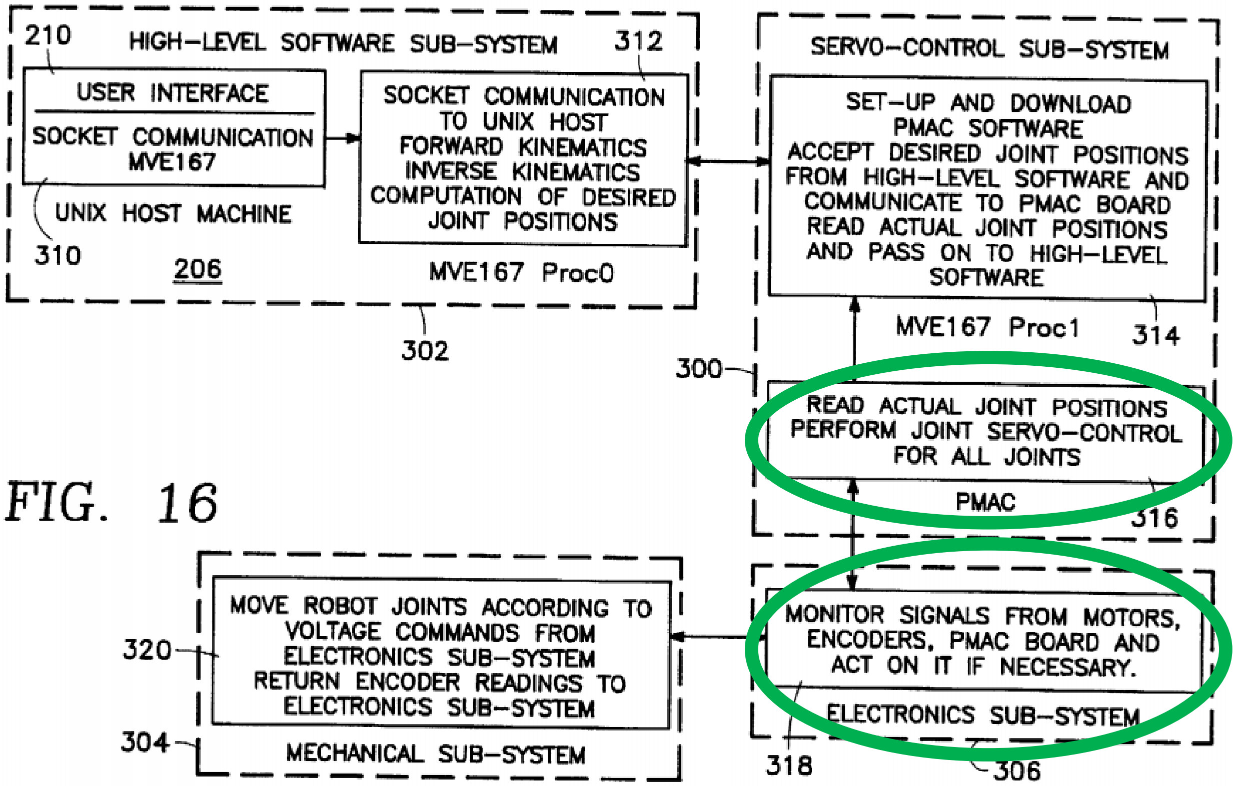


FIG. 16

Ex.1003, ¶¶140-41.

Faraz alone, or in view of Ohm, thus describe "*a joint sensor system coupling the fixable joints to the servomechanism, the sensor system generating joint configuration signals*."

(8) "a brake system coupled to the fixable joints, the brake system releasably inhibiting articulation of the fixable joints previously configured in an at least substantially fixed configuration, the brake system including a brake release actuator for releasing the fixable joints to a manually repositionable configuration in which the fixable joints can be manually articulated."

The '200 patent's use of the terms "*brake release actuator*" and "*actuator*" includes a button that releases the brakes. The '200 patent states that "[p]ositioning of the manipulator in preparation for surgery is facilitated by providing a handle 128 affixed to the distal end of second link 122. Handle 128 has an actuation button 130 that releases brakes 124 so as to allow movement of set-up joints 56." Ex.1001, 10:20-24. Claim 1 (as well as claims 10-12, 14, and 17) state that a "*brake release actuator*" or "*actuator*" releases the brakes that inhibit joint movement.

As explained with respect to element 6, Faraz teaches that ***"[e]ach joint 30 is equipped with locking means such as a pneumatic brake*** 38. Air pressure can be applied to lock pneumatic brakes 38. When brakes 38 are not locked ends 36 of arms 22 may be freely moved." Ex.1004, 3:59-62. Faraz also teaches that its brakes use friction to inhibit movement of the joints. Ex.1003, ¶145. Describing the detailed structure of the brakes, Faraz explains that "[w]hen compressed air is introduced into cavity 72 then rotor disc 74 is driven downwardly so that ***a friction surface 80 on rotor disc 74 firmly engages a friction member 82*** attached to first side 30A of joint 30." Ex.1004, 4:5-8. Faraz thus discloses "*a brake system coupled to the fixable joints*."

Faraz describes use of the stand as follows. First, 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." *Id.*, 6:8-12. Then, "locks 38 are applied… to prevent points 60 from moving from the incision points." *Id.*, 6:12-14. Similarly, Faraz explains that "[w]hen pneumatic brakes 38 are applied then pneumatic brakes 38 hold joints 30 rigidly and prevent ends 36 from moving." *Id.*, 4:8-10. Faraz thus discloses "*the brake system releasably inhibiting articulation of the fixable joints previously configured in an at least substantially fixed configuration*." Ex.1003, ¶¶147-48. The "*substantially fixed configuration*" in Faraz is the configuration prior to releasing the brakes. *Id.*

Faraz discloses several embodiments of its stand, including (i) a non-motorized "passive positioning stand" (Ex.1004, 3:50-51); and (ii) a stand with motors on "any or all of the joints" (*id.*, 6:27-29). A POSA would have understood that to position the arms (*id.*, 3:28-33, 6:8-12), at least the joints without motors must be manually moved. Ex.1003, ¶149. As explained above in Section V.A.4.a)(6), the '200 patent does not require that the "fixable joints" also be "driven." Faraz thus discloses that releasing the brakes puts arms in a "*manually repositionable configuration in which the fixable joints can be manually articulated*."

Faraz does not expressly disclose the form of actuator for releasing the brakes. However, a POSA would have understood that the brakes would be manually released and that to do so a "*brake release actuator*" such as a button or switch would be used. Ex.1003, ¶151.

Faraz thus renders obvious "*a brake system…in which the fixable joints can be manually articulated*."

Faraz and Ohm therefore render claim 1 obvious.

b) Claim 10

Claim 10 depends from claim 1 and specifies "*[t]he robotic surgery system of claim 1, wherein the joint sensor system transmits the joint configuration signals to a computer of the servomechanism*."

As Dr. Cimino explains, a POSA would have understood that the joint sensor system would "*transmit[] the joint configuration signals to a computer of the servomechanism*," because the ordinary use of joint position sensors prior to the priority date of the '200 patent was to provide feedback to the servomechanism used to control the joint positions. *Id.*, ¶155.

In addition, as explained above with respect to claim 1, element 7, Ohm teaches that a "servo-control software module" called "PMAC software" runs on a computer board called the "Proc1 board" as part of a "Servo-Control Sub-System." Ex.1005, Fig. 16, 20:6-13, 31:13-14. The PMAC software "read[s] actual joint positions" based on "signals from motors, encoders" transmitted from the "Electronics Sub-System." *Id.*, Fig. 16, 33:14-19.

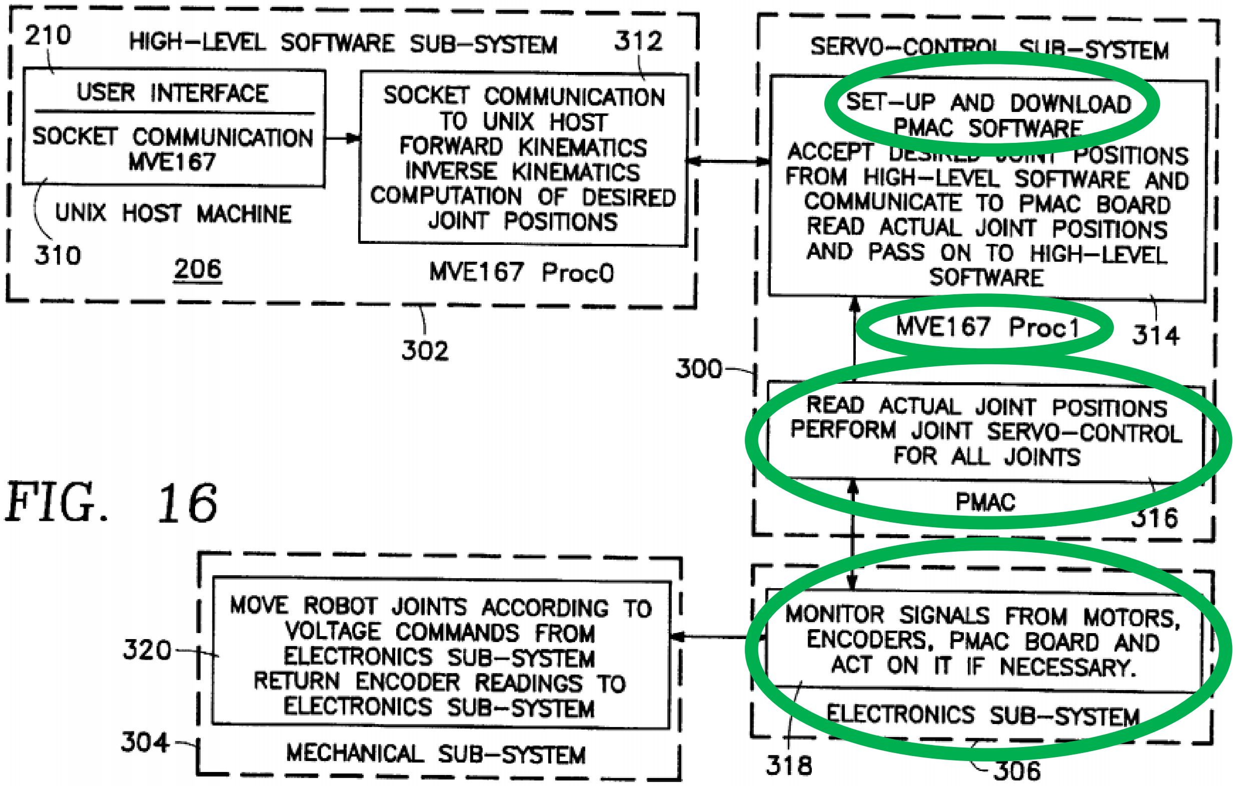


FIG. 16

Ex.1003, ¶¶157-58.

Faraz and Ohm thus teach "*[t]he robotic surgery system of claim 1, wherein the joint sensor system transmits the joint configuration signals to a computer of the servomechanism.*"

Faraz and Ohm therefore render obvious claim 10.

c) Claim 11

Claim 11 depends from claim 10 and specifies "*[t]he robotic surgery system of claim 10, wherein the computer calculates a coordinate system transformation between a reference coordinate system affixed relative to the base and the end effector using the joint configuration signals.*"

The ’200 patent admits that coordinate system transformations are prior art. Ex.1001, 2:10-15. One prior art reference that discloses the transformations is Ohm. Ex.1003, ¶161.

As explained above with respect to claim 10, Ohm teaches that an electronics sub-system sends signals from motors and encoders (“*joint configuration signals*”) to a servo-control sub-system with PMAC software. The PMAC software “read[s] actual joint positions and pass[es] [them] on to high-level software.” Ex.1005, Fig. 16. The high-level software sub-system, running on a “Unix Host Machine” (“*computer*”) performs “forward kinematics” and “inverse kinematics” computations (“*a coordinate system transformation between a reference coordinate system affixed relative to the base and the end effector using the joint configuration signals*.”). *Id.*; Ex.1003, ¶162.

More specifically, Ohm uses the term “tip” to refer to the “tip of the end effector 12’” as shown in Figure 1B. Ex.1005, 18:4-6. Ohm discloses kinematic computations including a “forward kinematics computation” that determines the “tip position and orientation” based on known joint angle positions, and an “inverse kinematics” computation that determines the joint angle positions based on “a desired tip position and orientation.” *Id.*, 22:46-50; Ex.1003, ¶163.

Ohm explains that “[a]t all of the joints k, there is a coordinate transformation matrix A*(k) defined as follows in terms of the angles of rotation θ(k). When taken sequentially from the base of the manipulator to the tip, these transformations reflect a roll, pitch, pitch, pitch, pitch, roll, pitch, yaw, sequence of rotations for the master robot 8…" *Id.*, 23:49-56; Ex.1003, ¶164. Ohm further explains that "[t]he matrix A*(k) transforms any arbitrary vector, expressed in the coordinate system attached to the k+1 link, to the coordinate system attached the k link." Ex.1005, 24:13-16. Ohm then discloses an algorithm that "computes recursively the attitude matrix of a coordinate system attached to the tip of the manipulator, as well as the location of this tip." *Id.*, 24:46-48. The algorithm "starts at the tip of the manipulator and ends at the base." *Id.*, 24:62-63. "At the termination of the algorithm, the matrix S stores the attitude matrix that ***transforms tip coordinates to base coordinates. Its transpose S* is a coordinate transformation in the opposite direction.*** The corresponding vector L stores the location of the tip in base coordinates." *Id.*, 24:65-25:3.

The "base coordinates" in Ohm correspond to the "*reference coordinate system affixed relative to the base*" in the '200 patent. The "tip coordinates" in Ohm correspond to the "*end effector*" in the '200 patent. Ex.1003, ¶165.

Ohm thus discloses "*[t]he robotic surgery system of claim 10, wherein the computer calculates a coordinate system transformation between a reference coordinate system affixed relative to the base and the end effector using the joint configuration signals.*"

Faraz and Ohm therefore render claim 11 obvious.

d) Claim 12

Claim 12 depends from claim 11 and specifies "*[t]he robotic surgery system of claim 11, further comprising a plurality of robotic linkages, each linkage including a plurality of joints coupled to the sensor system and supporting an associated end effector, wherein the computer calculates coordinate system transformations between the reference coordinate system and each of the end effectors using the joint configuration signals*."

Claim 12 requires a "plurality" of robotic linkages, but otherwise repeats the elements of claim 11. In other words, claim 12 requires two or more robotic arms, whereas claim 11 (via dependence on claim 1) requires one or more robotic arms.

Faraz depicts a surgery system with two robotic arms. *See above*, Claim 1; Ex. 1004, Fig. 1. As explained above with respect to claim 11, Ohm discloses "*each linkage including a plurality of joints coupled to the sensor system and supporting an associated end effector, wherein the computer calculates coordinate system transformations between the reference coordinate system and each of the end effectors using the joint configuration signals*." The coordinate system transformation described in Ohm applies equally to systems with two arms—a POSA would have understood that the same transformation can simply be performed separately for each arm. Ex.1003, ¶¶170-71. A POSA would have been motivated to perform the coordinate system transformation for two arms for the same reason as for one arm—to enable the system to control the movement of each arm. *Id.*, ¶171.

Faraz and Ohm therefore render claim 12 obvious.

B. Ground 2: Faraz, Ohm, and Sackier

1. Summary of Sackier

Sackier was published in 1994 in the journal Surgical Endoscopy. The journal was in public circulation, and had been received and cataloged in at least one library in 1994. Ex.1010. Sackier is therefore prior art to the ’200 patent under at least 35 U.S.C. § 102(b).

Sackier is directed to a system for robotically assisted laparoscopic surgery. Ex. 1009, Title. The system is called AESOP, for Automated Endoscope System for Optimal Positioning. *Id.*, 64. A photograph of the system is shown in Sackier’s Figure 1:

Fig. 1. A photograph of AESOP demonstrating the positioning arm holding the laparoscope, the computer control unit, the foot switch (bottom left) and the hand switch (bottom center)

The AESOP system two main parts: a chassis and a positioner. *Id.* The chassis, shown in Figure 1 on the bottom, contains power system and a control computer that "is responsible for interpreting the commands from the surgeon (who has a foot controller and a hand controller) into action by applying power to the actuators which position the robot." *Id.* The positioner, shown in Figure 1 on the top and right, "is an electromechanical device which attaches to the rail of the surgical table. This is the device which is attached to the laparoscope by a collar and collar holder (Figs. 1 and 2) and holds and moves the laparoscope." *Id.* The positioning arm has joints. *Id.* Sackier's Figure 3 shows the joints:

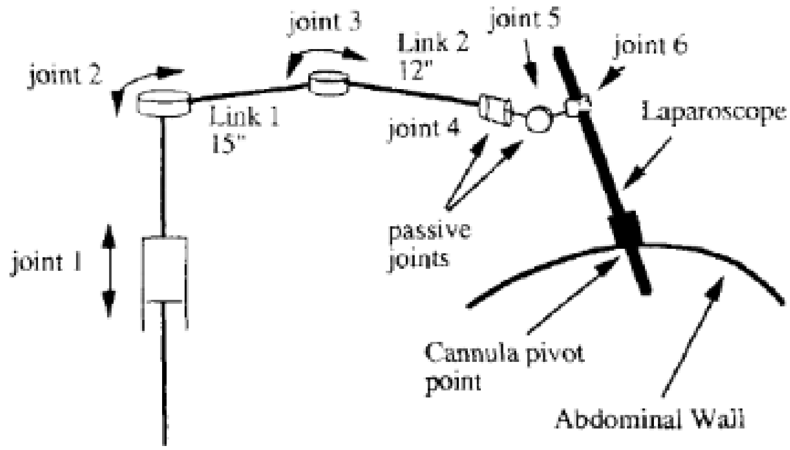


Fig. 3. The joint structure of the positioner, collar holder, and collar

In use, a surgeon grasps the positioner and depresses a "disable" button, causing the "AESOP to function as a manual scope holder. When the disable button has been pressed, the joints become passive and the surgeon can easily move the positioner to any location. After releasing the disable button the positioner becomes rigid once again." *Id.* The surgeon can also move the positioner using the foot or hand controller. *Id.*

2. A POSA Would Have Considered Faraz with Ohm and Sackier

The reasons for considering Faraz and Ohm together are described above in Section V.A.3. A POSA considering Faraz would have been motivated to consider multiple references describing known means for driving and controlling the joints, and would have considered Sackier in addition to Ohm. Ex.1003, ¶82. The systems described in Faraz and Sackier contain similar features. *Id.* Both contain multi-jointed robotic arms that hold a surgical implement. *Id.* Both teach use of brakes to fix the position of joints. *Id.* Both specifically describe their intended use in laparoscopic surgery. *Id.*; Ex. 1004, Abstract; Ex. 1009, Title.

A POSA following his or 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, ¶¶75-77, 83. A POSA considering Faraz would have looked to other references that provide more detail about incorporating motorized joints, because Faraz's instructs the reader to use known means for implementing those features. Ex.1003, ¶¶83-84. Sackier is one such reference a POSA would have considered. *Id.* When implementing Faraz, the POSA would have refined Faraz's features based on Sackier's implementation of analogous features and description of its mode of operation. *Id.*, ¶84.

For example, a POSA would have understood based on Sackier that a robotic arm holding a surgical implement could include a brake release button, that would allow a surgeon to manually position a robotic arm. Ex.1003, ¶85. A POSA would have understood the benefits of including such a button, namely that as taught by Sackier the "device is extremely simple to use" and gives the surgeon as much control as desired to position the device. *Id.*; Ex. 1009, 66.

3. Claims 1 and 10-12 Are Obvious in View of Faraz, Ohm, and Sackier

As explained above, Faraz and Ohm disclose all the elements in claims 1 and 10-12, thereby rendering those claims obvious.

Patent Owner may contend that the combination of Faraz and Ohm does not expressly disclose a robotic arm with joints that can be both motorized ("*a plurality of driven joints*") and manually positionable ("*a plurality of releasably fixable joints*"). Any such contention should be rejected for the above reasons. In addition, a POSA would have understood based on Sackier that a robotic surgical arm could have joints that could be both motorized and manually positionable.

Sackier explains that to use its robotic surgical arm, a surgeon grasps the positioner and depresses a "disable" button, causing the "AESOP to function as a manual scope holder. Ex.1003, ¶174. When the disable button has been pressed, the joints become passive and the surgeon can easily move the positioner to any location. *Id.* After releasing the disable button the positioner becomes rigid once again." Ex. 1009, 64. The surgeon can also move the positioner using the foot or hand controller. *Id.* A control computer "is responsible for interpreting the commands from the surgeon (who has a foot controller and a hand controller) into action by applying power to the actuators which position the robot." *Id.* A POSA would have found it obvious to configure Faraz's system to include joints driven by motors that could also be manually repositionable by actuating a button. Ex.1003, ¶174.

To the extent Patent Owner contends that claims 1 and 10-12 require use of a single brake release actuator ("*the brake system including a brake release actuator for releasing the fixable joints*"). Faraz and Ohm render obvious use of a single brake release actuator for the reasons explained above. In addition, Sackier discloses use of a single brake release actuator. Namely, Sackier explains that to use its robotic surgical arm, a surgeon grasps the positioner and depresses a "disable" button, causing the "AESOP to function as a manual scope holder. Ex.1003, ¶175. When the disable button has been pressed, the joints become passive and the surgeon can easily move the positioner to any location. After releasing the disable button the positioner becomes rigid once again." Ex. 1009, 64.

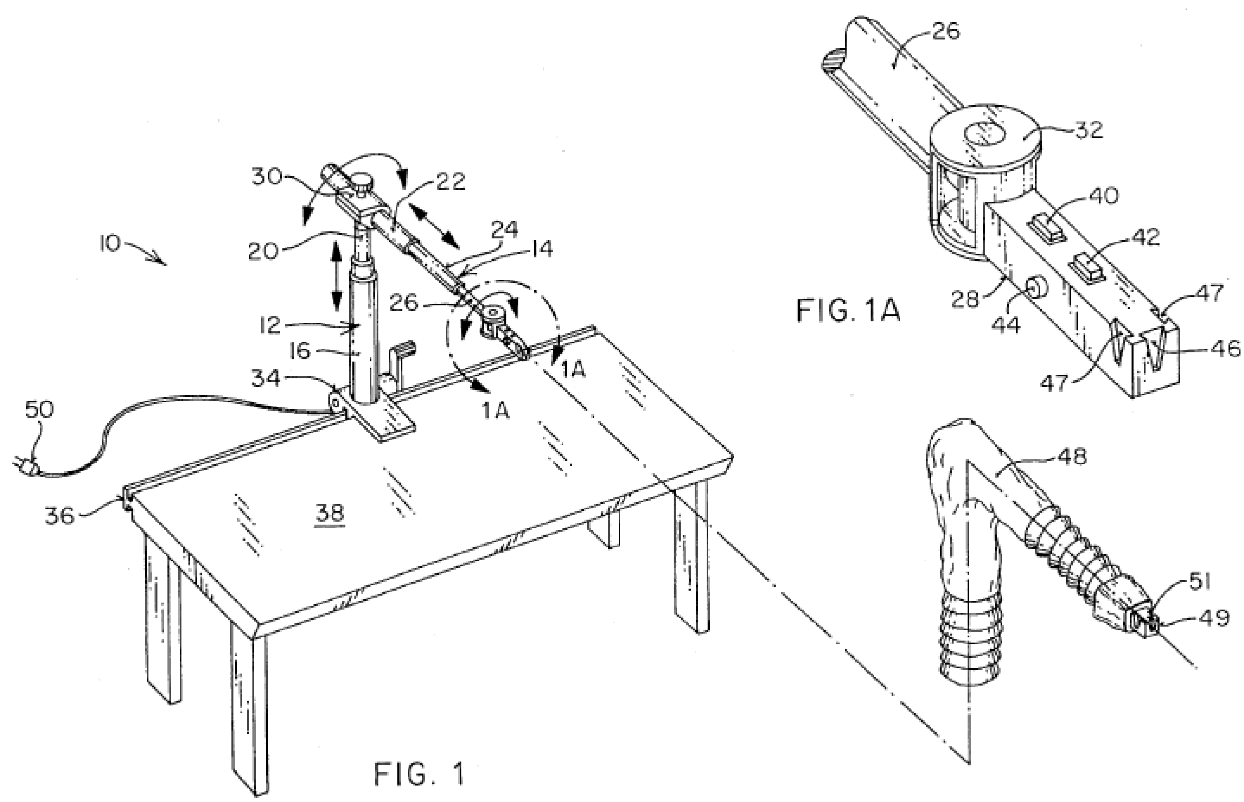
Accordingly, Faraz, Ohm, and Sackier render claims 1 and 10-12 obvious.

C. Ground 3: Faraz, Lathrop, and Tarn

1. Summary of Lathrop

Lathrop was filed on September 16, 1994 and issued on September 17, 1996. Lathrop is therefore prior art to the '200 patent under at least 35 U.S.C. § 102(b) and 102(e).

Lathrop is directed to a "peritoneal distension robotic arm." Ex.1006, Title. The arm is used for "manipulating parts of the body in surgical procedures, particularly useful for peritoneal distension in laparoscopic surgery." *Id.*, Abstract. Peritoneal distension refers to lifting the abdominal wall away from the underlying organs to improve visibility and accessibility. *Id.*, 1:24-28, Figs. 11-12. Lathrop's arm provides power-assisted lifting and lowering, has convenient controls, and provides patient and operator safety in the event of a power failure. *Id.*, 1:60-2:8. The arm can be used in other types of surgical procedures besides distension. *Id.*, 2:9-12. Lathrop's Figure 1 depicts the robotic arm:



The support structure 10 is mounted to a surgical table by clamping means 34. *Id.*, 6:55-56. The support structure 10 has a vertical post 12 and horizontal arm 14. *Id.*, 6:48-51. The vertical post and horizontal arm have telescoping segments. *Id.* The horizontal arm is pivotally attached to the vertical post. *Id.*, 6:52-54. An end segment 28 (*see* Fig. 1A) is attached to the arm by a rotatable joint 32. *Id.*, 6:58-59. The arm includes powered lifting means and locking means. *Id.*, 6:63-65. Switches 40 and 42 raise and lower the arm, while switch 44 releases the locking means. *Id.*, 6:63-65, 9:6-11. Surgical instruments are mounted in apertures 51 of attachment 49. *Id.*, 7:10-14.

Lathrop describes in detail the locking means for its robotic arm. *Id.*, 8:16-9:16, 9:26-53. Both the horizontal arm and the end segment include locking means that lock the arm and end segment joints into position. *Id.*, 8:8-17, 8:56-58, 9:4-5. "Locking means 58, 60 are configured so as to be in the 'locked' position when no power is applied to the solenoid 82." *Id.*, 8:33-35; *see also id.*, 9:45-48. Lathrop explains that "preferably, the locking mechanisms are biased in a locked position when no power is applied" (*id.*, 3:43-45), "so as to maintain the position of the support structure in the event of a power failure" (*id.*, 6:2-6).

In a preferred embodiment, "[l]ocking actuator switch 44 is disposed on the side surface of distal portion 134 of end segment 28 to provide actuation of the locking mechanisms." *Id.*, 9:9-11, Figs. 1, 4. Lathrop describes using this single "locking actuator switch" for ease of use:

> The horizontal arm of the support structure is positioned over a desired point on the patient's body, usually over the lower abdomen. This may be performed by grasping the horizontal arm and depressing switch 44 to release the locking mechanisms, then rotating or extending the arm to the desired location. Once the arm is in position, locking actuator switch 44 is released so as to re-lock the arm in position.

Id., 10:7-16. Similarly, Lathrop explains that:

> A mechanism is provided for releasably locking the position of the horizontal arm relative to the vertical post (i.e., radial distance and angle of rotation relative to the vertical axis defined by the post) preferably including an actuator switch at the distal end of the horizontal arm. Thus, the treating physician can vertically align the distal end of the horizontal arm over a desired location using a single hand which both actuates the switch and manipulates the end of the arm.

Id., 2:67-3:8.

2. Summary of Tarn

Tarn was published in 1986. The article was in public circulation, and had been received and cataloged in at least one library by 1987. Ex.1011. Tarn is therefore prior art to the ’200 patent under at least 35 U.S.C. § 102(b).

Tarn is directed to a method for the coordinated control of two robot arms. Ex.1007, 1193. Tarn explains that coordination among multiple robotic arms is essential, to allow the arms to “operate in a kinematically and dynamically coordinated fashion and respond to the working environment without collisions.” *Id.* Tarn’s control method “uses a dynamic coordinator acting on relative position and velocity task space errors and/or on relative force-torque errors between the two arms as sensed at the end effectors.” *Id.*, 1194.

Tarn presents a mathematical model for controlling two PUMA 560 robot arms. *Id.* Each PUMA 560 robot, depicted below, has six joints. *Id.* (Table 1).

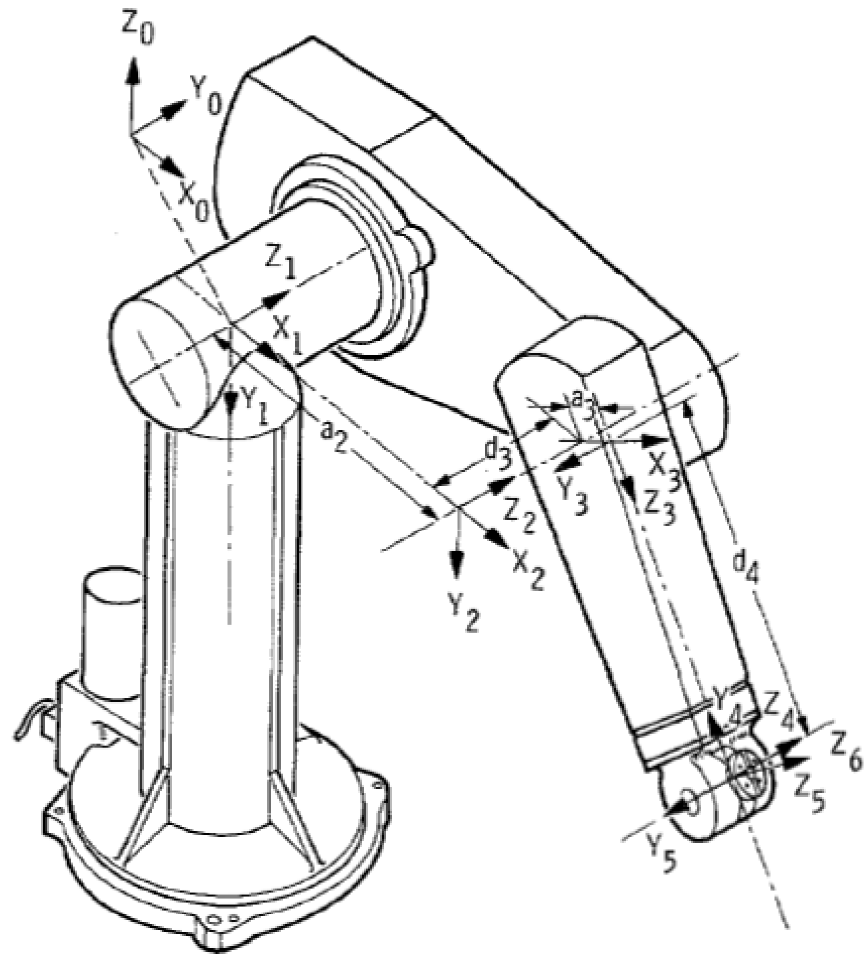


Figure 1 PUMA 560 Reference Frames

Tarn's mathematical model takes as an input the positions of each joint, as well as inertia parameters for the robot arm. *Id.* ("q – (q_1, q_2, … q_6) is the joint position vector….$D_{ij}(q)$ is the inertial load projection function to joint 'i'…"). Tarn provides an example form of the functions using the specific parameters for the PUMA 560 robot arm, computed from actual measurements and design drawings. *Id.*, 1194-95 (Tables 1-2).

Tarn then explains that "[a]ny tasks like material handling can be described by the position and orientation of the tool (end-effector) attached to the robot arm." *Id.*, 1195. Tarn adopts three angles to represent the end-effector orientation, and derives the transformation from the world coordinate system to the tool coordinate system. *Id.* (referring to T_{ot} matrix). Tarn then derives "the general forward kinematic solution for end effector position in the task space as a function of joint variables for the PUMA 560 robot arm." *Id.*, 1196 (Equation 5).

Next, Tarn teaches how to coordinate control of two dynamically cooperating robot arms. *Id.*, 1198. To do so, Tarn designs a control algorithm including an "optimal coordinator" that "is operating on the difference between outputs of the two robots, minus the constant offset distance." *Id.* Tarn further teaches how to minimize the error in offset distance between the two end-effectors, by calculating an error based on the relative position of the end effectors minus the constant offset distance. *Id.*, 1199 (Equation 12). In essence, Tarn discloses how to not only calculate the position of the end effectors of two robot arms relative to one another, but also how to smoothly coordinate those positions to perform a cooperative task such as holding and transferring an object. *Id.*, 1198.

Finally, Tarn explains how its control algorithms were tested using computer simulations. For instance, Table 3 shows simulation results for control of two robot arms, reporting maximum relative position errors in millimeters, with and without use of the optimal coordinator ("Δv"). *Id.* Tarn reports that "[a]s seen in Table 3, the optimal coordinator reduces the relative error by a factor of 3." *Id.*, 1201. Accordingly, Tarn concludes that the simulations validate its dynamic control method for two cooperating robot arms. *Id.*

3. A POSA Would Have Considered Faraz with Lathrop and Tarn

Faraz teaches that its stand can be adapted to be a "robotic surgery system" by "affixing angular position sensors" to the joints and by adding "motors or other actuators [that] could be connected using known means to drive and control the motion of any or all of the joints in stand 10." *Id.* 6:23-29. Lathrop is one reference that describes such known means, and Lathrop's system has many features that are similar to Faraz. Ex.1003, ¶86. Both contain multi-jointed robotic arms that hold a surgical end effector. *Id.* Both teach use of position sensors for sensing the position of joints. *Id.* Both teach use of brakes to fix the position of joints. *Id.* And both were developed and filed as U.S. Patent applications in the mid to late 1990s. *Id.*

A POSA following his or 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, ¶¶75-77, 87. A POSA would have been motivated to improve patient safety and ease of operation of the robotic surgery system. Ex.1003, ¶88. For that reason, a POSA would have been motivated to incorporate Lathrop's teachings about convenient controls and patient and operator safety in the event of a power failure into Faraz. *Id.* Particularly given the nature of robotics as a field whose practitioners are well-versed in successfully modifying and adapting robots using known components and concepts such as those used in other robots, a POSA would have had little difficulty adapting Lathrop's simple brake switch biased in a locked position for use in Faraz. Ex.1003, ¶¶75, 88.

The POSA considering Faraz also would have considered Tarn, which is another reference describing known means for controlling motorized joints. Ex.1003, ¶89. Faraz teaches that its surgical stand can be automated, via the addition of known motors and position sensors to the joints of each arm. *Id.* A POSA would have understood that the addition of motors and position sensors would also require a computer programmed to control the motors and interpret the position signals. *Id.* A POSA would have naturally looked to references that disclose known techniques for doing so. *Id.*

One such reference is Tarn. *Id.*, ¶90. As explained above, Tarn discloses a method for the coordinated control of two robot arms that interprets joint signals. As Dr. Cimino explains, a POSA would have been motivated to coordinate control of the two robotic arms so that when the surgeon moves master control, the system can use knowledge of the joint angles to determine and provide the intended motions in the slave arms and/or to ensure patient safety by avoiding collisions. Ex.1003, ¶90. As Tarn explains:

> The basic research objective of coordinated control of two arms is to design a control system which is able to command both arms in such a way that two arms operate in a kinematically and dynamically coordinated fashion and respond to the working environment without collisions.

Ex.1007, 1193. When adding motors to Faraz, the POSA would have refined that feature's implementation based on Tarn's teachings about how to coordinate operation of two robotic arms. Ex.1003, ¶91. Particularly given the nature of robotics as a field whose practitioners are well-versed in successfully modifying and adapting robots using known components and concepts, and the detailed kinematics presented by Tarn, a POSA would have had no difficulty adapting Tarn's kinematics for use in Faraz. *Id.*

4. Claims 14 and 17 Are Obvious in View of Faraz, Lathrop, and Tarn

As set forth below, Faraz, Lathrop, and Tarn disclose all the elements in claims 14 and 17, thereby rendering those claims obvious. Faraz is the base reference. Lathrop is a secondary reference that discloses a single switch to control the brakes, and brakes biased in a locked configuration. Tarn is a secondary reference that discloses calculating the position and orientation of end effectors on two robotic arms relative to one another.

a) Claim 14

(1) "A support structure for supporting a first robotic surgical manipulator relative to a second robotic surgical manipulator, each surgical manipulator coupled to a servomechanism so as to robotically manipulate tissues of a patient body with a surgical end effector, the support structure comprising:"

The '200 patent uses the term "*manipulator*" to include an actively driven portion of a robotic arm that holds a surgical end effector. Ex.1003, ¶178. The '200 patent states that "[g]enerally, the arms of cart 50 will include a positioning portion which remains in a fixed configuration while manipulating tissue, and a driven portion which is actively articulated under the direction of surgeon's console 150. The actively driven portion is herein referred to as a manipulator 58." Ex.1001, 7:5-9. The '200 patent further states that "robotic manipulators 58 preferably include a linkage 62 that constrains movement of tool 54." *Id.*, 7:36-38.

As explained above with respect to claim 1, elements 1-5, Faraz discloses a surgical stand for supporting two robotic arms with surgical end-effectors, and Faraz alone discloses or at least renders obvious using a servomechanism. *See, e.g.*, Ex.1004, Fig. 1. The term "manipulator" refers to an actively driven portion of a robotic arm that holds a surgical end effector. Ex.1003, ¶179. Claim 1 recites that same concept in element 5 using the term "manipulate" instead of "manipulator": "*a plurality of driven joints coupled to a servomechanism for moving the end effector so as to manipulate tissues*." As explained for claim 1 above, Faraz discloses that element.

In particular, as explained for element 5 of claim 1, Faraz discloses that "any or all of the joints in stand 10" can be motorized. Ex.1004, 6:27-29. A POSA would have understood based on that disclosure that some of the joints, such as the wrist joints depicted in Figure 2A, could be motorized ("*a plurality of driven joints coupled to a servomechanism*"), to permit robotic control of the end effector ("*for moving the end effector*"). Ex.1003, ¶180. In that example, each wrist (which includes motorized joints) and its end effector of Faraz would correspond to the "*robotic surgical manipulators*" of claim 14. Ex.1004, Fig.2A.

Thus, to the extent the preamble of claim 14 is limiting, Faraz discloses it.

(2) "a base coupled to the first manipulator;"

As explained above with respect to claim 1, element 2, Faraz discloses a "*base*." Faraz depicts the base 12 as being "*coupled to the first manipulator*," via a pillar 14, arm support 16, and arm 22. Ex.1004, Fig. 1. These four components are circled in green below.

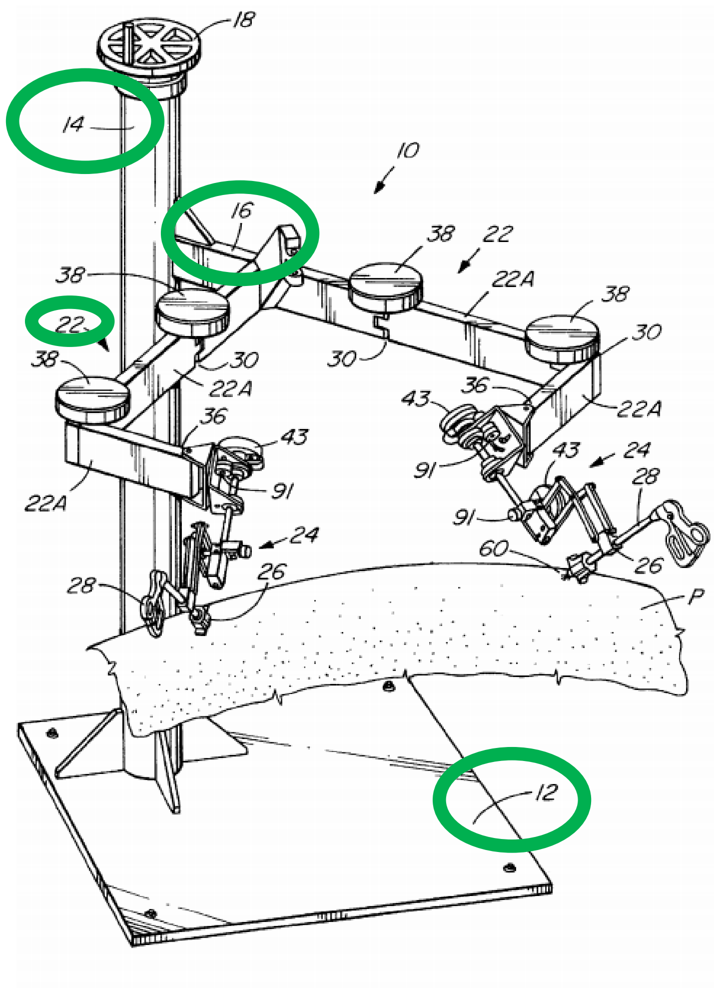


FIG. 1

Ex,1003, ¶183.

Faraz thus discloses "*a base coupled to the first manipulator.*"[5]

[5] Petitioner notes that claim 14 is silent on how the first manipulator is coupled to the base, and is silent on whether or not the first manipulator includes an "articulated linkage" or a "brake system."

(3) "a manipulator support movably supporting the second manipulator relative to the base;"

As explained above with respect to the preceding element, Faraz discloses a base coupled to two arms, each of which can be motorized in whole or in part. As explained above with respect to claim 1, elements 4-6, each arms has joints that allow movement of the manipulator relative to the base. *See, e.g.*, Ex.1004, Fig. 1 (item 30), Fig. 2A (item 55); Ex.1003, ¶185. Faraz thus discloses "*a manipulator support movably supporting the second manipulator relative to the base*."

(4) "an articulated linkage having a plurality of joints coupling the base to the manipulator support so as to allow manual movement of the second manipulator relative to the base;"

As explained above with respect to claim 1, elements 4 and 6, Faraz discloses an arm 22 and wrist 24 ("*an articulated linkage*") movably supporting the end effector relative to the base, and also discloses that each arm and wrist has a plurality of joints ("*a plurality of joints coupling the base to the manipulator*") for pre-configuring the linkage. *See, e.g.*, Ex.1004, Fig. 1, 3:27-33 ("Arms 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.1003, ¶187. Faraz thus discloses a "*linkage having a plurality of joints coupling the base to the manipulator support*."

As explained above with respect to claim 1, element 8, at least some of the joints of Faraz's arm can be "*manually articulated*." *See, e.g.*, Ex.1004, 6:8-12 ("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.1003, ¶189.

Faraz thus discloses "*an articulated linkage having a plurality of joints coupling the base to the manipulator support so as to allow manual movement of the second manipulator relative to the base*."

(5) "a brake system releasably inhibiting movement of the joints, wherein the brake system can release the joints supporting the second manipulator upon actuation of a single actuator; and"

As explained above with respect to claim 1, element 8, Faraz discloses a "*brake system… releasably inhibiting articulation of the fixable joints*…" *See, e.g.*, Ex.1004, 3:59-62 ("Each joint 30 is equipped with locking means such as a pneumatic brake 38. Air pressure can be applied to lock pneumatic brakes 38. When brakes 38 are not locked ends 36 of arms 22 may be freely moved."); Ex.1003, ¶191. Faraz thus discloses "*a brake system releasably inhibiting movement of the joints*."

Faraz does not expressly disclose use of a single actuator to release the brakes. A POSA, however, would be motivated to use a single actuator (e.g., a button or switch) to release the brakes, and would have no technically difficulty in modifying Faraz to do so. Ex.1003, ¶193. Faraz thus renders obvious "*a brake system releasably inhibiting movement of the joints, wherein the brake system can release the joints supporting the second manipulator upon actuation of a single actuator*."

Faraz in view of Lathrop also teaches use of a single actuator to release the brakes. Ex.1003, ¶195. In particular, Lathrop describes a locking (brake) system controlled by "[l]ocking actuator switch 44," which "is disposed on the side surface of distal portion 134 of end segment 28 to provide actuation of the locking mechanisms." *Id.*, 9:9-11, Figs. 1, 4. Lathrop likewise describes using a single "locking actuator switch" for ease of use:

> The horizontal arm of the support structure is positioned over a desired point on the patient's body, usually over the lower abdomen. This may be performed by grasping the horizontal arm and ***depressing switch 44 to release the locking mechanisms***, then rotating or extending the arm to the desired location. Once the arm is in position, locking actuator switch 44 is released so as to re-lock the arm in position.

Id., 10:7-16. Similarly, Lathrop explains that:

> ***A mechanism is provided for releasably locking the position of the horizontal arm*** relative to the vertical post (i.e., radial distance and angle of rotation relative to the vertical axis defined by the post) preferably including ***an actuator switch at the distal end of the horizontal arm***. Thus, the treating physician can vertically align the distal end of the horizontal arm over a desired location ***using a single hand which both actuates the switch*** and manipulates the end of the arm.

Id., 2:67-3:8. In light of this disclosure in Lathrop, a POSA would have understood the design and benefits of using a "*single actuator*" to release the brakes to permit manual positioning of a robotic surgical arm. Ex.1003, ¶197.

Faraz in view of Lathrop thus renders obvious "*a brake system releasably inhibiting movement of the joints, wherein the brake system can release the joints supporting the second manipulator upon actuation of a single actuator.*"

(6) "a sensor system coupling the manipulator support to the servomechanism, the sensor system transmitting position signals to the servomechanism, the servomechanism calculating a position or orientation of the first manipulator relative to the second manipulator using the signals."

As explained above with respect to claim 1, element 7, Faraz teaches that the joints of its arm can be equipped with position sensors that generate joint configuration signals, and send such signals to a servomechanism. *See* Ex.1004, 6:24-27 ("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 linkage 25."); *see also* Ex.1003, ¶199. Faraz thus discloses, or at least renders obvious, "*a sensor system coupling the manipulator support to the servomechanism, the sensor system transmitting position signals to the servomechanism*."

A POSA would further have known based on Faraz's teachings how to configure "*the servomechanism [to] calculat[e] a position or orientation of the first manipulator relative to the second manipulator using the signals*" even though Faraz does not explicitly describe such calculations. The '200 patent admits that coordinate system transformations are prior art. Ex.1001, 2:10-15. A POSA would have known how to calculate the position and orientation of each manipulator separately, using well-known coordinate system transformations. Ex.1003, ¶¶200-04. Faraz thus renders the above claim element obvious.

Patent Owner may contend that Faraz does not disclose sufficient detail to render obvious calculation of the relative position or orientation of the two manipulators. Such a contention would lack merit, because to the extent a POSA would have desired additional details on how to calculate the relative positions or orientations, numerous prior art references disclosed such calculations. Ex.1003, ¶206. One such reference is Tarn. *Id.*

As explained above in Section V.C.2, Tarn presents a mathematical model for controlling two PUMA 560 robot arms, each arm having six joints. Ex.1007, 1193.

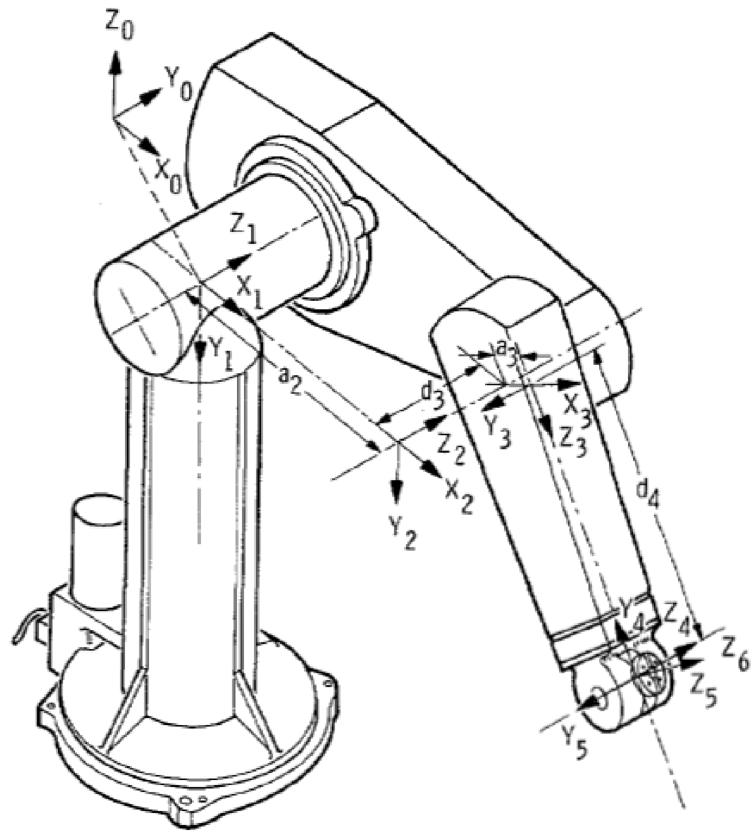


Figure 1 PUMA 560 Reference Frames

Tarn states that its method for coordinating control of two robotic arms "is basically a computational scheme ***to be implemented in the real-time controller by using digital computer*** in the real-time control loop." Ex. 1007, 1201. Tarn also states that "[a]ny tasks like material handling can be described by the position and orientation of the tool (end-effector) attached to the robot arm." *Id.*, 1195. Tarn then describes its computational scheme to control the robot arm, including movement of the end-effector. *Id.*, 1195-96, 1199-1201. The claim term "servomechanism" refers to a device with or coupled to a processor, that can move the end effector. Tarn's "digital computer" with a "real-time controller" is a device with a processor that Tarn uses to move the end effector. Ex. 1007, 1201. Tarn therefore discloses a "*servomechanism*." Ex.1003, ¶¶208-09.

Tarn's mathematical model takes as an input the positions of each joint, as well as information related to the geometric parameters of the robot arm. *Id.*, 1194 ("q – (q_1, q_2, … q_6) is the joint position vector."). Tarn derives "the general forward kinematic solution for ***end effector position*** in the task space ***as a function of joint variables*** for the PUMA 560 robot arm." *Id.*, 1196 (Equation 5). A POSA would thus understand based on Tarn how to program a "*servomechanism [to] calculate[e] a position or orientation of*" each manipulator. Ex.1003, ¶210.

Next, Tarn designs an algorithm for controlling coordination of two such arms, which includes an "optimal coordinator" that "is operating on the ***difference between outputs of the two robots***, minus the constant offset distance." Ex.1007, 1198. Tarn further teaches how to minimize the error in offset distance between the two end-effectors, by calculating an error based on the ***relative position of the end effectors*** minus the constant offset distance. *Id.*, 1199 (Equation 12) which is a "*calculat[ion] [of] a position or orientation of the first manipulator relative to the second manipulator*." Ex.1003, ¶212.

Tarn also reports simulations based on a task of two arms holding and moving an object. Ex.1007, 1200. The simulation results report the "***relative position error***" in millimeters between the two end-effectors, which is, again, provided by Equation 12. Tarn's Table 3 depicts these results (*id.*, 1199):

Table 3 Simulation Results for Coordinated Control of Two PUMA 560 Robot Arms

DYNAMIC MODEL PARAMETER ERRORS	ROBOT "a"	0%	+10%	−10%	−20%	+30%
	ROBOT "b"	0%	+10%	+10%	+20%	+30%
MAX. RELATIVE POSITION ERROR (mm)	WITH ΔV	0.008	0.42	0.76	1.52	1.25
	WITHOUT ΔV	0.023	1.20	2.20	4.50	3.60
MAX. RELATIVE VELOCITY ERROR (mm/sec)	WITH ΔV	0.045	0.23	0.20	0.45	0.65
	WITHOUT ΔV	0.137	0.63	0.61	1.20	1.80
TOTAL TRAJECTORY TIME (sec)		6	6	6	6	6

Ex.1003, ¶213.

In short, a POSA would have known based on Tarn how to calculate the position of each end effector of the two robot arms, and how to calculate the positions of the end effectors of two robot arms relative to one another. Ex.1003, ¶214. Faraz in view of Tarn thus discloses "*a sensor system coupling the manipulator support to the servomechanism, the sensor system transmitting position signals to the servomechanism, the servomechanism calculating a position* *or orientation of the first manipulator relative to the second manipulator using the signals*."

Accordingly, Faraz in view of Lathrop and Tarn render claim 14 obvious.

b) Claim 17

Claim 17 is identical to claim 14, except for two slight differences in the "brake system" and "sensor system" elements, as explained below. Thus, the reasons Faraz in view of Lathrop and Tarn render claim 14 obvious apply to the corresponding elements of claim 17 as well.

(1) "A support structure for supporting a first robotic surgical manipulator relative to a second robotic surgical manipulator, each surgical manipulator coupled to a servomechanism so as to robotically manipulate tissues of a patient body with a surgical end effector, the support structure comprising:"

This element is identical to the preamble of claim 14.

(2) "a base coupled to the first manipulator;"

This element is identical to element 2 of claim 14.

(3) "a manipulator support movably supporting the second manipulator relative to the base;"

This element is identical to element 3 of claim 14.

(4) "an articulated linkage having a plurality of joints coupling the base to the manipulator support so as to allow manual movement of the second manipulator relative to the base;"

This element is identical to element 4 of claim 14.

(5) "a brake system *biased toward a locked configuration to prevent inadvertent movement of the manipulator by* releasably inhibiting inadvertent movement of the joints, wherein the brake system can release the joints supporting the second manipulator upon actuation of a single actuator;"

This element is almost identical to element 5 of claim 14, except that this element also recites "*biased toward a locked configuration to prevent inadvertent movement of the manipulator by*" (italicized above).

Faraz in view of Lathrop discloses this additional requirement. Specifically, Lathrop describes in detail the locking means for its robotic arm. Ex.1006, 8:16-9:16, 9:26-53. Both the horizontal arm and the end segment include locking means that lock the arm and end segment joints into position. *Id.*, 8:8-17, 8:56-58, 9:4-5. "***Locking means 58, 60 are configured so as to be in the 'locked' position when no power is applied to the solenoid 82***." *Id.*, 8:33-35; *see also id.*, 9:45-48. Lathrop explains that "***preferably, the locking mechanisms are biased in a locked position when no power is applied***." *Id.*, 3:43-45. Lathrop teaches doing so to "maintain the position of the support structure in the event of a power failure" for patient safety. *Id.*, 6:2-6; Ex.1003, ¶223.

Faraz in view of Lathrop thus discloses this element.

(6) "a sensor system coupling the manipulator support to the servomechanism, the sensor system transmitting position signals to the servomechanism, *the sensor system coupled to the joints so that the position signals comprise joint configuration signals of*

> ***the joints*, the servomechanism calculating a position or orientation of the first manipulator relative to the second manipulator using the signals."**

This element is almost identical to element 6 of claim 14, except that this element also recites "*the sensor system coupled to the joints so that the position signals comprise joint configuration signals of the joints*" (italicized above).

As explained above with respect to element 7 of claim 1, and element 6 of claim 14, Faraz discloses the additional requirement. Specifically, Faraz discloses that "[t]he 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 linkage 25." Ex.1004, 6:24-27. These position sensors have been circled in green on Faraz's Figure 1, reproduced below:

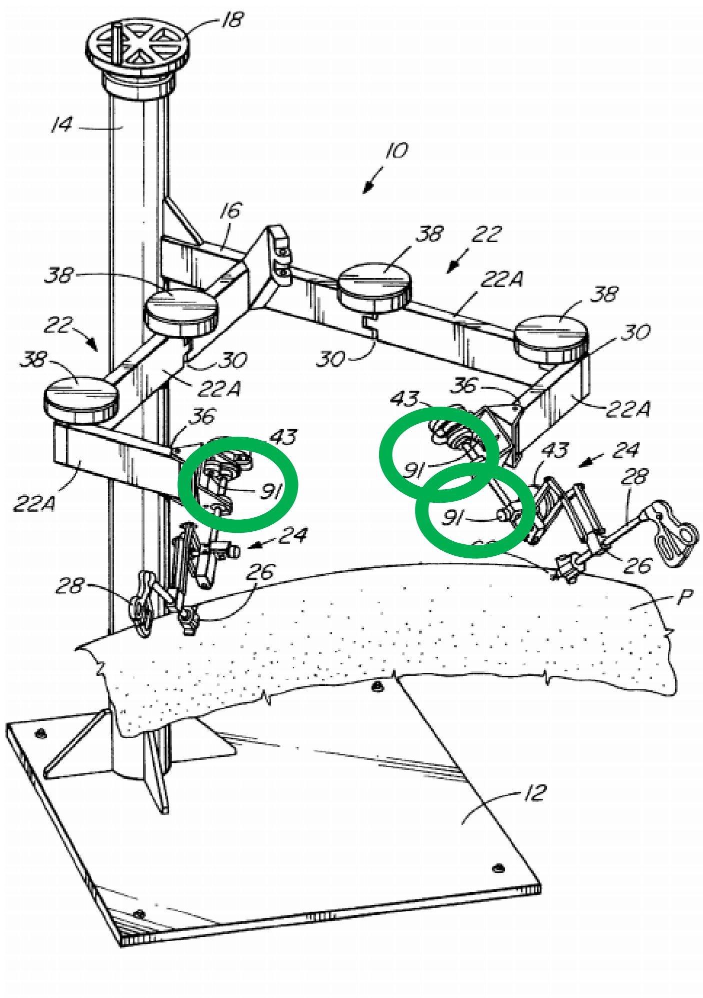


FIG. 1

Ex.1003, ¶¶226-27.

As Dr. Cimino explains, a POSA would have understood that position sensors affixed to joints by definition "*generat[e] joint configuration signals*." Ex.1003, ¶228. A POSA would also have understood that the position sensors would "*coupl[e] the fixable joints to the servomechanism*," because the ordinary use of joint position sensors prior to the priority date of the '200 patent was to provide feedback to the servomechanism used to control the joint positions. *Id.*

Faraz thus discloses the above element.

* * *

Accordingly, Faraz in view of Lathrop and Tarn render claim 17 obvious.

D. Ground 4 – Faraz, Lathrop, Tarn, and Sackier

1. A POSA Would Have Considered Faraz with Lathrop, Tarn, and Sackier

The reasons for considering Faraz, Lathrop, and Tarn together are described above in Section V.C.3. A POSA considering Faraz would have been motivated to consider multiple references describing known means for driving and controlling the joints, and would have considered Sackier as well. Ex.1003, ¶¶75-77, 84, 92. The systems described in Faraz and Sackier contain similar features. Ex.1003, ¶82. Both contain multi-jointed robotic arms that hold a surgical implement. *Id.* Both teach use of brakes to fix the position of joints. *Id.* Both specifically describe their intended use in laparoscopic surgery. *Id.*; Ex. 1004, Abstract; Ex. 1009, Title.

A POSA following his or 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, ¶¶75-77, 93. A POSA considering Faraz would have looked to other references that provide more detail about incorporating motorized joints, because Faraz instructs the reader to do so. Ex.1003, ¶93. Sackier is one such reference. *Id.* When implementing

Faraz, the POSA would have refined Faraz's features based on Sackier's implementation of analogous features and description of its mode of operation. Ex.1003, ¶¶83-84. In particular, a POSA would have understood based on Sackier that a robotic arm holding a surgical implement could include a brake release button, that would allow a surgeon to manually position a robotic arm. Ex.1003, ¶95. A POSA would have understood based on Sackier the benefits of including such a button, namely that as taught by Sackier the "device is extremely simple to use" and gives the surgeon as much control as desired to position the device. Ex.1003, ¶¶84, 95; Ex. 1009, 66.

2. Claims 14 and 17 Are Obvious in View of Faraz, Lathrop, Tarn, and Sackier

As explained above, Faraz, Lathrop, and Tarn disclose all the elements in claims 14 and 17, thereby rendering those claims obvious.

Patent Owner may contend that the combination of Faraz, Lathrop, and Tarn does not expressly disclose a robotic arm with joints that can be both motorized and manually positionable. Any such contention should be rejected for the above reasons. In addition, a POSA would have understood based on Sackier that a robotic surgical arm could have joints that could be both motorized and manually positionable. Ex.1003, ¶232.

Sackier explains that to use its robotic surgical arm, a surgeon grasps the positioner and depresses a "disable" button, causing the "AESOP to function as a manual scope holder. When the disable button has been pressed, the joints become passive and the surgeon can easily move the positioner to any location. After releasing the disable button the positioner becomes rigid once again." Ex. 1009, 64. The surgeon can also move the positioner using the foot or hand controller. *Id.* A control computer "is responsible for interpreting the commands from the surgeon (who has a foot controller and a hand controller) into action by applying power to the actuators which position the robot." *Id.*

Patent Owner may also contend that Lathrop's disclosure of a single brake release acutuator is somehow insufficient. Faraz, Lathrop, and Tarn render obvious use of a single brake release actuator for the reasons explained above. In addition, Sackier discloses use of a single brake release actuator. Namely, Sackier explains that to use its robotic surgical arm, a surgeon grasps the positioner and depresses a "disable" button, causing the "AESOP to function as a manual scope holder. Ex.1003, ¶233. When the disable button has been pressed, the joints become passive and the surgeon can easily move the positioner to any location. After releasing the disable button the positioner becomes rigid once again." Ex. 1009, 64.

Accordingly, Faraz, Lathrop, Tarn, and Sackier render claims 14 and 17 obvious.

II. NO SECONDARY CONSIDERATIONS EXIST

As described above, Faraz in view of Ohm, Sackier, Lathrop, and/or Tarn teaches systems that render *prima facie* obvious the challenged claims of the ’200 patent. No secondary indicia of non-obviousness exist having a nexus to the putative “invention” of the ’200 patent contrary to that conclusion. Auris reserves its right to respond to any assertion of secondary indicia of non-obviousness advanced by Patent Owner.

III. CONCLUSION

For the reasons set forth above, Auris Surgical Robotics, Inc. respectfully asks the Board to initiate *inter partes* review and find claims 1, 10-12, 14, and 17 of the ’200 patent to be unpatentable based on the grounds provided herein.

Dated: August 5, 2019

Respectfully submitted,

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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 13,630 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."

Dated: August 5, 2019 By /Thomas A. Broughan III/

Certificate of Service (37 C.F.R. § 42.6(e)(4))

I hereby certify that the attached Petition for *Inter Partes* Review and supporting materials were served as of the below date by Federal Express on the Patent Owner at the correspondence address indicated for U.S. Patent No. 6,246,200.

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