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Tissue manipulation device

Abstract

A tissue manipulation device includes an end effector assembly disposed at a distal end of a shaft portion, the end effector assembly including a tissue engaging assembly having first and second tissue engaging arms that each include a first arm segment, a second arm segment, and a third arm segment that are coupled by living hinges. When an adjustment member coupled to the end effector assembly is displaced from a first position to a second position, the end effector assembly transition from a first undeployed position, in which the first and second tissue engaging arms are disposed a first configuration adapted for insertion into a patient, to a second deployed position, in which the first and second tissue engaging arms are disposed a second configuration adapted to manipulate a tissue of the patient.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation-in-part of U.S. patent application Ser. No. 17/945,819, filed on Sep. 15, 2022, which claims the benefit of U.S. Provisional Patent Application No. 63/245,310, filed Sep. 17, 2021, and U.S. Provisional Patent Application No. 63/335,937, filed Apr. 28, 2022, each of which is incorporated by reference herein in its entirety. This application also claims the benefit of U.S. Provisional Patent Application No. 63/352,867, filed Jun. 16, 2022, and U.S. Provisional Patent Application

No. 63/424,840, filed Nov. 11, 2022, each of which is incorporated by reference herein in its entirety.

FIELD

(1) The claimed invention relates to surgical devices, and more specifically to a tissue manipulation device.

BACKGROUND

(2) A prostatectomy is a medical procedure to surgically remove the prostate gland of a male patient. The procedure is often performed due to disease of the prostate, such as cancer. The procedure may be performed by open surgery or laparoscopically by the use of endoscopic instruments through small incisions in the patient. In brief, the prostate is located along the urethra leading to the bladder, and removal of the prostate is performed by exposing the prostate, dissecting the tissue surrounding the prostate, removing the prostate, and then suturing the urethra to the bladder. One problem often encountered during a prostatectomy is that the prostate is difficult to position and maneuver by the surgeon to expose the tissue and place the tissue under tension during dissection to extract the gland. This is especially a problem with a laparoscopic prostatectomy. Another problem is that the neurovascular bundles adjacent to the prostate can be damaged during the prostatectomy negatively affecting normal penile functionality. Precise dissection is important to minimize damage to surrounding tissue and especially the neurovascular bundles. Therefore, it would be desirable to provide an instrument which can be inserted through the urethra to engage the prostate and then enable the prostate's position to be precisely manipulated during a prostatectomy. It would also be desirable to provide a device that may be simple to disassemble for post-procedure cleaning and sterilization.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a perspective view of an embodiment of the tissue manipulation device;
(2) FIG. **2** is an exploded view of a portion of the embodiment of the tissue manipulation device of FIG. **1**;
(3) FIG. **3** is a cross-sectional view of the embodiment of the tissue manipulation device of FIG. **1** with a securing member in an engaged position;
(4) FIG. **4**A is a cross-sectional view of the embodiment of the tissue manipulation device of FIG. **1** with the securing member in an engaged position and in a first securing member position;
(5) FIG. **4**B is a cross-sectional view of the embodiment of the tissue manipulation device of FIG. **1** with the securing member in an engaged position and in a second securing member position;
(6) FIG. **5** is a cross-sectional view of the embodiment of the tissue manipulation device of FIG. **1** with the securing member in a disengaged position;
(7) FIG. **6** is a cross-sectional view of a distal end of a shaft portion of the embodiment of the tissue manipulation device of FIG. **1** with the end effector in a first undeployed position;
(8) FIG. **7** is a perspective of an embodiment of a removable assembly of the tissue manipulation device of FIG. **1**;
(9) FIG. **8** is a cross-sectional view of the distal end of the shaft portion of the embodiment of the tissue manipulation device of FIG. **1** with the end effector in a second deployed position;
(10) FIG. **9**A is a front view of an embodiment of the securing member;
(11) FIG. **9**B is a front view of the embodiment of the securing member of FIG. **9**A;
(12) FIG. **9**C is a perspective view of the embodiment of the securing member of FIG. **9**A;
(13) FIG. **10**A is a top view of the embodiment of the tissue manipulation device of FIG. **1**;
(14) FIG. **10**B is a side view of the embodiment of the tissue manipulation device of FIG. **10**A;
(15) FIG. **10**C is a bottom view of the embodiment of the tissue manipulation device of FIG. **10**A;

(16) FIG. **11** is an exploded view of a portion of a further embodiment of the tissue manipulation device;
(17) FIG. **12** is a cross-sectional view of a shaft portion of the embodiment of the tissue manipulation device of FIG. **11**;
(18) FIG. **13** is a cross-sectional view of the embodiment of the tissue manipulation device of FIG. **11**;
(19) FIG. **14**A is a rear view of an embodiment of the tissue manipulation device coupled to an embodiment of a first robotic interface;
(20) FIG. **14**B is a rear view of an embodiment of the tissue manipulation device coupled to an embodiment of a first robotic interface;
(21) FIG. **14**C is a rear view of an embodiment of the tissue manipulation device coupled to an embodiment of a first robotic interface;
(22) FIG. **15**A is a rear view of an embodiment of the tissue manipulation device coupled to an embodiment of a second robotic interface;
(23) FIG. **15**B is a rear view of an embodiment of the tissue manipulation device coupled to an embodiment of a second robotic interface;
(24) FIG. **16** is a perspective view of an embodiment of the removable portion of an embodiment of the tissue manipulation device;
(25) FIG. **17**A is a side view of a portion of the torque member of the removable portion of the embodiment of the tissue manipulation device of FIG. **16**;
(26) FIG. **17**B is a partial perspective view of the torque member of the removable portion of the embodiment of the tissue manipulation device of FIG. **20**A;
(27) FIG. **17**C is a cross-sectional view of the embodiment of the torque member taken along section line **17**C-**17**C in FIG. **17**A;
(28) FIG. **17**D is top view of a portion of the torque member of the removable portion of the embodiment of the tissue manipulation device of FIG. **16**;
(29) FIG. **17**E is a cross-sectional view of the embodiment of the torque member taken along section line **17**E-**17**E in FIG. **17**A;
(30) FIG. **18**A is a cross-sectional view of a portion of the shaft portion of an embodiment of the tissue manipulation device, and the cross-sectional view is taken along the shaft axis;
(31) FIG. **18**B is a cross-sectional view of a portion of the shaft portion of an embodiment of the tissue manipulation device, and the cross-sectional view is taken normal to the shaft axis adjacent to a distal end of a linear portion of the shaft portion;
(32) FIG. **18**C includes various cross-sectional views of a portion of the shaft portion of an embodiment of the tissue manipulation device, and the cross-sectional view is taken normal to the shaft axis adjacent to a distal end of a linear portion of the shaft portion;
(33) FIG. **18**D is a cross-sectional view of a portion of the shaft portion of an embodiment of the tissue manipulation device, and the cross-sectional view is taken along the shaft axis;
(34) FIG. **19**A is a partial perspective view of an embodiment of a torque member of a removable portion of an embodiment of the tissue manipulation with the shaft portion removed for clarity;
(35) FIG. **19**B is a further partial perspective view of the embodiment of the torque member of the removable portion of FIG. **19**A with the shaft portion removed for clarity;
(36) FIG. **19**C is a cross-sectional view of the embodiment of the torque member taken along section line **19**C-**19**C in FIG. **19**D;
(37) FIG. **19**D is side view of a portion of the torque member of the removable portion of the embodiment of the tissue manipulation device of FIG. **19**A;
(38) FIG. **19**E is top view of a portion of the torque member of the removable portion of the embodiment of the tissue manipulation device of FIG. **19**A;
(39) FIGS. **19**F to **19**H are various partial perspective views of the torque member of the removable portion of the embodiment of the tissue manipulation device of FIG. **19**A;

(40) FIG. **191** is a front view of the torque member of the removable portion of the embodiment of the tissue manipulation device of FIG. **19**A;
(41) FIG. **19**J is a cross-sectional view of the embodiment of the torque member taken along section line **19**J-**17**J in FIG. **17**K;
(42) FIG. **19**K is a perspective view of the embodiment of the torque member of the removable portion of FIG. **19**A;
(43) FIG. **20**A is a perspective view of an embodiment of the tissue manipulation device with the shaft portion removed for clarity;
(44) FIG. **20**B is a perspective view of a portion of the embodiment of the tissue manipulation device of FIG. **20**A with the shaft portion removed for clarity;
(45) FIG. **20**C is side view of the torque member of the removable portion of the embodiment of the tissue manipulation device of FIG. **20**A;
(46) FIGS. **20**D and **20**E are various perspective views of the torque member of the removable portion of the embodiment of the tissue manipulation device of FIG. **20**A;
(47) FIG. **20**F is a cross-sectional view of the embodiment of the torque member taken along section line **20**F-**20**F in FIG. **20**C;
(48) FIGS. **21**A and **21**B are a bottom perspective view and a top perspective view, respectively, of an embodiment of a tissue engaging assembly prior to assembly within an end effector assembly;
(49) FIGS. **22**A to **22**C are a top view, a first side view, and a second side view, respectively, of the embodiment of the tissue engaging assembly of FIGS. **21**A and **21**B;
(50) FIG. **23** is a partial perspective view of a first tissue engaging arm of the embodiment of the tissue engaging assembly of FIGS. **22**A to **22**C;
(51) FIG. **24**A is a bottom view of the first tissue engaging arm of FIG. **23**;
(52) FIG. **24**B is a cross-sectional view of the first tissue engaging arm taken along section line **24**B-**24**B in FIG. **24**A;
(53) FIG. **25** is a side view of an embodiment of an end effector assembly that includes the embodiment of the tissue engaging assembly of FIGS. **21**A and **21**B with the end effector assembly in a first undeployed position;
(54) FIGS. **26**A to **26**C are a side view, a top view, and a perspective view, respectively, of the embodiment of the end effector assembly of FIG. **25** in a second deployed position;
(55) FIG. **27** is a perspective view of the embodiment of the end effector assembly of FIG. **25** in the second deployed position with a housing of the end effector assembly removed for clarity;
(56) FIGS. **28**A to **28**G are various views of an embodiment of a tissue manipulation device that includes the embodiment of the end effector assembly of FIG. **25** in the first undeployed position;
(57) FIG. **29**A is a cross-sectional view of the embodiment of the tissue engaging assembly taken along section line **29**A-**29**A in FIG. **28**B;
(58) FIG. **29**B is a cross-sectional view of the embodiment of the tissue engaging assembly taken along section line **29**B-**29**B in FIG. **28**B with the end effector assembly in the second deployed position;
(59) FIGS. **30**A and **30**B are a perspective view and a side view, respectively, of the tissue engaging assembly with a portion of the body portion removed for clarity and with an adjustment wheel in a locked position; and
(60) FIGS. **31**A and **31**B are a perspective view and a side view, respectively, of the tissue engaging assembly of FIGS. **30**A and **30**B with the adjustment wheel in an unlocked position.

DETAILED DESCRIPTION

(61) Referring to FIG. **1**, a tissue manipulation device **10** includes a handle portion **12** extending along a longitudinal axis **14** from a proximal end **16** to a distal end **18**, and an adjustment member **22** is displaceably coupled to the proximal end **16** of the handle portion **12**. As illustrated in the cross-sectional view of FIG. **3**, a securing member **24** is coupled to the handle portion **12** and the securing member **24** extends along a member axis **26** from a proximal end **28** to a distal end **29**.

The securing member **24** includes an engagement portion **31** disposed at or adjacent to the distal end **29** of the securing member **24**, and the proximal end **28** of the securing member **24** is coupled to a portion of the adjustment member **22** such that the securing member **24** is displaceable along the member axis **26** between a first securing member position **133** (illustrated in FIG. **4**A) and a second securing member position (illustrated in FIG. **4**B). In addition, the securing member **24** is pivotably coupled to the handle portion **12** and is pivotably displaceable from between an engaged position **36** (illustrated in FIG. **4**A) and a disengaged position **39** (illustrated in FIG. **5**). In the engaged position **36**, the member axis **26** is parallel to or coaxially aligned with the longitudinal axis **14**, and in the disengaged position **39**, the member axis **26** is not parallel to or coaxially aligned with the longitudinal axis **14**.

(62) Referring again to FIG. **1**, the tissue manipulation device **10** also includes a shaft portion **40** extending from a proximal end **42** to a distal end **44** along a shaft axis **47** (illustrated in FIG. **10**A), and the proximal end **42** of the shaft portion **40** is coupled to the distal end of the handle portion **12**. The tissue manipulation device **10** further includes an end effector **48** removably coupled to the distal end **44** of the shaft portion **40**, and the end effector is operable between a first undeployed position **49** (illustrated in FIGS. **1** and **6**) and a second deployed position **51** (illustrated in FIG. **8**).

(63) With reference to FIG. **3**, the tissue manipulation device **10** additionally includes a wire **52** (e.g., a flexible wire **52**) extending from a proximal end **54** to a distal end **56** (illustrated in FIG. **8**), and the distal end **56** of the wire **52** is coupled to the end effector **48**. The proximal end **54** of the wire **52** is removably coupled to the engagement portion **31** of the securing member **24** when the securing member **24** is in the engaged position **36** (illustrated in FIG. **4**A) and the proximal end **54** of the wire is disengaged from the engagement portion **31** of the securing member **24** when the securing member **24** is in the disengaged position **39** (illustrated in FIG. **5**). In addition, when the securing member **24** is in the engaged position **36** (illustrated in FIG. **4**A), the wire **52** couples the securing member **24** and the end effector **48** such that (a) when the securing member **24** is displaced from the first securing member position **133** (illustrated in FIG. **4**A) to the second securing member position **35** (illustrated in FIG. **4**B), the end effector **48** is displaced from the first undeployed position **49** (illustrated in FIGS. **1** and **6**) to the second deployed position **51** (illustrated in FIG. **8**) and (b) when the securing member **24** is displaced from the second securing member position **35** (illustrated in FIG. **4**B) to the first securing member position (illustrated in FIG. **4**A), the end effector **48** is displaced from the second deployed position **51** (illustrated in FIG. **8**) to the first undeployed position **49** (illustrated in FIGS. **1** and **6**).

(64) So configured, when the securing member **24** is in the disengaged position **39**, the end effector **48** may be decoupled from the distal end **44** of the shaft portion **40** and the wire **52** is configured to be removed from the shaft portion **40** through an aperture **41** (illustrated in FIG. **3**) defined at the distal end **44** of the shaft portion **40**. Accordingly, the wire **52** and attached end effector **48** may at least partially define a removable portion **57** (illustrated in FIG. **7**) that may be separated and removed from the handle portion **12** and shaft portion **40** to allow the for separate processing (e.g., washing and sterilization) of the handle portion **12** and shaft portion **40**. The removable portion **57** may also be processed separately from, or instead of, the handle portion **12** and shaft portion **40**. In some embodiments, the removable portion **57** may further include one or more components may be coupled to the wire **52** and/or the end effector **58**, such as one or more torque links **58** illustrated in FIG. **7**.

(65) Turning to the tissue manipulation device **10** in more detail, and with reference to FIGS. **1**, **2**, and **3**, the handle portion **12** may extend along the longitudinal axis **14** from the proximal end **16** to the distal end **18** and may include a grip portion **59** that may extend along the longitudinal axis **14** from the proximal end **16** of the handle portion **12** to a distal end **117** of the grip portion **59** at a first intermediary point **60** of the handle portion **12** that is proximal to the distal end **18** of the handle portion **12**. The grip portion **59** may be shaped and dimensioned to be grasped by the hand of a user during a procedure. The grip portion **59** may include a plurality of slots **61** that each

extends parallel to the longitudinal axis **14** from a point at or distal to the proximal end **16** of the handle portion **12** to a point at or proximal to the first intermediary point **60** of the handle portion **12**. The plurality of slots **61** may be radially arrayed about the longitudinal axis **14**, and the plurality of slots **61** may cooperate to define a plurality of ridges **62**. Correspondingly, the plurality of ridges **62** may be radially arrayed about the longitudinal axis **14**, and each of the plurality of ridges **62** may extend parallel to the longitudinal axis **14** from a point at or distal to the proximal end **16** of the handle portion **12** to a point at or proximal to the first intermediary point **60** of the handle portion **12**. An outer end surface **63** of each of the plurality of ridges **62** may be contoured or textured to comfortably and securely be grasped by the hand of a user during a procedure.
(66) Referring to FIGS. **2** and **3**, the handle portion **12** may further include a central bore **64** that may extend along the longitudinal axis **14** from the proximal end **16** of the handle portion **12** to the first intermediary point **60** of the handle portion **12** or to a point distal to the first intermediary point **60** of the handle portion **12**. The central bore **64** may include an end portion **71** and a portion of the end portion **71** may include a threaded portion **72**.
(67) Referring to FIGS. **1** to **3**, the tissue manipulation device **10** may further include the adjustment member **22** which is displaceably coupled to the proximal end **16** of the handle portion **12**. With reference to FIGS. **2** and **3**, the adjustment member **22** may extend along the longitudinal axis **14** from a proximal end **65** to a distal end **66**, and an insertion portion **67** may extend from the distal end **66** to an intermediary point **68**. An input portion **73** may extend proximally from the insertion portion **67**, and the input portion **73** may extend from the intermediary point **68** to the proximal end **65** of the adjustment member **22**. The insertion portion **67** may be at least partially received in the end portion **65** of the central bore **64** of the handle portion **12**, and a threaded portion **69** of an outer surface **70** of the insertion portion **67** may threadedly engage the threaded portion **72** of the end portion **65** of the central bore **64** of the handle portion **12**. Accordingly, when a user rotates the input portion **73** (relative to the handle portion **12**) about the longitudinal axis **14** in a first rotational direction, the adjustment member **22** displaces distally along the longitudinal axis **14**. Correspondingly, when the user rotates the input portion **73** (relative to the handle portion **12**) about the longitudinal axis **14** in a second rotational direction, the adjustment member **22** displaces proximally along the longitudinal axis **14**.
(68) As illustrated in the exploded view of FIG. **2**, the tissue manipulation device **10** may include the securing member carrier **74** that may extend from a proximal end **76** to a distal end **78** along an axis that may be along or parallel to the longitudinal axis **14**. The securing member carrier **74** may include a pair of opposing side walls **80***a*, **80***b* that may have corresponding inner surfaces that are planar or substantially planar. A pivot post **82** may extend between, and may be fixed relative to, the pair of inner surfaces of the pair of opposing side walls **80***a*, **80***b*, and the pivot post **82** may extend in a direction that is transverse to the longitudinal axis **14**. The pivot post **82** may be disposed at any suitable location on the securing member carrier **74**, such as at or adjacent to the proximal end **76** of the securing member carrier **74**, for example.
(69) The securing member carrier **74** may be displaceably disposed in any suitable portion of the central bore **64** of the handle portion **12**. For example, as illustrated in the cross-sectional view of FIG. **3**, the proximal end **76** of the securing member carrier **74** may be distal to the to the proximal end **16** of the handle portion **12** and the distal end **78** of the securing member carrier **74** may be proximal to the to the distal end **18** of the handle portion **12**. In some embodiments, a portion of the proximal end **76** of the securing member carrier **74** may be coupled to or in contact with a portion of the adjustment member **22** that is at or adjacent to the distal end **66** of the adjustment member **22** such that a displacement of the adjustment member **22** along the longitudinal axis **14** for a first distance in a distal direction will result in a corresponding displacement of the securing member carrier **74** along the longitudinal axis **14** for the first distance in the distal direction. Similarly, a displacement of the adjustment member **22** along the longitudinal axis **14** for a second distance in a proximal direction will result in a corresponding displacement of the securing member carrier **74**

along the longitudinal axis **14** for the second distance in the proximal direction.

(70) As illustrated in FIGS. **2**, **3**, and **9**A, the tissue manipulation device **10** may include the securing member **24** that may extend along the member axis **26** from the proximal end **28** to the distal end **29**. Referring to FIGS. **9**A and **9**B, the securing member **24** may be planar or substantially planar, and may be at least partially defined by a first side surface **84***a* and a second side surface **84***b* opposite to the first side surface **84***a*. The first side surface **84***a* and the second side surface **84***b* may be separated by a constant width, and the width may be less than the distance separating the pair of inner surfaces of the pair of opposing side walls **80***a*, **80***b* of the securing member carrier **74** (illustrated in FIG. **2**) such that all or a portion of the securing member **24** may be disposed between the pair of inner surfaces of the pair of opposing side walls **80***a*, **80***b* of the securing member carrier **74** when the securing member **24** is in the engaged position **36** (illustrated in FIG. **4**A).

(71) Still referring to FIG. **9**A, the securing member **24** may include a shaft portion **86** that may extend along the member axis **26** from the proximal end **28** of the securing member **24** to an intermediate point **88**. A lateral portion **90** may extend distally from the shaft portion **86**, and may extend along an axis that is parallel to and offset from the member axis **26** from a point aligned with the intermediate point **88** to a point at or adjacent to the distal end **29** of the securing member **24**. A support arm **92** may extend from a distal portion of the lateral portion **90** that is at or adjacent to the distal end **29** of the securing member **24**. In particular, the support arm **92** may extend inwardly (i.e., towards the member axis **26**) from a portion of an inner lateral edge **102** of the lateral portion **90** that is proximal to the distal end **29** of the securing member **24**. The support arm **92** may extend along an axis that is transverse (or substantially transverse) to the member axis **26**. The engagement portion **31** that is adapted to couple to the proximal end **54** of the wire **52** (as illustrated in FIG. **3**) may be disposed on a portion of the support arm **92**, such as a portion at or adjacent to an end portion of the support arm **92**. The engagement portion **31** may be any feature that may removably coupled to the proximal end **54** of the wire **52**, such as a slot or a yoke feature. In other embodiments, such as embodiments not having a support arm **92**, the engagement portion **31** may be disposed at any suitable portion of the securing member **24**, such as a portion of the securing member **24** that is at or adjacent to the distal end **29** of the securing member **24**.

(72) The securing member **24** may also include a stop arm **94** that may extend from a portion of the lateral portion **90** that is proximal to the distal end **29** of the securing member **24**. In particular, the stop arm **94** may extend inwardly extend from a portion of the inner lateral edge **102** of the lateral portion **90** that is proximal to the distal end **29** of the securing member **24**. The stop arm **94** may extend along an axis that is transverse (or substantially transverse) to the member axis **26**, and this axis may be parallel or substantially parallel to the axis of the support arm **92** such that the stop arm **94** is proximally offset from the axis of the support arm **92** (e.g., offset in direction extending along the member axis **26** towards the proximal end **28** of the securing member **24**). The stop arm **94** may be positioned on the securing member **24** such that a portion of a lower surface of the stop arm **94** may contact a portion of a stop post **96** (illustrated in FIG. **3**) when the securing member **24** is in the first securing member position (illustrated in FIG. **4**A) to prevent further proximal displacement of the securing member **24**. The stop post **96** may extend in a direction that is transverse to the longitudinal axis **14** (and parallel to the pivot post **82**), and the stop post may be fixedly coupled to a portion of the handle portion **12** in any suitable location to allow for the contact between the portion of the lower surface of the stop arm **94** and the portion of the stop post **96** when the securing member **24** is in the first securing member position (illustrated in FIG. **4**A) The stop arm may have a curved end **95** that may be configured to contact the stop post **96** to prevent further pivoting of the securing member **24** relative to the handle member **12**.

(73) The securing member **24** may additionally include a resilient member **98** that may be coupled to or integrally formed with the securing member **24**. For example, the resilient member **98** may be spring that extends along (or parallel to) the member axis **26** and may expand and retract along (or

parallel to) the member axis **26**. The resilient member **98** may include a plurality of parallel portions disposed transverse to the member axis **26**, and ends of the parallel portions are coupled by alternating curved portions. A first end portion **99** of the resilient member **98** may be configured to be in contact with the stop post **96** when the securing member **24** is in the engaged position **36** (illustrated in FIG. **4**A) and the first end portion **99** of the resilient member **98** may be configured to not contact the stop post **96** when the securing member **24** is pivoted to the disengaged position **39** (illustrated in FIG. **5**). While the resilient member **98** has been described as integrally formed with the securing member **24**, in some embodiments, the resilient member **98** may be coupled to any suitable portion of the securing member **24**.

(74) The securing member **24** may be pivotably or rotatably coupled to the securing member carrier **74** in any suitable manner. For example, a pivot aperture **100** may be disposed in a portion of the securing member **24** at or adjacent to the proximal end **28** of the securing member **24**, such as a portion of the shaft portion **86** that is at or adjacent to the proximal end **28** of the securing member **24**. The pivot post **82** of the securing member carrier **74** may be disposed through the pivot aperture **100** such that the securing member **24** is pivotably displaceable about the pivot post **82** between the engaged position **36** (illustrated in FIG. **4**A) and the disengaged position **39** (illustrated in FIG. **5**). The securing member **24** may be pivoted (for example, about the pivot post **82**) to any suitable degree such that the engagement portion **31** of the securing member **24** may be disengaged or decoupled from the proximal end **54** of the wire **52**. As such, when in the disengaged position **39**, the member axis **26** of the securing member **24** may form an angle between 1° degree and 180° with the longitudinal axis **14** to allow the engagement portion **31** of the securing member **24** to disengage or decouple from the proximal end **54** of the wire **52**.

(75) Because the securing member **24** is fixedly coupled to the securing member carrier **74** by the pivot post **82** in the engaged position **36**, the securing member **24** may translate with the securing member carrier **74** along the longitudinal axis **14** when the securing member carrier **74** is longitudinally displaced by the adjustment member **22**, as previously described. In addition, because the first end portion **99** of the resilient member **98** of the securing member **24** is in contact with the stop post **96** coupled to the handle portion **12**, the proximal end **76** of the securing member carrier **74** is biased into engagement with the distal end **66** of the adjustment member **22**. The resilient member **98** also biases the engagement portion **31** of the securing member **24** (which is coupled to the proximal end **54** of the wire **52**) toward the proximal end **16** of the handle portion **12**, which maintains tension in the wire **52**.

(76) The securing member **24** may also include a grip tab **104** that may facilitate the grasping of the securing member **24** by a user to pivot the securing member **24** from the engaged position **36** the disengaged position **39**, and vice versa. The grip tab **104** may extend from a portion of the lateral portion **90** that is proximal to the distal end **29** of the securing member **24**, and the grip tab **104** may extend outwardly from a portion of an outer lateral edge **106** of the lateral portion **90** that is proximal to the distal end **29** of the securing member **24**.

(77) Turning again to the handle portion **12** of the tissue manipulation device **10**, FIG. **1** illustrates an embodiment in which the handle portion **12** includes a wheel housing portion **108** that is distal to the distal end **117** of the grip portion **59** and coupled to or integrally formed with the distal end **117** of the grip portion **59**. With reference to FIG. **3**, the wheel housing portion **108** may include a proximal support portion **110** and a distal support portion **112**. The proximal support portion **110** may be cylindrical or substantially cylindrical and may extend along the longitudinal axis **14** from a proximal end **114** to a distal end **116**. The proximal end **114** may be coupled to or integrally formed with the distal end **117** of the grip portion **59**, and one or more interior surfaces of the proximal support portion **110** may cooperate to form a portion of the central bore **64** of the handle portion **12**.

(78) The distal support portion **112** may be distal to and longitudinally offset from the proximal support portion **110**. The distal support portion **112** may be cylindrical or substantially cylindrical

and may extend along the longitudinal axis **14** from a proximal end **118** to a distal end **120**. In embodiments including the wheel housing portion **108**, the distal end **120** of the distal support portion **112** may be disposed at or correspond to the distal end of the handle portion **12**. One or more interior surfaces of the distal support portion **112** may cooperate to form a portion of the central bore **64** of the handle portion **12**. An adjustment wheel **122** may be disposed in the space between the proximal end **118** of the distal support portion **112** and the distal end **116** of the proximal support portion **110**, and the adjustment wheel **122** will be discussed in more detail below.
(79) As illustrated in FIG. **2**, a guard portion **124** may couple the proximal support portion **110** and the distal support portion **112**. In particular, the guard portion **124** may include a first arm **126** having a first distal portion **127** extending from a portion of the distal support portion **112** along an axis that is substantially transverse to the longitudinal axis **14**. The first arm **126** may also include a first proximal portion **128** extending from a portion of the proximal support portion **110** along an axis that is substantially transverse to the longitudinal axis. A first lateral portion **130** may extend between an end portion of the first distal portion **127** and an end portion of the first proximal portion **128**.
(80) The guard portion **124** may further include a second arm **132** having a second distal portion **134** extending from a portion of the distal support portion **112** along an axis that is substantially transverse to the longitudinal axis **14**. The second arm **132** may also include a second proximal portion **136** extending from a portion of the proximal support portion **110** along an axis that is substantially transverse to the longitudinal axis **14**. A second lateral portion **138** may extend between an end portion of the second distal portion **134** and an end portion of the second proximal portion **136**. The second arm **132** may be symmetrical to the first arm **126** about a plane extending along the longitudinal axis **14**. So configured, with the adjustment wheel **122** disposed in the space between the proximal end **118** of the distal support portion **112** and the distal end **116** of the proximal support portion **110**, the first arm **126** and the second arm **132** of the guard portion **124** surround the adjustment wheel **122** to protect against unwanted rotation due to inadvertent contact with the adjustment wheel **122**.
(81) Referring now to FIG. **10**A, the tissue manipulation device **10** also includes the shaft portion **40** extending from the proximal end **42** to the distal end **44** along the shaft axis **47**. The proximal end **42** of the shaft portion **40** may be coupled to the distal end **18** of the handle portion **12**. In embodiments including the wheel housing portion **108**, the proximal end **42** of the shaft portion **40** may be coupled to the distal end **120** of the distal support portion **112** (illustrated in FIG. **3**). However, the proximal end **42** of the shaft portion **40** may be coupled to any suitable portion of the shaft portion **40**, such as the distal end **117** of the grip portion **59** (illustrated in FIG. **1**) in embodiments that do not include the wheel housing portion **108**. The distal end **44** of the shaft portion **40** may be removably coupled to a portion of the end effector **48**.
(82) The shaft portion **40** may have any suitable shape or combination of shapes. For example, the shaft portion **40** may include a linear portion **140** and a curved portion **142**. The linear portion **140** may extend from the proximal end **42** of the shaft portion to an intermediate point **144** of the shaft portion **40**. The portion of the shaft axis **47** that extends along the linear portion **140** may be aligned with the longitudinal axis **14** or may be parallel to the longitudinal axis **14**. In some embodiments, the portion of the shaft axis **47** that extends along the linear portion **140** may form an angle (i.e., an acute angle) with the longitudinal axis **14**. The curved portion **142** of the shaft portion **40** may extend from the intermediate point **144** of the shaft portion **40** to the distal end **44** of the shaft portion **40**. In some embodiments, the curved portion **142** may be linear and the portion of the shaft axis **47** that extends along the curved portion **142** may form an angle (i.e., an acute angle) with the longitudinal axis **14** and/or with the portion of the shaft axis **47** that extends along the linear portion **140**. In other embodiments, the shaft portion **40** may not have a curved portion **142** and the linear portion **140** may extend from the proximal end **42** of the shaft portion **40** to the distal end **44** of the shaft portion **40**. In still further embodiments, the shaft portion **40** may not have

a linear portion **140** and the curved portion **142** may extend from the proximal end **42** of the shaft portion **40** to the distal end **44** of the shaft portion **40**.

(83) As illustrated in FIG. **3**, the shaft portion **40** may have one or more exterior surfaces **145** and may have one or more interior surfaces **147** that define a shaft interior portion **146**. The shaft interior portion **146** may open into, be in communication, and/or be aligned with the central bore **64** of the handle portion **12**. The one or more exterior surfaces **145** and one or more interior surfaces **147** may have any suitable cross-sectional shape of combination of shapes. For example, the one or more exterior surfaces **145** and/or the one or more interior surfaces **147** may have a circular (or polygonal) cross-sectional shape. The cross-sectional shape of any of the one or more exterior surfaces **145** and/or the one or more interior surfaces **147** may be uniform along the entire shaft portion **40** or along one or more segments of the shaft portion **40** (e.g., the linear portion **140**).

(84) With reference to FIG. **3**, the tissue manipulation device **10** additionally includes the wire **52** that extends from the proximal end **54** to the distal end **56** (illustrated in FIG. **8**), and the distal end **56** of the wire **52** may be coupled to a portion of the end effector **48**, such as a proximal portion **148** of the end effector **48**. All or a portion of the wire **52** may be flexible to allow the wire **52** to extend through the curved portion **142** of the shaft portion **40**. The wire **52** may be a single unitary part or may be an assembly of two or more segments and/or components. For example, as illustrated in FIG. **3**, the wire **52** may include a coupling portion **52***a* disposed at or adjacent to the proximal end **54** of the wire **52**. As illustrated in FIG. **3**, the proximal end **54** of the wire **52** may be removably coupled to the engagement portion **31** of the securing member **24** when the securing member **24** is in the engaged position **36** (illustrated in FIG. **4**A), and the proximal end **54** of the wire **52** may be shaped or dimensioned to be removably engaged by the engagement portion **31** of the securing member **24**.

(85) As illustrated in FIGS. **1**, the tissue manipulation device **10** additionally includes the end effector **48** removably and rotatably coupled to the distal end **44** of the shaft portion **40**, and the end effector is operable between a first undeployed position **49** (illustrated in FIGS. **1** and **6**) and a second deployed position **51** (illustrated in FIG. **8**). The distal end **56** of the wire **52** may be coupled to the proximal portion **148** of the end effector **48** such that when the securing member **24** is displaced (e.g., displaced distally in a direction along the member axis **26**) from the first securing member position (illustrated in FIG. **4**A) to the second securing member position **35** (illustrated in FIG. **4**B), the end effector **48** is transitioned (e.g., expanded or deployed) from the first undeployed position **49** (illustrated in FIGS. **1** and **6**) to the second deployed position **51** (illustrated in FIG. **8**). Correspondingly, when the securing member **24** is displaced (e.g., displaced proximally in a direction along the member axis **26**) from the second securing member position **35** (illustrated in FIG. **4**B) to the first securing member position **133** (illustrated in FIG. **4**A), the end effector **48** is transitioned (or contracted) from the second deployed position **51** (illustrated in FIG. **8**) to the first undeployed position **49** (illustrated in FIGS. **1** and **6**).

(86) Turning to the end effector **48** in more detail, FIG. **10**A illustrates an embodiment of the end effector **48** having a housing **150** that extends from a proximal end **151** to a distal end **152** along an end effector axis **153**, and two windows **154***a*, **154***b* are formed on opposing lateral ends of the housing **150**. As shown in the cross-sectional view of FIG. **8**, the housing **150** includes a plurality of interior surfaces that cooperate to define a cavity **156** within the housing **150**. In the cavity **152**, disposed for extension through each of the windows **154***a*, **154***b*, is one of two sets **21***a* and **21***b* of two tissue engaging members **20**. The tissue engaging members **20** are extendible from the first undeployed position **49** (illustrated in FIGS. **1** and **6**) to the second deployed position **51** (illustrated in FIG. **8**). In each of sets **21***a* and **21***b*, the first of the two tissue engaging members **20** is formed by a proximal member **20***a* and a distal member **20***c*, and the second of the two tissue engaging members **20** is formed by a proximal member **20***b* and a distal member **20***d*.

(87) Each tissue engaging member **20** represents a hinged wing which is extendible radially through their respective windows **154***a*, **154***b* of the distal end. Turning to the first set **21***a*,

proximal member **20***a* has a socket **33** which receives a curved member or shaft extending from the distal member **20***c* to form a hinge similar to a ball and socket joint. One side of the socket **33** extends to form a finger **34** which may be received in an opening **37** of distal member **20***c* shaped to receive finger **34**. Proximal member **20***a* has a barb **38** which extends from the other side of the socket **33**. Similarly, the proximal member **20***b* has a curved member or shaft **226** which is received in socket **43** of distal member **20***d* to form a hinge also similar to a ball and socket joint. One side of the socket **43** extends to form a finger **228** which may be received in an opening **45** of proximal member **20***b* shaped to receive finger **228**. Proximal member **20***d* has a barb **46** which extends from the other side of socket **43**. Proximal member **20***a* and distal member **20***d* may be of the same first length, and proximal member **20***b* and distal member **20***c* may be of the same second length, where the first length is less than the second length. The second set **21***b* is a mirror image of the first set **21***a*, and operates identically to the first set **21***a*.

(88) In the first set **21***a*, a hole **230** is provided at the end **230** of distal member **20***c* through which extends a pin **50** through two openings in the sides of housing **150** near the distal end **152**, and a hole is also provided at end of distal member **20***d* through which the pin **50** also extends. In the second set **21***b*, a pin **53** similarly extends through holes **233** through two openings in the sides of housing **150** near the distal end **152**. Each of pins **50** and **53** are adjacent the one of windows **154***a*, **154***b* through which their respective tissue engaging member sets **21***a* and **21***b* are extendible and retractable.

(89) As illustrated in FIG. **8**, the end effector **48** also includes a plunger **30** disposed at least partially in the housing **150** at or adjacent to the distal end **152** of the housing **150**, and the plunger **30** is longitudinally displaceable relative to the housing **150**. In particular, a proximal end **158** of the plunger **30**, which may correspond to (or be at or adjacent to) the proximal portion **148** of the end effector **48**, may be coupled to the distal end **56** of the wire **52**. The proximal end **158** of the plunger **30** may be coupled to the distal end **56** of the wire **52** in any suitable manner. For example, the distal end **56** of the wire **52** may include an enlarged portion **160** (such as a ball end) that is disposed within a cavity **162** formed in a portion of the plunger **30**. Thus, a distal displacement of the distal end **56** of the wire **52** results in a distal displacement of the plunger **30** with respect to the housing **150**, and a proximal displacement of the distal end **56** of the wire **52** results in a proximal displacement of the plunger **30** with respect to the housing **150**. In addition, the enlarged portion **160** and the cavity **162** are shaped and dimensioned configured to allow the plunger **30** (and the entire housing **150**) to rotate relative to the distal end **56** of the wire **52**.

(90) The plunger **30** additionally includes two plunger sockets **30***c*, **30***d* formed in a distal end **164** of the plunger **30**. At end **49***a* opposite socket **33** of proximal member **20***a* forms a curved member or shaft **32***a*, and at end **49***b* opposite pin **42** of proximal member **20***b* forms a curved member or shaft **32***b*. For tissue engaging member set **21***a*, curved members **32***a* and **32***b* of proximal members **20***a* and **20***b*, respectively, are received beside each other in the plunger socket **30***c* and are rotatable therein. For tissue engaging member set **21***b*, curved members **32***a* and **32***b* of proximal members **20***a* and **20***b*, respectively, are received beside each other in the plunger socket **30***d* and are rotatable therein. The walls **30***f* forming the plunger sockets **30***c* and **30***d* extend upwards to form fingers with tapered ends. This facilitates insertion of curved members **32***a* and **32***b* in one of the plunger sockets **30***c* and **30***d* for respective tissue engaging member sets **21***a* and **21***b*, such that the curved members **32***a* and **32***b* may inserted or removed from these sockets only at an angle not achievable when the distal end is fully assembled, thereby preventing the curved members **32***a* and **32***b* from falling out of their respective sockets during normal operation.

(91) As the plunger **30** moves distally in the housing **150** towards the distal end **152**, the curved members **32***a* and **32***b* rotate in plunger socket **30***c* (for tissue engaging member set **21***a*) or **30***d* (for tissue engaging member set **21***b*), rotating curved members **36** and **42** of distal and proximal members **20***c* and **20***b*, respectively, in sockets **33** and **43** of proximal and distal members **20***a* and **20***d*, respectively, as distal members **20***c* and **20***d* rotate about pin **51** (for tissue engaging member

set **21***a*) or **54** (for tissue engaging member set **21***b*), thereby extending outwards from the distal end **16** simultaneously both sets **21***a* and **21***b* of tissue engaging members **20**. The degree of extension being controlled by the length of travel of the longitudinal drive mechanism and limited by fingers **34** and **44** of proximal and distal members **20***a* and **20***d*, respectively, being stopped by their full insertion into openings **37** and **45** of distal and proximal members **20***c* and **20***b*, respectively. As the plunger **30** moves towards the proximal end **151** of the housing **150**, the above-described outward rotation of member **20***a-d* occurs in the opposite direction, thereby retracting the tissue engaging members **20**. The degree of retracting may be controlled by the length of travel of the plunger **30** and limited by the surface **38***a* of barb **38** of proximal member **20***a* abutting the surface **23***b* of distal member **20***c*, and the surface **46***a* of barb **46** of distal member **20***d* abutting the surface **25** of proximal member **20***b*. When fully retracted, the tissue engaging members **20** are substantially contained in the housing **150**, and may extend slightly beyond the outer perimeter of the housing **150**, as shown in FIG. **6**.
(92) Accordingly, when a user rotates the adjustment member **22** relative to the handle portion **12** such that the adjustment member **22** translates distally, the securing member carrier **74** also moves distally, thereby translating the securing member **24** from the first securing member position **133** (illustrated in FIG. **4**A) to the second securing member position **35** (illustrated in FIG. **4**B). As the securing member **24** displaces from the first securing member position **133** to the second securing member position **35**, the distal end **56** of the wire **52** is displaced distally, thereby moving the plunger **30** distally within the housing **150** of the end effector **48**, and the end effector **48** is displaced from the first undeployed position **49** (illustrated in FIGS. **1** and **6**) to the second deployed position **51** (illustrated in FIG. **8**).
(93) Conversely, when a user rotates the adjustment member **22** relative to the handle portion **12** such that the adjustment member **22** translates proximally, the securing member carrier **74** also moves proximally (as illustrated in FIG. **4**B, due to the bias caused by the first end portion **99** of the resilient member **98** of the securing member **24** that is in contact with the stop post **96**), thereby translating the securing member **24** from the second securing member position **35** (illustrated in FIG. **4**B) to the first securing member position **133** (illustrated in FIG. **4**A). As the securing member **24** displaces from the second securing member position **35** to the first securing member position **133**, the distal end **56** of the wire **52** is displaced proximally, thereby moving the plunger **30** proximally within the housing **150** of the end effector **48**, and the end effector **48** is displaced from the second deployed position **51** (illustrated in FIG. **8**) to the first undeployed position **49**.
(94) While the embodiment of the end effector **48** has been described as having two sets **21***a*, **21***b* of two tissue engaging members **20** that are extendible from the first undeployed position **49** to the second deployed position **51**, other embodiments of the end effector are contemplated. In some of the other embodiments, the end effector **48** may be configured to extend, retract, or change position from a first position to a second position (and, optionally, further positions). In other embodiments, the end effector **48** may have a fixed configuration and not transition from a first position to a second position,
(95) In some embodiments, the end effector **48** may be rotatable relative to the shaft portion **40** during a procedure, providing the user with an advantageous additional rotational degree of freedom. In such embodiments, the adjustment wheel **122**, which may be disposed in the space between the proximal end **118** of the distal support portion **112** and the distal end **116** of the proximal support portion **110**, may be coupled to the end effector **48** to rotate the end effector **48** relative to the shaft portion **140**.
(96) In particular, as illustrated in FIG. **2**, the adjustment wheel **122** may have a central aperture **166** that may be adapted to be disposed around an outer surface **168** of a wheel hub **170**. The central aperture **166** may have a non-circular shape that may correspond to a non-circular shape of the outer surface **168** of the wheel hub **170** such that when the adjustment wheel **122** is rotated, the wheel hub **170** correspondingly rotates relative to the handle portion **12** (and the shaft portion **40**).

The wheel hub **170** may be elongated and may extend along a hub axis from a proximal end **172** to a distal end **174**, and the hub axis may be aligned with the longitudinal axis **14**. So configured, and as illustrated in FIG. **4**B, all or a portion of a proximal portion **176** of the wheel hub **170** may be disposed through (and may be rotatable within) the proximal support portion **110** of the wheel housing portion **108** of the handle portion **12**, and all or a portion of a distal portion **178** of the wheel hub **170** may be disposed through (and may be rotatable within) the distal support portion **112** of the wheel housing portion **108** of the handle portion **12**. The wheel hub **170** may be maintained in proper longitudinal alignment by a plurality of Belleville springs **180** that are disposed between a proximal surface of the distal support portion **112** and a surface of the adjustment wheel **122**, which is fixed to the wheel hub **170**.

(97) Still referring to FIG. **4**B, the wheel hub **170** may have a central aperture **171** that extends through the wheel hub **170** from the proximal end **172** to the distal end **174** along the hub axis, and the central aperture **171** is in communication with the central bore **64** of the handle portion **12** As such, a portion of the wire **52** may be disposed through, and may displace longitudinally within, the central aperture **171** of the wheel hub **170**. A plurality of gear teeth **182** may be disposed about a circumferential surface at the distal end **174** of the wheel hub **170** surrounding the central aperture **171**, and the plurality of gear teeth **182** rotate about the longitudinal axis **14** as the adjustment wheel **122** is rotated.

(98) Referring now to FIG. **7**, the removable portion **57** of the tissue manipulation device **10** may include two or more torque links **58** that cooperate to rotatably couple the adjustment wheel **122** and the end effector **48**. The two or more torque links **58** may include a first torque link **58***a* that may be rotatably coupled to the wheel hub **170**. In particular, as illustrated in FIG. **2**, the first torque link **58***a* may be elongated and may extend along an axis from a proximal end **182***a* to a distal end **184***a*, and a link bore **186***a* may extend through the first torque link **58***a* from the proximal end **182***a* to the distal end **184***a*. As such, a portion of the wire **52** may be disposed through, and may displace longitudinally within, the link bore **186***a*. A plurality of gear teeth **188***a* may be disposed about a circumferential surface at the distal end **184***a* of the first torque link **58***a* surrounding the link bore **186***a*. In addition, a plurality of receiving notches **190***a* may be disposed about a circumferential surface at the proximal end **182***a* of the first torque link **58***a* surrounding the link bore **186***a*. When the removable portion **57** is secured to the handle portion **12** and the shaft portion **40** of the tissue manipulation device **10**, and when the securing member **24** is in the engaged position **36** (illustrated in FIG. **4**A), each of the plurality of receiving notches **190***a* of the first torque link **58***a* may engage a corresponding one of the plurality of gear teeth **182** of the wheel hub **170** such that a rotation of the wheel hub **170** causes a corresponding rotation of the first torque link **58***a*.

(99) Each of the two or more torque links **58** of the removable portion **57** may be identical. For example, the two or more torque links **58** may also include a second torque link **58***b* that may be identical to the first torque link **58***a*. That is, the second torque link **58***b* may be elongated and may extend along an axis from a proximal end **182***b* to a distal end **184***b*, and a link bore **186***b* may extend through the second torque link **58***b* from the proximal end **182***b* to the distal end **184***b*. As such, a portion of the wire **52** may be disposed through, and may displace longitudinally within, the link bore **186***b*. A plurality of gear teeth **188***b* may be disposed about a circumferential surface at the distal end **184***b* of the second torque link **58***b* surrounding the link bore **186***b*. In addition, a plurality of receiving notches **190***b* may be disposed about a circumferential surface at the proximal end **182***b* of the second torque link **58***b* surrounding the link bore **186***b*. When the removable portion **57** is secured to the handle portion **12** and the shaft portion **40** of the tissue manipulation device **10**, and when the securing member **24** is in the engaged position **36** (illustrated in FIG. **4**A), the second torque link **58***b* may be disposed distal to the first torque link **58***a* such that each of the plurality of gear teeth **188***a* of the first torque link **58***a* may engage a corresponding one of the plurality of receiving notches **190***b* of the second torque link **58***b* such that a rotation of the first

torque link **58***a* causes a corresponding rotation of the second torque link **58***b*.
(100) In some embodiments, the removable portion **57** may include any number of additional torque links **58**, which may include the most distal torque link **58***z*. Distal torque link **58***z* may be identical to the first and second torque links **58***a*, **58***b*, and all other included torque links **58**. As such, when the first torque link **58***a* is rotated by a corresponding rotation of the adjustment wheel **122**, the second torque link **58***b* is also rotated as previously described, and the chain reaction of rotation would also rotate the distal torque link **58***z*. When the distal torque link **58***z* rotates, the gear teeth **188***z* of the distal torque link **58***z* also rotate, as would be understood by one having ordinary skill in the art. The gear teeth **188***z* of the distal torque link **58***z* engage corresponding receiving notches **192** on a proximal end of a connector portion **194** of the end effector **48**. The connector portion **194** is fixedly coupled to the housing **150** of the end effector **48**, and when the distal torque link **58***z* rotates from rotation of the adjustment wheel **122** as previously described, the end effector **40** also rotates relative to the shaft portion **40** about the end effector axis **153**.
(101) In some embodiments, the two or more torque links **58** include only two torque links, so the second torque link **58***b* corresponds to the distal torque link **58***z*. In other embodiments, the orientation of the on the gear teeth **188***a* and the receiving notches **190***a* previously described may be reversed. For example, the proximal end **182** of the first torque link **58***a* may have the gear teeth **188***a* and the distal end **184***a* of the first torque link **58***a* may include the receiving notches **190***a*, and all other torque links **58** and associated components may also be reversed. In other embodiments, the gear teeth **188***a* and the receiving notches **190***a* may be identical features such that the orientation of the torque links **58** along the wire **52** of the removable portion **57** does not matter.
(102) As illustrated in FIG. **7**, the removable portion **57** may include the two or more torque links **58** (for example, sixteen torque links **58**), and a portion of the wire **52** may extend through the link bore **186** of each of the two or more torque links **58**. In some embodiments, the removable portion **57** may also include a spring **196** that may surround a portion of the wire **52**, and the spring may extend from a proximal end **197** to a distal end **198** along an axis aligned with the portion of the wire **52**. The proximal end **197** of the spring **196** may be coupled to a portion of the wire **52** adjacent to the proximal end **54** of the wire **52**, such as a distal end of the coupling portion **52***a* disposed at or adjacent to the proximal end **54** of the wire **52**.
(103) The distal end **198** of the spring **196** may be directly or indirectly coupled to the proximal end **182***a* of the first torque link **58***a*. In some embodiments, the distal end **198** of the spring **196** may be coupled to a proximal end of a cylindrical member **199**, and the distal end of the cylindrical member **199** may be in contact with a portion of the proximal end **182***a* of the first torque link **58***a*. So positioned, the spring **195** operates to bias the first torque link **58***a* towards the distal end **56** of the wire **52**, which biases the distal end **184***a* of the first torque link **58***a* into engagement with the proximal end **182***b* of the second torque link **58***b*, which similarly biases each of the remaining torque links **58** distally such that the gear teeth **188***z* at the distal end **184***z* of the distal torque link **58***z* is biased into engagement with the corresponding receiving notches **192** on the proximal end of the connector portion **194** of the end effector **48**.
(104) Accordingly, when the securing member **24** is pivoted from the engaged position **36** (illustrated in FIG. **4**A) to the disengaged position **39** (illustrated in FIG. **5**), the removable portion **57** may be removed from the shaft portion **40** and handle portion **12**. In some embodiment, a locking mechanism (not shown), such as a pin extending through an aperture, may couple the end effector **48** to the distal end **44** of the shaft portion **40**, and this locking mechanism should be disabled (e.g., by removing the pin) prior to removing the removable portion **57**. Once the end effector **48** is no longer secured to the distal end **44** of the shaft portion **40**, the end effector **48** may be grasped by a user and displaced along the end effector axis **153** away from the distal end **44** of the shaft portion **40** until a proximal end **200** of the removable portion **57**, which may be the proximal end **54** of the wire **52**, extends past the distal end **44** of the shaft portion **40**. One having

ordinary skill in the art would recognize that the removable portion **57** would be bendable between any two adjacent torque links **58**, and this ability to bend allows the chain of torque links **58** allows the removable portion **57** to be passed through the curved portion **142** of the shaft portion **40** when inserting or removing the removable portion **57** for disassembly or reassembly.
(105) Once the removable portion **57** has been removed from the handle portion **12** and shaft portion **40**, the handle portion **12** and shaft portion **40** may undergo a process (e.g., washing and sterilization). Alternatively, the removable portion **57** may also be processed separately from, or instead of, the handle portion **12** and shaft portion **40**. To reattach the removable portion **57**, or to attach a new removable portion **57**, the described steps are reversed.
(106) Turning to a further embodiment illustrated in FIGS. **11** to **13**, the tissue manipulation device **200** may be substantially identical to the tissue manipulation device **10** previously described, with the exception that a rigid torque member **202** may replace one or more of the torque links **58**. In particular, the torque member **202** may extend along an axis **205** from a proximal end **204** to a distal end **206**, and the axis **205** may be aligned with the portion of the shaft axis **47** that extends along the linear portion **140** of the shaft portion **40**. The torque member **202** may include a central bore **208** that extends through the torque member **202** from the proximal end **204** to the distal end **206** along the axis **205**. The torque member may have any suitable cross-sectional shape or combination of shapes to allow the torque member **202** to transmit torque and to fit in the linear portion **140** of the shaft portion **40**.
(107) The torque member **202** may be a single, unitary part or may be an assembly of two or more components that cooperate to form the torque member **202**. In operation, a portion of the wire **52** may be disposed through, and be longitudinally displaceable within, the central bore **208** of the torque member **202**. In some embodiments, a guide sheath (not shown) may surround all or a portion of the portion of the wire **52** that extends through the central bore **208** of the torque member **202**.
(108) A plurality of receiving notches **210** may be disposed about a circumferential surface at the proximal end **204** of the torque member **202** surrounding the central bore **208**. When the securing member **24** is in the engaged position **36** (illustrated in FIG. **13**), each of the plurality of receiving notches **210** of the torque member **202** may engage a corresponding one of the plurality of gear teeth **182** of the wheel hub **170** such that a rotation of the wheel hub **170** causes a corresponding rotation of the torque member **202** about the axis **205**.
(109) The torque member **202** may extend distally such that the distal end **206** of the torque member **202** is disposed at or adjacent to the intermediate point **144** of the shaft portion **140**, which is at a distal end of the distal end of the linear portion **140** of the shaft portion **40** and at a proximal end of the of the curved portion **142** of the shaft portion **40**. A plurality of gear teeth **212** may be disposed about a circumferential surface at the distal end **204** of the torque member **202** surrounding the central bore **208**. The plurality of gear teeth **212** may be disposed on a removable end portion **214** that forms the distal end **206** of the torque member **202**. The plurality of gear teeth **212** may engage a first of two or more torque links **58** that may be identical to those previously described, and the two or more torque links **58** may be disposed in the curved portion **142** of the shaft portion **140**. As such, each of the plurality of gear teeth **212** at the distal end **204** of the torque member **202** may engage a corresponding one of the plurality of receiving notches **190***a* of the first torque link **58***a* such that a rotation of the torque member **202** causes a corresponding rotation of the first torque link **58***a*. The rotation of the first torque link **58***a* causes a corresponding rotation of the second torque line **58***b* (and any additional torque links **58**) to rotate the end effector **48** relative to the distal end **44** of the shaft portion **40**.
(110) Advantageously, the torque member **202** efficiently transmits a torque applied to the proximal end **204** of the torque member **202** to the distal end **206** of the torque member **202** without rotational lag, allowing for precise rotational control and more immediate response when a user rotates the adjustment wheel **122**.

(111) In some embodiments, the torque member **202** may not be a portion of the removable portion **57** that may be removed through the distal end **44** of the shaft portion **40** as a unit when the securing member **24** is pivoted from the engaged position **36** (illustrated in FIG. **4**A) to the disengaged position **39** (illustrated in FIG. **5**). However, in other embodiments, the torque member **202** may be a portion of the removable portion **57**, and the proximal end **204** of the torque member **202** may be disposed adjacent to the proximal end **54** of the wire **52** or adjacent to a portion of the coupling portion **52***a*, In such an embodiment, a feature (not shown) coupled to or formed on the wire **52** (or coupling portion **52***a*) may prevent the proximal end **204** of the torque member **202** from displacing beyond the proximal end **54** of the wire **52** when the removable portion **57** is removed through the distal end **44** of the shaft portion **40**.
(112) For example, FIGS. **16** to **18**D illustrate an embodiment of a removable portion **300** that may include an embodiment of a torque member **302**. In this embodiment, the torque member **302** may extend along an axis **304** from a proximal end **306** to a distal end **308**, and the axis **304** may be aligned with the portion of the shaft axis **47** that extends along the linear portion **140** of the shaft portion **40** (see FIG. **10**A). The axis **304** may also be parallel to or aligned with (in an unbent or linear configuration) with the X-axis of the reference coordinate system of FIGS. **16** and **17**A. The torque member **302** may be configured to transmit torque that is input at the proximal end **306** to the output end **308** when the torque member **302** is rotated about the axis **304**. The torque member **302** may also be configured to allow for bending of the torque member **302** about an axis that is normal to the axis **304** such that the torque member **302** may bend only in a first bending plane, thereby allowing the torque member **302** to efficiently transmit torque without lag or loss from slop, while allowing one or more portions of the torque member **302** to selectively bend when the removable portion **300** to be passed through the curved portion **142** of the shaft portion **40** when inserting or removing the removable portion **300** for disassembly or reassembly.
(113) Turning to FIG. **17**A, the torque member **302** may include a base **310** that extends from the proximal end **306** to the distal end **308**. The base **310** may have a constant cross-sectional shape along the length of the torque member **302**. As illustrated in FIG. **17**E, the cross-sectional shape of the base **310** (when viewed along the axis **304**) may be defined by an upper edge **312** and a lower edge **314** that is parallel to and offset from the upper edge **312**. Each of the upper edge **312** and a lower edge **314** may be parallel to the Y-axis of the reference coordinate system of FIGS. **16** and **17**C. The cross-sectional shape of the base **310** may be further defined by a first lateral edge **316** and a second lateral edge **318**. The first lateral edge **316** may extend along or substantially along the Z-axis of the reference coordinate system of FIGS. **16** and **17**C from a first end of the upper edge **312** to a first end of the lower edge **314**. The second lateral edge **318** may extend along or substantially along the Z-axis of the reference coordinate system of FIGS. **16** and **17**C from a second end of the upper edge **312** to a second end of the lower edge **314**. Each of the first lateral edge **316** and the second lateral edge **318** may be curved to partially curved to form a segment of a circle, for example.
(114) A plurality of projections **320** may extend from the base **310**, and each of the plurality of projections **320** may be spaced along the X-axis of the reference coordinate system of FIGS. **16** and **17**C from an adjacent other of the plurality of projections **320**. The plurality of projections **320** may extend along the entire length of the base **310** from the proximal end **306** to the distal end **308** of the torque member **302**. In other embodiments, the plurality of projections **320** may extend along one or more portions of the length of the base **310**. When viewed in cross-section (along the axis **304**), as illustrated in FIG. **17**C, each of the plurality of projections **320** may be include a first projection portion **322***a* and a second projection portion **322***b*, and the first projection portion **322***a* and the second projection portion **322***b* may be symmetrically formed about a plane **325**, which is parallel to the X-Z plane of the reference coordinate system of FIGS. **16** and **17**C, and the plane **325** may extend along the axis **304**. The first projection portion **322***a* may be defined by an upper projection edge **326***a* and a lower projection edge **328***a*. The lower projection edge **238***a* may

extend along or generally along the Y-axis of the reference coordinate system of FIGS. **16** and **17**C, and the upper projection edge **326***a* may be obliquely disposed (or downwardly sloped) towards the lower projection edge **328***a* as the upper projection edge **326***a* extends away from the plane **325**. A lateral edge **330***a* may extend between a first end of the upper projection edge **326***a* and a first end of the lower projection edge **328***a*, and the lateral edge **330***a* may be at least partially curved or rounded. As such, the upper projection edge **326***a*, the lower projection edge **328***a*, and the lateral edge **330***a* may cooperate to generally form shape of a wedge. A second lateral edge **332***a* may extend from a second end of the lower projection edge **328***a* to a first portion of the upper edge **312** of the base **310**, and the second lateral edge **332***a* may be least partially curved or rounded.

(115) The second projection portion **322***b* may be a mirror image of the first projection portion **322***a* and may be symmetrical to the first projection portion **322***a* about the plane **325**. In particular, the second projection portion **322***b* may be defined by an upper projection edge **326***b* and a lower projection edge **328***b*. The lower projection edge **238***b* may extend along or generally along the Y-axis of the reference coordinate system of FIGS. **16** and **17**C, and the upper projection edge **326***b* may be obliquely disposed (or downwardly sloped) towards the lower projection edge **328***b* as the upper projection edge **326***b* extends away from the plane **325**. A lateral edge **330***b* may extend between a first end of the upper projection edge **326***b* and a first end of the lower projection edge **328***b*, and the lateral edge **330***b* may be curved or rounded. As such, the upper projection edge **326***b*, the lower projection edge **328***b*, and the lateral edge **330***b* may cooperate to generally form shape of a wedge. A second lateral edge **332***b* may extend from a second end of the lower projection edge **328***b* to a second portion of the upper edge **312** of the base **310**, and the second lateral edge **332***a* may be least partially curved or rounded.

(116) Each of the plurality of projections **320** may also include a wire bore **334** from a proximal end of each of the plurality of projections **320** to a distal end of each of the plurality of projections **320**. Each of the wire bores **334** in each of the plurality of projections **320** may be aligned or generally aligned with the other plurality of projections **320** over the length of the axis **304** such that, in operation, a corresponding portion of the wire **52** may be disposed through, and be longitudinally displaceable within, the wire bore **334** of each of the plurality of projections **320**. The wire bore **334** may have any suitable shape to receive the corresponding portion of the wire **52**. For example, the wire bore **334** may be a substantially U-shaped notch **336** formed between the first projection portion **322***a* and the second projection portion **322***b*, and the notch may extend through and along the plane **325**. The notch may have a first lateral portion **338***a* that extends downwardly from a second end of the upper projection edge **326***a* of the first projection portion **322***a* and a second lateral portion **338***b* that extends downwardly from a second end of the upper projection edge **326***b* of the second projection portion **322***b*. A notch end edge **340** may extend (e.g., extend parallel to or generally parallel to the Y-axis of the reference coordinate system of FIGS. **16** and **17**C) between an end of the first lateral portion **338***a* and an end of the second lateral portion **338***b*.

(117) With reference to FIG. **17**A, each of the plurality of projections **320** may be spaced along the X-axis of the reference coordinate system of FIGS. **16** and **17**C from an adjacent other of the plurality of projections **320**. For example, a first **320***a* of the plurality or projections **320** may have a distal lateral edge **342***a* that may be disposed a first distance D**1** along the X-axis from a proximal lateral edge **344***b* of a second **320***b* of the plurality or projections **320**. The second **320***a* of the plurality or projections **320** may have a distal lateral edge **342***b* that may be disposed a second distance D**2** along the X-axis from a proximal lateral edge **344***c* of a third **320***c* of the plurality or projections **320**. In some embodiments, the first distance D**1** may be equal to the second distance D**2**. In some embodiments, the distance along the X-axis between a distal lateral edge **342***x* of any of the plurality of projections **320** from a proximal lateral edge **344***x* of an adjacent one of the plurality or projections **320** may be the first distance D**1**.

(118) As illustrated in FIG. **17**A, when viewed along the Y-axis of the reference coordinate system,

a first neck edge **346** and a second neck edge **348** extends obliquely towards the base **310** to form a narrowed neck portion **350** that upwardly extends from the base **310**. The spacing between the first and second adjacent plurality of projections **320**, as well as the combination of cross-sectional shapes of each of the plurality of projections **320**, allow the torque member **302** to bend along an axis that is parallel to the Y-axis of the reference coordinate system of FIGS. **16** and **17**A, that this axis may be normal to the plane **325**. Thus, any portion of the torque member **302** may bend clockwise or counterclockwise about the axis when viewed along the Y-axis, as shown in FIG. **17**A. Thus, rotation is allowed in a single bending plane (plane **325**), but not along any other planes or along any axis that is not parallel to the Y-axis of the reference coordinate system of FIGS. **16** and **17**A. This ensure sufficient rigidity of the torque member **302** when the torque member **302** is rotated about the X-axis of the reference coordinate system of FIGS. **16** and **17**A while allowing the torque member **302** to bend within a single plane to allow for insertion or extraction of the removable portion **300** through the curved portion **142** of the shaft portion **40**.

(119) As illustrated in FIGS. **18**A to **18**D, the torque member **302** may also include one or more alignment features **352** that ensures that the removable portion **300** is oriented correctly when inserted into the distal end **44** of the shaft portion **40** during the assembly (or reassembly) of the tissue manipulating device **10**. The one or more alignment features **352** may include a protrusion **356** formed at or adjacent to the distal end **354** of the linear portion **140** of the shaft portion **40** or at or adjacent to the proximal end of the curved portion **142** of the shaft portion **40**. The protrusion **356** may be formed as a depression (e.g., a dome-shaped depression) in the shaft portion **40** and the depression may extend into the shaft interior portion **146**. In some embodiments, the depression may be a dome-shaped depression that may be symmetrically formed or disposed about a plane that extends through the shaft axis **47** and is parallel to the X-Z of the reference coordinate system of FIGS. **1** and **18**D, and the depression may be formed on an upper surface of the shaft portion **40**, wherein the direction “upper” corresponds to the direction along the Z-axis in which the curved portion **142** of the shaft portion **40** extends.

(120) The alignment feature **352**, such as the depression, may be positioned to not contact a portion of the upper projection edges **326***a*, **326***b* of the first projection portion **322***a* or the second projection portion **322***b* of the torque member **302** when the removable portion **300** is positioned correctly for insertion. However, when the removable portion **300** is positioned incorrectly upon insertion into the shaft portion **40**, the alignment feature **352** may contact a portion of the sloped upper projection edges **326***a*, **326***b* of the first projection portion **322***a* or the second projection portion **322***b* to rotate the torque member **302**, and the entire removable portion **300**, into correct alignment to allow for the curving of the torque member **302** upon insertion into the shaft portion **40**. FIG. **18**C illustrates various orientations of the torque member **302** relative to the alignment feature **352** within the shaft portion **40**.

(121) FIGS. **19**A to **19**K illustrate a further embodiment of a removable portion **400** that may include an embodiment of a torque member **402** that may be similar to, but have a slightly different cross-sectional shape from, the torque member **302** illustrated in FIGS. **16** to **18**D. As illustrated in FIG. **19**K, the torque member **402** may extend along an axis **404** from a proximal end **406** to a distal end **408**, and the torque member **402** may include a base **410** that extends from the proximal end **406** to the distal end **408**. The base **410** may have a constant cross-sectional shape along the length of the torque member **402**. As illustrated in FIG. **19**J, the cross-sectional shape of the base **410** (when viewed along the axis **404**) may be defined by an upper edge **412** and a lower edge **314** that is parallel to and offset from the upper edge **412**. Each of the upper edge **412** and a lower edge **414** may be parallel to the Y-axis of the reference coordinate system of FIG. **19**J. The cross-sectional shape of the base **410** may be further defined by a first lateral edge **416** and a second lateral edge **418**. The first lateral edge **416** may extend along or substantially along the Z-axis of the reference coordinate system of FIG. **19**J from a first end of the upper edge **412** to a first end of the lower edge **414**. The second lateral edge **418** may extend along or substantially along the Z-axis

of the reference coordinate system of FIG. **19**J from a second end of the upper edge **412** to a second end of the lower edge **414**. Each of the first lateral edge **416** and the second lateral edge **418** may be curved, contoured, or partially curved.

(122) A plurality of projections **420** may extend from the base **410**, and each of the plurality of projections **420** may be spaced along the X-axis of the reference coordinate system of FIG. **19**D from an adjacent other of the plurality of projections **420**. The plurality of projections **420** may extend along the entire length of the base **410** or may extend along one or more portions of the length of the base **410**. When viewed in cross-section (along the axis **404**), as illustrated in FIG. **19**C, each of the plurality of projections **420** may be include a first projection portion **422***a* and a second projection portion **422***b*, and the first projection portion **422***a* and the second projection portion **422***b* may be symmetrically formed about a plane **425**, which is parallel to the X-Z plane of the reference coordinate system of FIGS. **19**C and **19**D, and the plane **425** may extend along the axis **404**. The first projection portion **422***a* may be defined by an upper projection edge **426***a* which may extend along or generally along the Y-axis of the reference coordinate system of FIG. **19**C, and a lateral edge **430***a* may extend between a first end of the upper projection edge **326***a* and a first end of the base **410** (e.g., a first end of the upper edge **412** of the base **410**), and the lateral edge **430***a* may be at least partially curved or rounded. The second projection portion **422***b* may be a mirror image of the first projection portion **422***a* and may be symmetrical to the first projection portion **422***a* about the plane **425**. In particular, the second projection portion **422***b* may be defined by an upper projection edge **426***b* which may extend along or generally along the Y-axis of the reference coordinate system of FIG. **19**C, and a lateral edge **430***b* may extend between a first end of the upper projection edge **426***b* and a second end of the base **410** (e.g., a second end of the upper edge **412** of the base **410**), and the lateral edge **430***b* may be at least partially curved or rounded.

(123) Each of the plurality of projections **420** may also include a wire bore **434** that from a proximal end of each of the plurality of projections **420** to a distal end of each of the plurality of projections **420**. Each of the wire bores **434** in each of the plurality of projections **420** may be aligned or generally aligned with the other plurality of projections **420** over the length of the axis **404** such that, in operation, a corresponding portion of the wire **52** may be disposed through, and be longitudinally displaceable within, the wire bore **434** of each of the plurality of projections **420**. The wire bore **434** may have any suitable shape to receive the corresponding portion of the wire **52**. For example, the wire bore **434** may be a substantially U-shaped notch **436** formed between the first projection portion **422***a* and the second projection portion **422***b*, and the notch **436** may extend through and along the plane **425**. The notch **436** may have a first lateral portion **438***a* that extends downwardly from a second end of the upper projection edge **426***a* of the first projection portion **422***a* and a second lateral portion **438***b* that extends downwardly from a second end of the upper projection edge **426***b* of the second projection portion **422***b*. A notch bottom edge **440** may extend between an end of the first lateral portion **438***a* and an end of the second lateral portion **438***b*, and the notch bottom edge **440** may have the shape of a segment of a circle.

(124) With reference to FIG. **19**D, each of the plurality of projections **420** may be spaced along the X-axis of the reference coordinate system of FIGS. **19**D and **19**K from an adjacent other of the plurality of projections **420**. For example, a first **420***a* of the plurality or projections **420** may have a distal lateral edge **442***a* that may be disposed a first distance D**1** along the X-axis from a proximal lateral edge **444***b* of a second **420***b* of the plurality or projections **420**. The second **420***a* of the plurality or projections **420** may have a distal lateral edge **442***b* that may be disposed a second distance D**2** along the X-axis from a proximal lateral edge **444***c* of a third **420***c* of the plurality or projections **420**. In some embodiments, the first distance D**1** may be equal to the second distance D**2**. In some embodiments, the distance along the X-axis between a distal lateral edge **442***x* of any of the plurality of projections **420** from a proximal lateral edge **444***x* of an adjacent one of the plurality or projections **420** may be the first distance D**1**.

(125) As illustrated in FIG. **19**D, when viewed along the Y-axis of the reference coordinate system,

a first neck edge **446** and a second neck edge **448** extends obliquely towards the base **410** to form a narrowed neck portion **450** that extends upward from the base **410**. The spacing between the first and second adjacent plurality of projections **420**, as well as the combination of cross-sectional shapes of each of the plurality of projections **420**, allow the torque member **402** to bend along an axis that is parallel to the Y-axis of the reference coordinate system of FIGS. **19**C and **19**D, that this axis may be normal to the plane **425**. Thus, any portion of the torque member **402** may bend clockwise or counterclockwise about the axis when viewed along the Y-axis, as shown in FIG. **19**D. Thus, rotation is allowed in a single bending plane (plane **425**), but not along any other planes or along any axis that is not parallel to the Y-axis of the reference coordinate system of FIG. **19**D. This ensures sufficient rigidity of the torque member **402** when the torque member **402** is rotated about the X-axis of the reference coordinate system of FIGS. **19**D and **19**K while allowing the torque member **402** to bend within a single plane to allow for insertion or extraction of the removable portion **400** through the curved portion **142** of the shaft portion **40**.

(126) FIGS. **20**A to **20**F illustrate a further embodiment of a removable portion **500** that may include an embodiment of a torque member **502** that may be similar to, but have a different cross-sectional shape from, the torque member **302** illustrated in FIGS. **16** to **18**D and the torque member **402** illustrated in FIGS. **19**A to **19**K. As illustrated in FIG. **19**A, the torque member **502** may extends along an axis **504** from a proximal end **506** to a distal end **508**, and the torque member **502** may include a base **510** that extends from the proximal end **506** to the distal end **508**, and the base **510** may be similar to the base **410** of base **310** previously described.

(127) A plurality of projections **520** may extend from the base **510**, and each of the plurality of projections **520** may be spaced along the X-axis of the reference coordinate system of FIG. **20**A from an adjacent other of the plurality of projections **420**, in a manner similar or identical to the plurality of projections **420** or the plurality of projections **320** previously described. Each of the plurality of projections may have a rectangular of square (or substantially rectangular or square) cross-sectional shape, as illustrated in FIG. **20**F. Each of the plurality of projections **520** may also include a wire bore **534** that extends from a proximal end of each of the plurality of projections **520** to a distal end of each of the plurality of projections **520**. Each of the wire bores **534** in each of the plurality of projections **520** may be aligned or generally aligned with the other plurality of projections **520** over the length of the axis **504** such that, in operation, a corresponding portion of the wire **52** may be disposed through, and be longitudinally displaceable within, the wire bore **534** of each of the plurality of projections **520**. The wire bore **534** may have any suitable shape to receive the corresponding portion of the wire **52**. For example, the wire bore **534** may be cylindrical and may have an axis that extends parallel to the X-axis of the reference coordinate system of FIG. **20**C. In cross-section, the wire bore **534** may have a circular edge **540** that may be symmetrically disposed about a plane **525** that is parallel to the X-Z plane of the reference coordinate system of FIG. **20**A, and the plane **525** may extend along the axis **504**.

(128) With reference to FIG. **20**C, each of the plurality of projections **520** may be spaced along the X-axis of the reference coordinate system of FIG. **20**C from an adjacent other of the plurality of projections **520** in a manner identical to that of the plurality of projections **420** or the plurality of projections **320** previously described. The spacing between the first and second adjacent plurality of projections **520**, as well as the combination of cross-sectional shapes of each of the plurality of projections **520**, allow the torque member **502** to bend along an axis that is parallel to the Y-axis of the reference coordinate system of FIG. **20**A, that this axis may be normal to the plane **525**. Thus, any portion of the torque member **502** may bend clockwise or counterclockwise about the axis when viewed along the Y-axis, as shown in FIG. **20**C. Thus, rotation is allowed in a single bending plane (plane **525**), but not along any other planes or along any axis that is not parallel to the Y-axis of the reference coordinate system of FIG. **20**A. As previously explained, this ensures sufficient rigidity of the torque member **502** when the torque member **502** is rotated about the X-axis of the reference coordinate system of FIG. **20**A while allowing the torque member **502** to bend within a

single plane to allow for insertion or extraction of the removable portion **500** through the curved portion **142** of the shaft portion **40**.
(129) The torque member **202** may be comprised of any suitable material or combination of materials, such as plastic or stainless steel.
(130) Turning now to the embodiment illustrated in FIGS. **21**A to **24**B, a tissue engaging assembly **600** may be used instead of the tissue engaging members **20** of the end effector **48** illustrated in FIGS. **8**, **11**, and **12**. In particular, the tissue engaging assembly **600** may be used in an embodiment of an end effector assembly **602** illustrated in FIGS. **25** to **26**C, and the embodiment of the end effector assembly **602** will be described in more detail below. The embodiment of the end effector assembly **602** may be used in the embodiment of the tissue manipulation device **10** previously described or in any other embodiment of a tissue manipulation device, and the end effector assembly **602** may rotate or otherwise displace relative to the distal end **44** of the shaft portion **40** as previously described.
(131) The tissue engaging assembly **600** may be a single, unitary part that may allow for two or more tissue engaging arms **604** that may be deployable to secure and/or displace a patient's prostate during a procedure. This single part may be manufactured or produced in any suitable manner, such as by injection molding the part using a plastic material. Similar to the end effector **48**, the end effector assembly **602** may be displaced from a first undeployed position **603** (illustrated in FIG. **25**) to a second deployed position **605** (illustrated in FIGS. **26**A to **26**C). For example, the end effector assembly **602** may be in the first undeployed position **603** to be inserted into the urethra of a patient, then the end effector assembly **602** may be transitioned to the second deployed position **605** when positioned within a portion of the patent's prostate, allowing the surgeon to physically manipulate or position the prostate as desired. When it is desired to remove the end effector assembly **602**, the end effector assembly **602** may be transitioned back to the first undeployed position **603** and removed from the urethra.
(132) Turning to **21**A to **24**B, the tissue engaging assembly **600** may include two, three, four, or more tissue engaging arms **604**. For example, the tissue engaging assembly **600** may include four tissue engaging arms **604**, which includes a first tissue engaging arm **604***a*, a second tissue engaging arm **604***b*, a third tissue engaging arm **604***c*, and a fourth tissue engaging arm **604***d*. FIGS. **21**A to **22**C illustrates the pre-assembled configuration of the tissue engaging assembly **600**, such as the configuration of the tissue engaging assembly **600** after injection molding and before assembly or integration into the end effector assembly **602** as illustrated in FIGS. **25** to **27**. With reference to FIG. **22**A, the first tissue engaging arm **604***a* may be elongated and may extend from a first end **606***a* to a second end **608***a* along a first arm axis **610***a* that may be parallel to (or aligned with) the X-axis of the reference coordinate system of FIG. **22**A, and the first end **606***a* may be coupled to a first portion **611***a* of a hub portion **611**. The first tissue engaging arm **604***a* may include two or more arm segments, and in some embodiments, the first tissue engaging arm **604***a* may include a first arm segment **612***a*, a second arm segment **614***a*, and a third arm segment **616***a*.
(133) Referring to FIG. **24**A, the first arm segment **612***a* of the first tissue engaging arm **604***a* may extend from a first end **618***a* to a second end **620***a* along the first arm axis **610***a*. The first end **618***a* of the first arm segment **612***a* may be adjacent to (or may correspond to) the first end **606***a* of the first tissue engaging arm **604***a*, and the first end **618***a* may be coupled to (and be adjacent to and offset from) the first portion **611***a* of the hub portion **611**. The first end **618***a* of the first arm segment **612***a* may be coupled to the first portion **611***a* of the hub portion **611** in any suitable manner, such as with a first hinge **622***a*. The first hinge **622***a* may be a living hinge that may extend between the first end **618***a* of the first arm segment **612***a* and the first portion **611***a* of the hub portion **611**.
(134) The first arm segment **612***a* may have any cross-sectional shape or combination of shapes (when viewed along the first arm axis **610***a*) from the first end **618***a* to the second end **620***a*. For example, as illustrated in FIG. **24**B, the first arm segment **612***a* may have a constant or

substantially constant cross-sectional shape (when viewed along the first arm axis **610***a*) from the first end **618***a* to the second end **620***a*, and the cross-sectional shape of first arm segment **612***a* may have a polygonal shape. The cross-sectional shape of the first arm segment **612***a* may be partially defined by a pair of opposed lateral edges **615***a*, **617***a* that may be parallel (or generally parallel) and extend along (or generally along) the Z-axis of the reference coordinate system of FIGS. **22**A and **24**B. The cross-sectional shape of the first arm segment **612***a* may also be partially defined by a pair of inner lateral edges **619***a*, **621***a* that each extends from an end of corresponding one of the pair of opposed lateral edges **615***a*, **617***a*, and the pair of inner lateral edges **619***a*, **621***a* converge along the Z-axis to form a V-shape.

(135) The second arm segment **614***a* of the first tissue engaging arm **604***a* may extend from a first end **625***a* to a second end **626***a* along the first arm axis **610***a*, and the first end **625***a* may be adjacent to (and offset from) the second end **620***a* of the first arm segment **612***a*. The first end **625***a* of the second arm segment **614***a* may be coupled to the second end **620***a* of the first arm segment **612***a* in any suitable manner, such as with a second hinge **627***a*. The second hinge **627***a* may be a living hinge that may extend between the first end **625***a* of the second arm segment **614***a* and the second end **620***a* of the first arm segment **612***a*. The cross-sectional shape of the second arm segment **614***a* may be identical or substantially identical to the cross-sectional shape of the first arm segment **612***a*.

(136) The third arm segment **616***a* may extend from a first end **628***a* to a second end **629***a* along the first arm axis **610***a*, and the first end **628***a* may be adjacent to (and offset from) the second end **626***a* of the second arm segment **614***a*. The first end **628***a* of the third arm segment **616***a* may be coupled to a second end **626***a* of the second arm segment **614***a* in any suitable manner, such as with a third hinge **630***a*. The third hinge **630***a* may be a living hinge that may extend between the first end **628***a* of the third arm segment **616***a* and the second end **626***a* of the second arm segment **614***a*. The second end **629***a* of the third arm segment **616***a* may be coupled to a portion of the first end cap segment **632***a* in any suitable manner, such as with a fourth hinge **633***a*. The fourth hinge **633***a* may be a living hinge that may extend between the second end **629***a* of the third arm segment **616***a* and the portion of the first end cap segment **632***a*. The cross-sectional shape of the second arm segment **614***a* may be identical or substantially identical to the cross-sectional shape of the first arm segment **612***a* and/or the second arm segment **614***a*.

(137) When the end effector assembly **602** is displaced from the first undeployed position **603** (illustrated in FIG. **25**) to the second deployed position **605** (illustrated in FIGS. **26**A to **26**C) in a manner that will be described in more detail below, a first mating feature **632***a* of the first arm segment **612***a* (or one or more portions of the first mating feature **632***a* of the first arm segment **612***a*) may engage a corresponding first mating feature **634***a* of the second arm segment **614***a* (or a corresponding one or more portions of the first mating feature **634***a* of the second arm segment **614***a*) to maintain the first arm segment **612***a* and the second arm segment **614***a* in a desired position when the end effector assembly **602** is in the second deployed position **605**. For example, as illustrated in FIG. **23**, the first mating feature **632***a* of the first arm segment **612***a* may include a first notch **636***a* that may be configured to receive a first protrusion **638***a* of the first mating feature **634***a* of the second arm segment **614***a*. A forward contact surface **640***a* may define a portion of the first protrusion **638***a*, and the forward contact surface **640***a* may be configured to contact an oblique contact surface **642***a* that defines a portion of the first notch **636***a* when the end effector assembly **602** is displaced to the second deployed position **605**.

(138) The forward contact surface **640***a* of the first protrusion **638***a* may be planar and may be normal or substantially normal to the first arm axis **610***a* when the end effector assembly **602** is in the first undeployed position **603**. The oblique contact surface **642***a* of the first notch **636***a* may be planar and may be disposed at an oblique angle relative to the first arm axis **610***a* when the end effector assembly **602** is in the first undeployed position **603**. Accordingly, when the end effector assembly **602** is displaced to the second deployed position **605** such that the first arm segment **612***a*

bends, rotates, or pivots relative to the second arm segment **614***a* (and/or vice versa) about the second hinge **627***a*, the planar surface of the forward contact surface **640***a* of the first protrusion **638***a* comes into contact with the planar oblique contact surface **642***a* of the first notch **636***a* to prevent further bending of the first arm segment **612***a* and the second arm segment **614***a* about the second hinge **627***a*.

(139) The first mating feature **632***a* of the first arm segment **612***a* may also include a pair of end surfaces **644***a* that may also partially define the first notch **636***a* and the second end **620***a* of the first arm segment **612***a*. Further, the first mating feature **634***a* of the second arm segment **614***a* may include a pair of lateral oblique contact surfaces **646***a* that may also partially define the first protrusion **638***a* and extend from the first end **625***a* (and towards the second end **626***a*) of the second arm segment **614***a*. In some embodiments, the pair of lateral oblique contact surfaces **646***a* may be symmetrically disposed about the first protrusion **638***a* such that a first of the pair of lateral oblique contact surfaces **646***a* may be on a first lateral side of the first protrusion **638***a* and a second of the pair of lateral oblique contact surfaces **646***a* may be on a second lateral side of the first protrusion **638***a*.

(140) The pair of end surfaces **644***a* of the first mating feature **632***a* of the first arm segment **612***a* may be planar and may be normal or substantially normal to the first arm axis **610***a* when the end effector assembly **602** is in the first undeployed position **603**. The lateral oblique contact surface **646***a* of the first mating feature **634***a* of the second arm segment **614***a* may be planar and may be disposed at an oblique angle relative to the first arm axis **610***a* when the end effector assembly **602** is in the first undeployed position **603**. Accordingly, when the end effector assembly **602** is displaced to the second deployed position **605** such that the first arm segment **612***a* bends, rotates, or pivots relative to the second arm segment **614***a* (and/or vice versa) about the second hinge **627***a*, the planar pair of end surfaces **644***a* comes into contact with the planar lateral oblique contact surfaces **646***a* to prevent further bending of the first arm segment **612***a* and the second arm segment **614***a* about the second hinge **627***a*. In some embodiments, the planar pair of end surfaces **644***a* comes into contact with the planar lateral oblique contact surfaces **646***a* at the same position as the forward contact surface **640***a* of the first protrusion **638***a* comes into contact with the planar oblique contact surface **642***a* of the first notch **636***a* to provide maximum resistance against further bending of the first arm segment **612***a* and the second arm segment **614***a* about the second hinge **627***a* when the end effector assembly **602** is displaced into the second deployed position **605**.

(141) In addition, when the end effector assembly **602** is displaced from the first undeployed position **603** (illustrated in FIG. **25**) to the second deployed position **605** (illustrated in FIGS. **26**A to **26**C), a second mating feature **648***a* of the second arm segment **614***a* (or one or more portions of the second mating feature **648***a* of the second arm segment **614***a*) may engage a corresponding first mating feature **650***a* of the third arm segment **616***a* (or a corresponding one or more portions of the first mating feature **650***a* of the third arm segment **616***a*) to maintain the third arm segment **616***a* and the second arm segment **614***a* in a desired position when the end effector assembly **602** is in the second deployed position **605**. For example, as illustrated in FIG. **23**, the first mating feature **650***a* of the third arm segment **616***a* may include a first notch **652***a* that may be configured to receive a second protrusion **654***a* of the second mating feature **648***a* of the second arm segment **614***a*. A forward contact surface **656***a* may define a portion of the second protrusion **654***a*, and the forward contact surface **656***a* may be configured to contact an oblique contact surface **658***a* that defines a portion of the first notch **652***a* of the first mating feature **650***a* of the third arm segment **616***a* when the end effector assembly **602** is displaced to the second deployed position **605**.

(142) The forward contact surface **656***a* of the second protrusion **654***a* may be planar and may be normal or substantially normal to the first arm axis **610***a* when the end effector assembly **602** is in the first undeployed position **603**. The oblique contact surface **658***a* of the first notch **652***a* of the first mating feature **650***a* of the third arm segment **616***a* may be planar and may be disposed at an oblique angle relative to the first arm axis **610***a* when the end effector assembly **602** is in the first

undeployed position **603**. Accordingly, when the end effector assembly **602** is displaced to the second deployed position **605** such that the third arm segment **616***a* bends, rotates, or pivots relative to the second arm segment **614***a* (and/or vice versa) about the third hinge **630***a*, the planar surface of the forward contact surface **656***a* of the second protrusion **654***a* comes into contact with the oblique contact surface **658***a* of the first notch **652***a* of the first mating feature **650***a* of the third arm segment **616***a* to prevent further bending of the third arm segment **616***a* and the second arm segment **614***a* about the third hinge **630***a*.

(143) The first mating feature **650***a* of the third arm segment **616***a* may also include a pair of end surfaces **660***a* that may also partially define the first notch **652***a* and the first end **628***a* of the third arm segment **616***a*. Further, the second mating feature **648***a* of the second arm segment **614***a* may include a pair of lateral oblique contact surfaces **662***a* that may also partially define the second protrusion **654***a* and extend from the second end **626***a* (and towards the first end **625***a*) of the second arm segment **614***a*. In some embodiments, the pair of lateral oblique contact surfaces **662***a* may be symmetrically disposed about the second protrusion **654***a* such that a first of the pair of lateral oblique contact surfaces **662***a* may be on a first lateral side of the second protrusion **654***a* and a second of the pair of lateral oblique contact surfaces **662***a* may be on a second lateral side of the second protrusion **654***a*.

(144) The pair of end surfaces **660***a* of the first mating feature **650***a* of the third arm segment **616***a* may be planar and may be normal or substantially normal to the first arm axis **610***a* when the end effector assembly **602** is in the first undeployed position **603**. The lateral oblique contact surface **662***a* of the second mating feature **648***a* of the second arm segment **614***a* may be planar and may be disposed at an oblique angle relative to the first arm axis **610***a* when the end effector assembly **602** is in the first undeployed position **603**. Accordingly, when the end effector assembly **602** is displaced to the second deployed position **605** such that the third arm segment **616***a* bends, rotates, or pivots relative to the second arm segment **614***a* (and/or vice versa) about the third hinge **630***a*, the planar pair of end surfaces **660***a* comes into contact with the planar lateral oblique contact surfaces **662***a* to prevent further bending of the third arm segment **616***a* and the second arm segment **614***a* about the third hinge **630***a*. In some embodiments, the planar pair of end surfaces **660***a* comes into contact with the planar lateral oblique contact surfaces **662***a* at the same position as the forward contact surface **656***a* of the second protrusion **654***a* comes into contact with the planar oblique contact surface **658***a* of the first notch **652***a* to provide maximum resistance against further bending of the third arm segment **616***a* and the second arm segment **614***a* about the third hinge **630***a* when the end effector assembly **602** is displaced into the second deployed position **605**.

(145) Referring to FIGS. **21**A to **22**A, the tissue engaging assembly **600** may include the second tissue engaging arm **604***b* that may be identical to the first tissue engaging arm **604***a*, and the second tissue engaging arm **604***b* may be arranged symmetrical to (i.e., a may be a mirror image of) the first tissue engaging arm **604***a* about a plane that extends through a third arm axis **210***c* and is parallel to the Y-Z plane of the reference coordinate system of FIGS. **21**B and **22**A. Accordingly, features of the second tissue engaging arm **604***b* that correspond to features of the first tissue engaging arm **604***a* are indicated by reference numbers of the first tissue engaging arm **604***a*, but are designated using a “b” suffix instead of the “a” suffix used with the first tissue engaging arm **604***a*.

(146) In particular, and as illustrated in FIG. **22**A, the second tissue engaging arm **604***b* may be elongated and may extend from a first end **606***b* to a second end **608***a* along a second arm axis **610***b* that may be parallel to (or aligned with) the X-axis of the reference coordinate system of FIG. **22**A, and the second arm axis **610***b* may be aligned with the first arm axis **610***a*. The first end **606***a* may be coupled to a second portion **211***b* of the hub portion **611**. The second tissue engaging arm **604***b* may include two or more arm segments, and the second tissue engaging arm **604***b* may include a first arm segment **612***b*, a second arm segment **614***b*, and a third arm segment **616***b*.

(147) Referring to FIG. **22**A, a first end **618***b* of the first arm segment **612***b* may be coupled to the

second portion **611***b* of the hub portion **611** with a first hinge **622***b*, which may be a living hinge. A first end **625***b* of the second arm segment **614***b* may be coupled to a second end **620***b* of the first arm segment **612***b* with a second hinge **627***b*, which may be a living hinge. A first end **628***b* of the third arm segment **616***b* may be coupled to a second end **626***b* of the second arm segment **614***b* with a third hinge **630***b*, which may be a living hinge. A second end **629***b* of the third arm segment **616***b* may be coupled to a portion of a second end cap segment **632***b* with a fourth hinge **633***b*, which may be a living hinge. The cross-sectional shape of each of the first arm segment **612***b*, the second arm segment **614***b*, and the third arm segment **616***b* of the second tissue engaging arm **604***b* may correspond to the cross-sectional shape of each of the first arm segment **612***a*, the second arm segment **614***a*, and the third arm segment **616***a* of the first tissue engaging arm **604***a*, respectively.
(148) Referring to FIGS. **21**A to **22**A, the tissue engaging assembly **600** may include the third tissue engaging arm **604***c* and the fourth tissue engaging arm **604***d*, which may be identical to the first tissue engaging arm **604***a* and the second tissue engaging arm **604***b*, respectively. Accordingly, features of the third tissue engaging arm **604***c* that correspond to features of the first tissue engaging arm **604***a* are indicated by reference numbers of the first tissue engaging arm **604***a*, but are designated using a “c” suffix instead of the “a” suffix used with the first tissue engaging arm **604***a*. Further, features of the fourth tissue engaging arm **604***d* that correspond to features of the first tissue engaging arm **604***a* are indicated by reference numbers of the first tissue engaging arm **604***a*, but are designated using a “d” suffix instead of the “a” suffix used with the first tissue engaging arm **604***a*.
(149) The third tissue engaging arm **604***c* and the fourth tissue engaging arm **604***d* may be arranged at an angle relative to the first tissue engaging arm **604***a* and the second tissue engaging arm **604***b*. For example, the third tissue engaging arm **604***c* may be elongated and may extend from a first end **606***c* to a second end **608***c* along a third arm axis **610***c*, and the fourth tissue engaging arm **604***d* may be elongated and may extend from a first end **606***d* to a second end **608***d* along a fourth arm axis **610***d* that may be aligned with the third arm axis **610***c*. The third arm axis **610***c* (and the fourth arm axis **610***d*) may be arranged at an angle (e.g., a right angle) with the first arm axis **610***a* (and the second arm axis **610***b*) such that the third arm axis **610***c* and the fourth arm axis **610***d* are each parallel to (or aligned with) the Y-axis of the reference coordinate system of FIG. **22**A, as illustrated in FIG. **22**A.
(150) In particular, and as illustrated in FIG. **22**A, the third tissue engaging arm **604***c* may be elongated and may extend from a first end **606***c* to a second end **608***c* along the third arm axis **610***c*. The first end **606***c* may be coupled to a third portion **611***c* of the hub portion **611**. The third tissue engaging arm **604***c* may include two or more arm segments, and the third tissue engaging arm **604***c* may include a first arm segment **612***c*, a second arm segment **614***c*, and a third arm segment **616***c*. Each of the first arm segment **612***c*, the second arm segment **614***c*, and the third arm segment **616***c* may be identical (or substantially identical) to the first arm segment **612***a*, the second arm segment **614***a*, and the third arm segment **616***a*, respectively, of the first tissue engaging arm **604***a* that was previously described. A second end **629***c* of the third arm segment **616***c* may be coupled to a portion of a third end cap segment **632***c*, as previously described.
(151) Further, as illustrated in FIG. **22**A, the fourth tissue engaging arm **604***d* may be elongated and may extend from a first end **606***d* to a second end **608***d* along the fourth arm axis **610***d*. The first end **606***d* may be coupled to a fourth portion **211***d* of the hub portion **611**. The fourth tissue engaging arm **604***d* may include two or more arm segments, and the fourth tissue engaging arm **604***d* may include a first arm segment **612***d*, a second arm segment **614***d*, and a third arm segment **616***d*. Each of the first arm segment **612***d*, the second arm segment **614***d*, and the third arm segment **616***d* may be identical (or substantially identical) to the first arm segment **612***b*, the second arm segment **614***b*, and the third arm segment **616***b*, respectively, of the second tissue engaging arm **604***b* that was previously described. A second end **629***d* of the third arm segment **616***d* may be coupled to a portion of a fourth end cap segment **632***d*, as previously described.

(152) As illustrated in FIG. **25**, the end effector assembly **602** may include a housing **664**, and the tissue engaging assembly **600** may be disposed within (or at least partially within) and/or may be coupled to a portion of the housing **664**. The housing **664** may be similar to the housing **150** of the embodiment of the end effector **48** previously described (with reference to FIGS. **6**, **8**, and **10**A, for example), and the housing **664** may extend from a proximal end **667** to a distal end **668** along an end effector axis **665**. Similar to the two windows **154***a*, **154***b* disclosed with reference to the housing **150** (illustrated in FIGS. **6** and **7**), the housing **664** of the current embodiment of the end effector assembly **602** may have two or more windows **666**. In particular, the housing **664** may have four windows (e.g., a first window **666***a*, a second window **666***b*, a third window **666***c*, and a fourth window **666***d*, and each window **666** may be associated (and operatively aligned) with a corresponding one of the first tissue engaging arm **604***a*, the second tissue engaging arm **604***b*, the third tissue engaging arm **604***b*, and the fourth tissue engaging arm **604***d*, respectively. Each of the first window **666***a*, the second window **666***b*, the third window **666***c*, and the fourth window **666***d* may be arrayed in any configuration on the housing **664**. For example, each of the first window **666***a*, the second window **666***b*, the third window **666***c*, and the fourth window **666***d* may be disposed at even intervals about the effector axis **665**, such as 90 degree intervals, as illustrated in FIG. **26**B. Any or all of the first window **666***a*, the second window **666***b*, the third window **666***c*, and the fourth window **666***d* may be elongated and may extend from a proximal end to a distal end along an axis that is parallel to or substantially parallel to the end effector axis **665**. One or more interior surfaces of the housing **664** may define or partially define a housing interior **676** (illustrated in FIG. **26**A), and each of the two or more windows **666** may extend from an exterior surface defining the housing **664** towards the end effector axis **665** such that each of the two or more windows **666** opens to the housing interior **676**.
(153) In some embodiments, the hub portion **611** of the tissue engaging assembly **600** may be disposed in (or within) the housing interior **676** of the housing **664** at or adjacent to the distal end **668**, and the hub portion **611** may be coupled (or fixedly coupled) to the portion of the housing **664** such that the hub portion **611** remains stationary relative to the housing **664** when the end effector assembly **602** is displaced from the first undeployed position **603** (illustrated in FIG. **25**) to the second deployed position **605** (illustrated in FIGS. **26**A to **26**C) and vice versa. In some embodiments, the hub portion **611** may be coupled to a portion of an end cap **670** coupled to the distal end **668** of the housing **664**, as best illustrated in FIG. **27** showing the end effector assembly **602** with the housing **664** omitted for clarity.
(154) As illustrated in FIG. **26**A, the end effector assembly **602** may also include a plunger **669** that may be similar or identical to the plunger **30** of the end effector **48** previously described, and the plunger **669** may be directly or indirectly coupled to one of more of the torque links **58** (see FIG. **7**) and/or to the torque member **202** (see FIG. **11**) that were previously described. The plunger **669** may be disposed at least partially in the housing **664** (i.e., within the housing interior **676**) at or adjacent to the distal end **668**, and the plunger **669** may be longitudinally displaceable relative to the housing **664** (i.e., displaceable along the end effector axis **665**) in the same manner as the plunger **30** previously described. All or a portion of each of the first end cap segment **632***a* of the first tissue engaging arm **604***a*, the second end cap segment **632***b* of the second tissue engaging arm **604***b*, the third end cap segment **632***c* of the third tissue engaging arm **604***c*, and the fourth end cap segment **632***d* of the fourth tissue engaging arm **604***b* may be secured to (or within, or partially within) a portion of the plunger **669** to couple the plunger **669** to the tissue engaging assembly **600**. In some embodiments, each of the first end cap segment **632***a* of the first tissue engaging arm **604***a*, the second end cap segment **632***b* of the second tissue engaging arm **604***b*, the third end cap segment **632***c* of the third tissue engaging arm **604***c*, and the fourth end cap segment **632***d* of the fourth tissue engaging arm **604***b* may form a pie-shaped wedge (illustrated in FIG. **21**B) that cooperate to form a disk-shape when assembled, and this disk-shape may be received into a complementary recess formed in the plunger **669**. As such when the plunger **669** is at a first

position, such as a first proximal position (illustrated for plunger **30** in FIG. **6**), the end effector assembly **602** is in the first undeployed position **603** illustrated in FIG. **25**. In such a position, each of the first arm axis **610***a*, the second arm axis **610***b*, third arm axis **610***c*, and fourth arm axis **610***a* are parallel or substantially parallel to the end effector axis **665**, and all or a portion of each of the first arm segment **612***a*, the second arm segment **614***a*, and the third arm segment **616***a* may be disposed within the interior portion **676** of the housing **664** (or within an aperture in the housing **664** forming the first window **666***a*).

(155) When the plunger **669** displaces distally (in the manner previously described in relation to plunger **30**) along the end effector axis **665** from this first proximal position to a second position, such as a second distal position (illustrated in FIG. **27** showing the end effector assembly **602** with the housing **664** omitted for clarity), the end effector assembly **602** transitions or displaces to the second deployed position **605** (illustrated in FIGS. **26**A to **26**C). In particular, with reference to FIGS. **21**B and **27**, the hub portion **611** of the tissue engaging assembly **600** is secured (and/or stationary) at the portion of the housing **664** that is at or adjacent to the distal end **668**, and with the end cap segments **632***a*-**632***d* of the tissue engaging arms **604***a*-**604***d* configured to displace distally with the plunger **669**, the tissue engaging arms **604***a*-**604***d* change in shape from the straight configuration of FIG. **25** to the deployed configuration of FIGS. **26**A to **26**C. In this deployed configuration, with respect to the first tissue engaging arm **604***a*, the first mating feature **632***a* of the first arm segment **612***a* may engage a corresponding first mating feature **634***a* of the second arm segment **614***a* to maintain the first arm segment **612***a* and the second arm segment **614***a* in the desired position when the end effector assembly **602** is in the second deployed position **605**, as previously described. In addition, in the second deployed position **605**, the second mating feature **648***a* of the second arm segment **614***a* (or one or more portions of the second mating feature **648***a* of the second arm segment **614***a*) may engage a corresponding first mating feature **650***a* of the third arm segment **616***a* (or a corresponding one or more portions of the first mating feature **650***a* of the third arm segment **616***a*) to maintain the third arm segment **616***a* and the second arm segment **614***a* in a desired position when the end effector assembly **602** is in the second deployed position **605**, also as previously described.

(156) So configured, a second segment axis **671** that extends through the second arm segment **614***a* from the first end **625***a* to the second end **626***a* along the first arm axis **610***a* is parallel to the end effector axis **665** and offset from the end effector axis **665** by a first distance D**1**, as illustrated in FIG. **27**. Further, a first segment axis **672** that extends through the first arm segment **612***a* from the first end **618***a* to the second end **620***a* is oblique relative to the end effector axis **665**, as illustrated in FIG. **27**. In some embodiments, the first segment axis **672** may form an angle between 20° and 70° (such as between 35° and 55°) with the end effector axis **665**. In addition, a third segment axis **674** that extends through the third arm segment **616***a* from the first end **628***a* to the second end **629***a* is oblique relative to the end effector axis **665**, as illustrated in FIG. **27**. In some embodiments, the third segment axis **674** may form an angle between 20° and 70° (such as between 35° and 55°) with the end effector axis **665**, and this angle may be equal (but oppositely disposed) to the angle formed by the first segment axis **672** and the end effector axis **665**, the third segment axis **674** may be a mirror image of the first segment axis **672** about an axis of symmetry that is normal to the end effector axis **665**. The first distance D**1** separating the second segment axis **671** from the end effector axis **665** when the end effector assembly **602** is the second deployed position **605** is greater than a second distance D**2** (illustrated in FIG. **25**, in which the view of the first tissue engaging arm **604***a* is blocked by the housing **664**) that separates the second segment axis **671** from the end effector axis **665** when the end effector assembly **602** is the first undeployed position **603**. In this the first undeployed position **603** illustrated in FIG. **25**, the second segment axis **671** may be parallel to the end effector axis **665**. Further, in this first undeployed position **603**, the first segment axis **672**, the second segment axis **671**, and the third segment axis **674** may all be coaxially aligned and may each be parallel to or substantially parallel to the end effector axis **665**.

(157) Turning to FIG. **26**C, in the second deployed position **605**, the second arm segment **614***a* may be completely external to the housing **664**, while a portion of the first arm segment **612***a* may extend through the first window **666***a* such that the first end **618***a* (see FIG. **24**A) of the first arm segment **612***a* is disposed within the housing interior **676** of the housing **664** (or within the aperture in the housing **664** forming the first window **666***a*) and the second end **620***a* of the first arm segment **612***a* is disposed external to the housing **664**. Alternatively, in some embodiments, all or a portion of the first hinge **622***a* (see FIG. **24**A) may be disposed within the housing interior **676** of the housing **664**, while the first end **618***a* of the first arm segment **612***a* may be disposed exterior to the housing **664** but adjacent (e.g., immediately adjacent to) the aperture in the housing **664** forming the first window **666***a*. Similarly, in the second deployed position **605**, a portion of the third arm segment **616***a* may extend through the first window **666***a* such that the second end **629***a* (see FIG. **24**A) of the third arm segment **616***a* is disposed within the housing interior **676** of the housing **664** (or within an aperture in the housing **664** forming the first window **666***a*) and the first end **628***a* (see FIG. **24**A) of the third arm segment **616***a* is disposed external to the housing **664**. Alternatively, in some embodiments, all or a portion of the fourth hinge **633***a* (see FIG. **24**A) may be disposed within the housing interior **676** of the housing **664**, while the second end **629***a* of the third arm segment **616***a* may be disposed exterior to the housing **664** but adjacent (e.g., immediately adjacent to) the aperture in the housing **664** forming the first window **666***a*.
(158) Any or all of the second tissue engaging arm **604***b*, the third tissue engaging arm **604***b*, and the fourth tissue engaging arm **604***d* may each displace or transition identically to the first tissue engaging arm **604***a* when the end effector assembly **602** is displaced from the first undeployed position **603** to the second deployed position **605** and vice versa, as illustrated in FIGS. **25** to **27**. Accordingly, the first tissue engaging arm **604***a*, the second tissue engaging arm **604***b*, the third tissue engaging arm **604***b*, and the fourth tissue engaging arm **604***d* may be disposed physically offset from each other but otherwise in an identical manner in each of the first undeployed position **603** and the second deployed position **605** and any point in between.
(159) The embodiment of the end effector assembly **602** may be coupled to the handle portion **12** of the tissue manipulation device **10** previously described. However, with reference to FIGS. **28**A to **28**G, the embodiment of the end effector assembly **602** may be coupled to an embodiment of a tissue manipulation device **700** that may have a body portion **702** that may include a grip portion **703** that is configured to be grasped by a single hand of a user during the procedure. In such an embodiment, as illustrated in the cross-sectional view of FIG. **29**B, a portion of the shaft portion **40** at or adjacent to (or distal to) the proximal end **42** of the shaft portion **40** may be coupled to a first portion **704** of the body portion **702**. In addition, an adjustment wheel **710** may be rotatably coupled to a second portion **705** of the body portion **702**. The adjustment wheel **710** may rotate relative to the second portion **705** of the body portion **702** about a wheel axis **709** that may be parallel to the X-axis of the reference coordinate system of FIG. **29**B. The adjustment wheel **710** may be similar in form and function to the adjustment wheel **122** previously described, and the adjustment wheel **710** may be coupled to the end effector assembly **602** to rotate the end effector assembly **602** about the end effector axis **665** (see FIG. **28**A) relative to the distal end **44** of the shaft portion **40**.
(160) To turn the adjustment wheel **710**, the adjustment wheel **710** may be displaced distally (against the proximally-directed bias force provided by spring **712**) by the user (not shown) from a locked position (illustrated in FIGS. **30**A and **30**B) to an unlocked position (illustrated in FIGS. **31**A and **31**B) to unlock the adjustment wheel **710** and allow the adjustment wheel **710** to rotate about the wheel axis **709**. Advantageously, the adjustment wheel **710** may be displaced distally when the user is gripping the grip portion **703** and uses a finger (e.g., a thumb) of the hand gripping the grip portion **703** to unlock and rotate the adjustment wheel **710**. When the adjustment wheel **710** has been rotated to a desired position, the user may release the adjustment wheel **710** which may then be displaced proximally by the spring **712** to the locked position in which the adjustment

wheel **710** is unable to rotate.

(161) With reference to FIG. **31**A, the adjustment wheel **710** may include an engagement portion **718** that may be circular or substantially circular in cross-sectional shape, and the engagement portion **718** may have the shape of a disk. A portion of the engagement portion **718** may extend out of a housing slot **722** formed in the housing portion **704**. A central aperture **724** be formed through the engagement portion **718**, and a plurality of locking slots **714** may extend radially along an inner edge forming the central aperture **724**. A post **716** that is adapted to be received into any one of the plurality of locking slots **714** may be secured to a cylindrical hub **726**. The cylindrical hub **726** may be fixed relative to the housing portion **704** such that when the post **716** is received into any one of the plurality of locking slots **714**, the adjustment wheel **710** is in the locked position and thus prevented from rotating relative to the cylindrical hub **726**, as illustrated in FIGS. **30**A and **30**B. However, when the adjustment wheel **710** is displaced distally (against the proximally-directed bias force provided by spring **712**) by the user from the locked position to the unlocked position (illustrated in FIGS. **31**A and **31**B), the engagement portion **718** displaces distally relative to the post **716** (and the cylindrical hub **726**) until the post **716** is no longer disposed in any one of the plurality of locking slots **714**. So positioned, the adjustment wheel **710** may be rotated freely about the wheel axis **709** by a user until the user ceases to force the adjustment wheel **710** in a distal direction, at which time the spring **712** displaces the adjustment wheel **710** proximally such that one of the plurality of locking slots **714** that is aligned with the post **716** receives the post **716** to lock the adjustment wheel **710** into the locked position of FIGS. **30**A and **30**B.

(162) With reference to FIG. **29**A, the tissue manipulation device **700** may also have an adjustment member **708** that may be similar in form and identical in function to the adjustment member **22**, and the adjustment member **708** may be coupled to the end effector assembly **602** to transition the end effector assembly **602** between the first undeployed position **603** (illustrated in FIG. **25**) and the second deployed position **605** (illustrated in FIGS. **26**A to **26**C). In particular, the adjustment member **708** may be elongated and extend along a longitudinal axis **741** from a proximal end **734** to a distal end **736**, and the longitudinal axis **741** may be coaxially aligned with the wheel axis **709**. An insertion portion **738** may extend from the distal end **736** to an intermediary point **739**, and an input portion **740** may extend proximally from the insertion portion **738** from the intermediary point **739** to the proximal end **734** of the adjustment member **708**. The insertion portion **738** may be at least partially received in a central bore **742** of the cylindrical hub **726**, and a threaded portion **744** of an outer surface **746** of the insertion portion **738** may threadedly engage a threaded portion **748** of the central bore **742** of cylindrical hub **726**.

(163) The adjustment member **708** may be coupled to the end effector assembly **602** by an elongated coupling portion **733** such that displacing the adjustment member **708** displaces the coupling portion **733** and transitions the end effector assembly **602** between the first undeployed position **603** (illustrated in FIG. **29**A) and the second deployed position **605** (illustrated in FIG. **29**B). The coupling portion **733** may include a wire **732** that may be similar or identical to the wire **52** previously discussed. That is, a proximal end **730** of the wire **732** may be secured to a portion of the adjustment member **708**, such as a portion at or adjacent to the distal end **736** of the adjustment member **708**, and a distal end **731** of the wire **732** may be secured to the end effector assembly **602** in any suitable manner, and may be secured to the plunger **669** in the same manner as the distal end **56** of the wire **52** is coupled to the end effector **48** (as illustrated in FIG. **3**). Accordingly, when a user rotates the input portion **740** (relative to the cylindrical hub **726** and the body portion **702**) about the longitudinal axis **741** in a first rotational direction, the adjustment member **708** displaces distally along the longitudinal axis **741** from a first adjustment member position (illustrated in FIG. **29**A) to a second adjustment member position (illustrated in FIG. **29**B), thereby distally displacing the distal end **731** of the wire **732** to transition the end effector assembly **602** from the first undeployed position **603** (illustrated in FIG. **29**A) to the second deployed position **605** (illustrated in FIG. **29**B). Correspondingly, when the user rotates the input portion **740** (relative to the relative

to the cylindrical hub **726** and the body portion **702**) about the longitudinal axis **741** in a second rotational direction, the adjustment member **708** displaces proximally along the longitudinal axis **741** from the second adjustment member position (illustrated in FIG. **29**B) to the first adjustment member position (illustrated in FIG. **29**A), thereby proximally displacing the distal end **731** of the wire **732** to transition the end effector assembly **602** from the second deployed position **605** (illustrated in FIGS. **29**B) to the first undeployed position **603** (illustrated in FIG. **29**A). Further, the when the user rotates the input portion **740** about the longitudinal axis **741** such that the adjustment member **708** displaces between the second adjustment member position and the first adjustment member position, the end effector assembly **602** may be transitioned to a semi-deployed position between the first undeployed position **603** and the second deployed position **605**.
(164) Referring again to FIG. **1**, the tissue manipulation device **10**, **700** may include a port **214** configured to deliver fluids to a treatment area. For example, the port **214** may extend from a portion of the housing portion **12**, such as a portion of the distal support portion **112** of the wheel housing portion **108**. In other embodiments, the port **214** may be coupled to a portion of the shaft portion **40**, as illustrated in FIGS. **28**A and **29**A. As illustrated in FIG. **3**, the port **214** may be cylindrical and may extend from an inner end **216** to an outer end **218** along an axis that may be transverse to the longitudinal axis **14**. The inner end **216** may be in communication with a chamber **219** within the distal support portion **112** and adjacent to the proximal end **42** of the shaft portion **40**. One or more seals may be disposed on the wheel hub **170** to prevent fluid in the chamber **219** from moving proximally. The shaft portion **40** may include a plurality of apertures **220** that may be at least partially disposed on the curved portion **142** of the shaft portion **40**. Each of the plurality of apertures **220** extends from the exterior surface **145** of the shaft portion **40** to the shaft interior portion **146**. One or more seals may be disposed distal to the plurality of apertures **220** to prevent fluid from moving distal to the one or more seals. As such, when a fluid is introduced into the outer end **218** of the port **214**, the fluid travels through the port **214** and into the chamber **219**, where the fluid enters the shaft interior portion **146** and travels distally towards the plurality of apertures **220**, where the fluid exits each of the plurality of apertures **220**. One having ordinary skill in the art would recognize that the fluid would flow in any gaps or passages associated with components disposed within the shaft interior portion **146**. For example, one having ordinary skill in the art would recognize that the fluid would flow through the link bores **286** of the torque links **58** or through gaps between the torque links **58** and portions of the one or more interior surfaces **147** defining the shaft interior portion **146**. The outer end **218** of the port **214** may be configured to connect to a source of fluid, and may have a luer fitting, for example. The fluid may be a liquid or gas that may be delivered to a treatment area of a patient that is at or adjacent to at least one of the plurality of apertures **220**. In operation, fluid may also be removed from the treatment area by entering any of the plurality of apertures **220** and exiting the outer end **218** of the port **214**.
(165) The tissue manipulation device **10** may be fabricated using any suitable material or combination of materials, such as materials that allow for the cleaning and sterilization of all or parts of the tissue manipulation device **10** (e.g., a plastic material or stainless steel). For example, all or portions of the handle portion **12**, the shaft portion **12**, and the end effector **48** may all be composed or made from stainless steel or plastic.
(166) In operation, the tissue manipulation device **10**, **700** may be used in a prostatectomy procedure. In particular, the tissue manipulation device **10**, **700** may be inserted transurethral by an operator, e.g., surgeon, into the penis of a patient, and the curved portion **142** of the shaft portion **40** allows the shaft portion **40** to travel along the patient's urethra and past the bony diaphragm structure of the pelvis until the distal end **152**, **668** of the housing **150**, **664** of the end effector **48**, **602** is located in the patient's prostate. Once in the prostate, the adjustment member **22**, **708** may be rotated by the surgeon to drive the tissue engaging members **20** (or the tissue engaging arms **604**) to extend into the prostate. Barbs **38** and **46** on the tissue engaging members facilitate gripping of the prostate. Although the tissue engaging members **20** (or the tissue engaging arms **604**) are shown

fully extended, in FIG. **8**, they may be extended to any desired degree by the surgeon between the undeployed position and full extension. The prostate's position can then be manipulated as needed to facilitate prostatectomy. The positioning of the prostate is provided under control of the surgeon, such as, raised or lowered by adjusting the tilt angle of the shaft portion **40** with respect to the patient's body, pulled or pushed by changing the extent of the shaft portion **40** passing through the urethra (i.e., slightly pushing or pulling the handle potion **12** or grip portion **703**), and, advantageously, bi-directionally rotated using the adjustment wheel **122**, **710**. In this manner, the surgeon can position the prostate to expose and apply tension to the tissue at the anterior side of the prostate, and thereby locate the area or zone of dissection and proceed to mobilize (or cut the surrounding tissue of) the prostate at its anterior side. The prostate's position may then be further manipulated with the tissue manipulation device **10**, **700** to facilitate exposing and placing under tension the area or zone of dissection and proceed to mobilize the tissue (or cut the surrounding tissue) along the posterior side and both lateral sides of the prostate. Once the prostate has been dissected, turning the adjustment member **22**, **708** may retract the tissue engaging members **20** (or the tissue engaging arms **604**). The prostate can then be removed from the patient and the urethra sutured to the bladder.
(167) The tissue manipulation device **10**, **700** thus provides a surgical instrument, which is useful in either open surgery or a laparoscopic prostatectomy, but may also be used in other surgical procedures to manipulate tissue structures other than the prostate via a natural or surgical opening or channel in the body of a patient. The control of the prostate's position enabled by the multiple degrees of rotational freedom of the tissue manipulation device **10** allows for precise dissection thereby minimizing the risk of damage to the neurovascular bundles and other tissue about the prostate.
(168) In some embodiments, the tissue manipulation device **10** may be configured for use in a robotic surgical procedure. For example, a robot (not shown) with a dynamic member, such as an arm, my interface with an embodiment of the tissue manipulation device **10** to position the tissue manipulation device **10** during the procedure. The robot, via a first robotic interface **236** (an embodiment of which is illustrated in FIG. **14**A) be directly or indirectly coupled to the tissue manipulation device **10** to rotate the adjustment wheel **122** (or an equivalent mechanism or gear) to rotate the end effector **48** about the end effector axis **153** relative to the distal end **44** of the shaft portion **40** to precisely position the end effector **48** during a procedure. The first robotic interface **236** may be any mechanism, assembly, or device that may interact or interface with the tissue manipulation device **10** to cause the adjustment wheel **122** (or any portion of the rotational assembly coupled to the adjustment wheel **122**) to rotate. For example, in the embodiment of FIG. **14**A, the first robotic interface **236** may be a gear **238** that interfaces with the adjustment wheel **122** (or an equivalent gear that acts as the adjustment wheel **122**) to rotate the adjustment wheel **122**. Instead of a single gear **238**, the first robotic interface **236** may include any number or combination of gears to turn the adjustment wheel **122** to a desired position. In other embodiments, such as that of FIG. **14**C, the first robotic interface **236** may be a drive pulley **240** with a belt **242** that is coupled the adjustment wheel **122** to rotate the adjustment wheel **122**. In the embodiment of FIG. **14**B, the drive pulley **240** and belt **242** may be coupled to a pulley equivalent to the adjustment wheel **122** to rotate the adjustment wheel **122**.
(169) In other embodiments, the robot, via a second robotic interface **246** (an embodiment of which is illustrated in FIG. **15**A), may be directly or indirectly coupled to the tissue manipulation device **10** to displace the wire **52** such that the end effector **48** is displaced from the first undeployed position **49** (illustrated in FIGS. **1** and **6**) to the second deployed position **51** (illustrated in FIG. **8**). The second robotic interface **246** may be any mechanism, assembly, or device that may interact or interface with the tissue manipulation device **10** to cause (a) the adjustment member **22** (or any portion of the rotational assembly coupled to the adjustment member **22**) to rotate and/or (b) the wire **52** to longitudinally displace. For example, in the embodiment of FIG. **15**A, the second

robotic interface **246** may be a gear **248** that interfaces with the adjustment member **22** (or an equivalent gear that acts as the adjustment member **22**) to rotate the adjustment member **22**. Instead of a single gear **248**, the second robotic interface **246** may include any number or combination of gears to turn the adjustment member **22** to a desired position. In other embodiments, such as that of FIG. **15**A, the second robotic interface **246** may be a drive pulley **250** with a belt **252** that is coupled the adjustment member **22** to rotate the adjustment member **22**. In some embodiments, the robot will include both the first robotic interface **236** and the second robotic interface **246**, or may include either the first robotic interface **236** or the second robotic interface **246**. The tissue manipulation device **700** may be configured for use in such a robotic surgical procedure in a similar manner.
(170) It will be apparent to those skilled in the art that the foregoing detailed disclosure is intended to be presented by way of example only, and is not limiting. Various alterations, improvements, and modifications will occur and are intended to those skilled in the art, though not expressly stated herein. These alterations, improvements, and modifications are intended to be suggested hereby, and are within the spirit and the scope of the claimed invention. The drawings included herein are not necessarily drawn to scale. Additionally, the recited order of processing elements or sequences, or the use of numbers, letters, or other designations, therefore, is not intended to limit the claims to any order, except as may be specified in the claims. Accordingly, the invention is limited only by the following claims and equivalents thereto.

Claims

1. A tissue manipulation device for minimally invasive surgery, comprising: a body portion; a shaft portion extending from a proximal end to a distal end along a shaft axis, wherein a portion of the shaft portion is coupled to a first portion of the body portion, and wherein the shaft portion includes one or more interior surfaces defining an interior portion; an adjustment member coupled to a second portion of the body portion, the adjustment member being displaceable relative to the second portion of the body portion from a first adjustment member position to a second adjustment member position; an elongated coupling portion, wherein a first portion of the coupling portion is coupled to a portion of the adjustment member, and wherein at least a portion of the coupling portion extends through the interior portion of the shaft portion; and an end effector assembly comprising; a housing extending from a proximal end to a distal end along an end effector axis, wherein the proximal end is coupled to the distal end of the shaft portion, wherein a first window extends along a first elongated portion of the housing from a proximal end to a distal end along an axis parallel to the end effector axis, and wherein a second window extends along a second elongated portion of the housing from a proximal end to a distal end along an axis parallel to the end effector axis, and wherein the housing defines a housing interior; and a tissue engaging assembly comprising: a first tissue engaging arm that includes a first arm segment, a second arm segment, and a third arm segment, the first arm segment of the first tissue engaging arm extending from a first end to a second end along a first arm segment axis, the second arm segment of the first tissue engaging arm extending from a first end to a second end along a second arm segment axis, and the third arm segment of the first tissue engaging arm extending from a first end to a second end along a third arm segment axis, wherein the first end of the first arm segment of the first tissue engaging arm is pivotably coupled to a portion of the housing at or adjacent to the distal end of the housing; a second tissue engaging arm that includes a first arm segment, a second arm segment, and a third arm segment, the first arm segment of the second tissue engaging arm extending from a first end to a second end along a first arm segment axis, the second arm segment of the second tissue engaging arm extending from a first end to a second end along a second arm segment axis, and the third arm segment of the second tissue engaging arm extending from a first end to a second end along a third arm segment axis, wherein the first end of the first arm segment of the second

tissue engaging arm is pivotably coupled to the portion of the housing at or adjacent to the distal end of the housing; and a plunger coupled to a second portion of the coupling portion, wherein the second end of the third arm segment of the first tissue engaging arm is coupled to a first portion of the plunger, and the second end of the third arm segment of the second tissue engaging arm is coupled to a second portion of the plunger, the plunger being disposed within the housing interior when the adjustment member is in the second adjustment member position, and the plunger being displaceable along the end effector axis when the adjustment member is displaced between the first adjustment member position and the second adjustment member position, wherein when the adjustment member is in the first adjustment member position, the end effector assembly is in a first undeployed position, in which: the second arm segment axis of the first tissue engaging arm is parallel to and offset from the end effector axis by a first distance; and the second arm segment axis of the second tissue engaging arm is parallel to and offset from the end effector axis by a second distance, and when the adjustment member is in the second adjustment member position, the end effector assembly is in a second deployed position, in which: the second arm segment axis of the first tissue engaging arm is parallel to and offset from the end effector axis by a third distance that is greater than the first distance; the second arm segment axis of the second tissue engaging arm is parallel to and offset from the end effector axis by a fourth distance that is greater than the second distance; a portion of the first arm segment of the first tissue engaging arm and a portion of the third arm segment of the first tissue engaging arm each extends through a corresponding portion of the first window of the housing; and a portion of the first arm segment of the second tissue engaging arm and a portion of the third arm segment of the second tissue engaging arm each extends through a corresponding portion of the second window of the housing.
2. The tissue manipulation device of claim 1, wherein the first distance is equal to the second distance, and the third distance is equal to the fourth distance.
3. The tissue manipulation device of claim 2, wherein a portion of the shaft axis is non-linear.
4. The tissue manipulation device of claim 3, wherein the portion of the shaft axis has an arcuate shape.
5. The tissue manipulation device of claim 4, wherein the portion of the shaft axis extends from a first point that is disposed between the proximal end of the shaft portion and the distal end of the shaft portion to a second point that is at or adjacent to the distal end of the shaft portion.
6. The tissue manipulation device of claim 1, wherein when the end effector assembly is in the first undeployed position: the first arm segment axis of the first arm segment of the first tissue engaging arm, the second arm segment axis of the second arm segment of the first tissue engaging arm, and the third arm segment axis of the third arm segment of the first tissue engaging arm are each coaxially aligned and parallel to the end effector axis; and the first arm segment axis of the first arm segment of the second tissue engaging arm, the second arm segment axis of the second arm segment of the second tissue engaging arm, and the third arm segment axis of the third arm segment of the second tissue engaging arm are each coaxially aligned and parallel to the end effector axis.
7. The tissue manipulation device of claim 6, wherein when the end effector assembly is in the second deployed position: the first arm segment axis of the first arm segment of the first tissue engaging arm forms a first oblique angle with the end effector axis; the third arm segment axis of the third arm segment of the first tissue engaging arm forms a second oblique angle with the end effector axis, and the first arm segment axis of the first arm segment of the second tissue engaging arm forms a third oblique angle with the end effector axis; and the third arm segment axis of the third arm segment of the second tissue engaging arm forms a fourth oblique angle with the end effector axis.
8. The tissue manipulation device of claim 7, wherein the first oblique angle, the second oblique angle, the third oblique angle, and the fourth obtuse angle are substantially equal.
9. The tissue manipulation device of claim 7, wherein each of the first oblique angle, the second

oblique angle, the third oblique angle, and the fourth obtuse angle is between 35° and 55°.
10. The tissue manipulation device of claim 1, wherein when the end effector assembly is in the second deployed position: the first end of the first arm segment of the first tissue engaging arm is disposed in the housing interior; the second end of the third arm segment of the first tissue engaging arm is disposed in the housing interior; the first end of the first arm segment of the second tissue engaging arm is disposed in the housing interior; and the second end of the third arm segment of the second tissue engaging arm is disposed in the housing interior.
11. The tissue manipulation device of claim 1, wherein the second end of the third arm segment of the first tissue engaging arm is pivotably coupled to the first portion of the plunger, and the second end of the third arm segment of the second tissue engaging arm is pivotably coupled to the second portion of the plunger.
12. The tissue manipulation device of claim 1, wherein the first end of the first arm segment of the first tissue engaging arm is pivotably coupled to a first portion of a hub that is secured to the portion of the housing at or adjacent to the distal end of the housing, and the first end of the first arm segment of the second tissue engaging arm is pivotably coupled to a second portion of the hub.
13. The tissue manipulation device of claim 12, wherein: the second end of the first arm segment of the first tissue engaging arm is pivotably coupled to the first end of the second arm segment of the first tissue engaging arm by a first living hinge; the second end of the second arm segment of the first tissue engaging arm is pivotably coupled to the first end of the third arm segment of the first tissue engaging arm by a second living hinge; the first end of the first arm segment of the first tissue engaging arm is pivotably coupled to the first portion of the hub by a third living hinge; the second end of the first arm segment of the second tissue engaging arm is pivotably coupled to the first end of the second arm segment of the second tissue engaging arm by a fourth living hinge; the second end of the second arm segment of the second tissue engaging arm is pivotably coupled to the first end of the third arm segment of the second tissue engaging arm by a fifth living hinge; and the first end of the first arm segment of the second tissue engaging arm is pivotably coupled to the second portion of the hub by a sixth living hinge.
14. The tissue manipulation device of claim 1, wherein the proximal end of the housing is rotatably coupled to the distal end of the shaft portion such that the housing and the tissue engaging assembly of the end effector assembly rotates about the end effector axis relative to the distal end of the shaft portion.
15. The tissue manipulation device of claim 14, further comprising an adjustment wheel coupled to the proximal end of the housing and to a third portion of the body portion such that the adjustment wheel is configured to rotate about a wheel axis relative to the body portion, the adjustment wheel being linearly displaceable along the wheel axis from a locked position, in which rotation of the adjustment wheel about the wheel axis is prevented, to an unlocked position, in which rotation of the adjustment wheel about the wheel axis rotates the housing about the end effector axis relative to the distal and of the shaft portion.
16. The tissue manipulation device of claim 15, further comprising a post fixed relative to the housing, and the adjustment wheel further comprising a plurality of locking slots, wherein in the locked position, the post is disposed within a corresponding one of the plurality of locking slots to prevent rotation of the adjustment wheel about the wheel axis, and in the unlocked position, the post is disposed remote from each of the plurality of locking slots to allow rotation of the adjustment wheel about the wheel axis.
17. The tissue manipulation device of claim 1, wherein the plunger is disposed within the housing interior when the adjustment member is in the first adjustment member position.
18. The tissue manipulation device of claim 1, wherein the portion of the shaft portion coupled to the first portion of the body portion is disposed at adjacent to the proximal end of the shaft portion.
19. The tissue manipulation device of claim 1, wherein the coupling portion is a wire, and wherein a proximal end of the wire is coupled to the portion of the adjustment member, and a distal end of

the wire is coupled to the plunger.

20. The tissue manipulation device of claim 1, the housing of the end effector assembly further comprising: a third window extending along a third elongated portion of the housing from a proximal end to a distal end along an axis parallel to the end effector axis; and a fourth window extending along a fourth elongated portion of the housing from a proximal end to a distal end along an axis parallel to the end effector axis; and the tissue engaging assembly further comprising: a third tissue engaging arm that includes a first arm segment, a second arm segment, and a third arm segment, the first arm segment of the third tissue engaging arm extending from a first end to a second end along a first arm segment axis, the second arm segment of the third tissue engaging arm extending from a first end to a second end along a second arm segment axis, and the third arm segment of the third tissue engaging arm extending from a first end to a second end along a third arm segment axis, wherein the first end of the first arm segment of the third tissue engaging arm is pivotably coupled to the portion of the housing at or adjacent to the distal end of the housing, and wherein the second end of the third arm segment of the third tissue engaging arm is coupled to a third portion of the plunger; a fourth tissue engaging arm that includes a first arm segment, a second arm segment, and a third arm segment, the first arm segment of the fourth tissue engaging arm extending from a first end to a second end along a first arm segment axis, the second arm segment of the fourth tissue engaging arm extending from a first end to a second end along a second arm segment axis, and the third arm segment of the fourth tissue engaging arm extending from a first end to a second end along a third arm segment axis, wherein the first end of the first arm segment of the fourth tissue engaging arm is pivotably coupled to the portion of the housing at or adjacent to the distal end of the housing, and wherein the second end of the third arm segment of the fourth tissue engaging arm is coupled to a fourth portion of the plunger, wherein in the first undeployed position: the second arm segment axis of the third tissue engaging arm is parallel to and offset from the end effector axis by a fifth distance, and the second arm segment axis of the fourth tissue engaging arm is parallel to and offset from the end effector axis by a sixth distance, and wherein in the second deployed position: the second arm segment axis of the third tissue engaging arm is parallel to and offset from the end effector axis by a seventh distance that is greater than the fifth distance, the second arm segment axis of the fourth tissue engaging arm is parallel to and offset from the end effector axis by an eighth distance that is greater than the sixth distance, a portion of the first arm segment of the third tissue engaging arm and a portion of the third arm segment of the third tissue engaging arm each extends through a corresponding portion of the third window of the housing, and a portion of the first arm segment of the fourth tissue engaging arm and a portion of the third arm segment of the fourth tissue engaging arm each extends through a corresponding portion of the fourth window of the housing.