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Tissue retractor, retraction modules, and associated methods

Abstract

A modular retractor may include a first body portion that houses a distraction mechanism for opening and closing a first arm and a second arm. A first pivoting member may be coupled to a distal end of the first arm and a second pivoting member may be coupled to a distal end of the second arm, for example. A first blade attachment mechanism may be coupled to the first pivoting member and a second blade attachment mechanism may be coupled to the second pivoting member. The first and second blade attachment mechanisms may be configured to couple to first and second blades and be independently inclinable. Various embodiments may include at least one connection point for connecting to at least one additional retractor module. Various embodiments may include at least one quick connect coupler for connecting to a snap on table mount.

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Background/Summary

CROSS-REFERENCE TO RELATED U.S. PATENT APPLICATION (1) This application is a continuation in part of: U.S. Nonprovisional patent application Ser. No. 17/336,860 entitled “Tissue Retractor, Retraction Modules, and Associated Methods,” filed Jun. 2, 2021 which is a continuation in part of U.S. Nonprovisional patent application Ser. No. 16/926,173 entitled “Tissue Retractor,” filed Jul. 10, 2020. This application also claims priority to U.S. Provisional Application Ser. No. 63/254,929 filed Oct. 12, 2021. The entire disclosure of each of the above applications is incorporated by reference in its entirety.

FIELD

(1) The present technology is generally related to medical devices to assist a surgeon during treatment of musculoskeletal disorders, and more particularly to a surgical system and method for accessing a surgical site to facilitate treatment. More particularly, the present disclosure is directed to a surgical retractor system including a primary retractor assembly and a secondary retractor assembly that are configured for various approaches to the spine, including for example, anterior, lateral, and oblique surgical techniques.

BACKGROUND

(2) Spinal disorders such as degenerative disc disease, disc herniation, osteoporosis, spondylolisthesis, stenosis, scoliosis and other curvature abnormalities, kyphosis, tumor, and fracture may result from factors including trauma, disease and degenerative conditions caused by injury and aging. Spinal disorders typically result in symptoms including pain, nerve damage, and partial or complete loss of mobility.

(3) Non-surgical treatments, such as medication, rehabilitation and exercise can be effective, however, may fail to relieve the symptoms associated with these disorders. Surgical treatment of these spinal disorders includes fusion, fixation, discectomy, laminectomy and implantable prosthetics. Surgical retractors may be employed during a surgical treatment to provide access and visualization of a surgical site. Such retractors space apart and support tissue and/or other anatomical structures to expose anatomical structures at the surgical site and/or provide a surgical pathway for the surgeon to the surgical site.

SUMMARY

(4) This disclosure describes a plurality of different embodiments and modules for use as a modular retractor system. The system may use any of the variously disclosed blades, extendable blades, and dilators. Additionally, this disclosure describes a quick connect and release coupler for securing the modular retractor system to a table mount.

(5) In an aspect, this disclosure describes a modular surgical retractor system including a modular retractor configured to couple and uncouple from a plurality of different add on modules. The retractor system may be designed for enabling access to a surgical site and/or forming an operative corridor, for example. In various embodiments, the retractor system may include a modular retractor having a longitudinal axis extending in a longitudinal direction and a lateral axis extending from a first lateral end to a second lateral end in a lateral direction, for example. In various embodiments, the modular retractor may include a first body portion that houses a distraction mechanism, a first arm and a second arm pivotally coupled together, and a first handle

coupled to the first arm and a second handle coupled to the second arm, for example. In various embodiments, a first pivoting member may be coupled to a distal end of the first arm and a second pivoting member may be coupled to a distal end of the second arm, for example. In various embodiments, a first blade attachment mechanism coupled to the first pivoting member and a second blade attachment mechanism coupled to the second pivoting member, the first and second blade attachment mechanisms being configured to couple to first and second blades, respectively. In various embodiments, a first actuator may be operably coupled to the distraction mechanism for opening and closing the first arm and the second arm, for example. In various embodiments, a second actuator for adjusting the angulation of the first pivoting member, and a third actuator for adjusting the angulation of the second pivoting member may be provided, for example. In various embodiments, the modular retractor may include at least one table mount quick release coupler.
(6) The details of one or more aspects of the disclosure are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the techniques described in this disclosure will be apparent from the description and drawings, and from the claims.

Description

BRIEF DESCRIPTION OF DRAWINGS
(1) FIG. **1** is a perspective view of an exemplary embodiment of a retractor system including a primary retractor assembly and a secondary retractor assembly in accordance with the principles of the disclosure.
(2) FIG. **2** is a perspective view of the primary retractor assembly of FIG. **1** in accordance with the principles of the disclosure.
(3) FIG. **3** is a perspective view of the secondary retractor assembly of FIG. **1** in accordance with the principles of the disclosure.
(4) FIG. **4** is a perspective view of the retractor system of FIG. **1** including a plurality of blades in accordance with the principles of the disclosure.
(5) FIG. **5** is a top down view of the primary retractor assembly of FIG. **2** in accordance with the principles of the disclosure.
(6) FIG. **6** is a top down view of the secondary retractor assembly of FIG. **3** in accordance with the principles of the disclosure.
(7) FIG. **7** is a cutaway view of the retractor system of FIG. **1** in accordance with the principles of the disclosure.
(8) FIG. **8** is an alternate cutaway view of the retractor system of FIG. **1** in accordance with the principles of the disclosure.
(9) FIG. **9** is a perspective view of an exemplary blade for use with the retractor system of FIG. **1** in accordance with the principles of the disclosure.
(10) FIG. **10** is an alternate perspective view of an exemplary blade and pin for use with the retractor system of FIG. **1** in accordance with the principles of the disclosure.
(11) FIG. **11** is a perspective view of an exemplary blade and shim for use with the retractor system of FIG. **1** in accordance with the principles of the disclosure.
(12) FIG. **12** is a perspective view of an exemplary set of nested dilators for coordinated use with the retractor system of FIG. **1** in accordance with the principles of the disclosure.
(13) FIG. **13**A is a top down view of the set of nested dilators of FIG. **12**, and FIG. **13**B is a top down view of a plurality of blades for use with the retractor system of FIG. **1** in accordance with the principles of the disclosure.
(14) FIG. **14** is a top down view of an exemplary retractor system having a plurality of blades surrounding a set of nested dilators in accordance with the principles of the disclosure.
(15) FIG. **15** is a top down view of an exemplary retractor system of FIG. **14** in a first partially

expanded position after removal of the set of nested dilators in accordance with the principles of the disclosure.
(16) FIG. **16** is a top down view of an exemplary retractor system of FIG. **14** in the first partially expanded position in accordance with the principles of the disclosure.
(17) FIG. **17** is a side view of the exemplary retractor system of FIG. **14** having a plurality of blades surrounding a set of nested dilators in accordance with the principles of the disclosure.
(18) FIG. **18** is a side view of the exemplary retractor system of FIG. **14** in a second expanded position in accordance with the principles of the disclosure.
(19) FIG. **19** is a side view of the exemplary retractor system of FIG. **14** in the second expanded position in accordance with the principles of the disclosure.
(20) FIG. **20** is a perspective view of a modular retractor.
(21) FIG. **21** is a perspective view of a modular retractor.
(22) FIG. **22** is a top down view of a modular retractor.
(23) FIG. **23** is a perspective view of an adjustment tool for use with disclosed modular retractor embodiments.
(24) FIG. **24** is a top down exploded parts view of a modular retractor.
(25) FIG. **25** is a perspective exploded parts view of a modular retractor.
(26) FIG. **26**A is a perspective view of a distraction mechanism for use with disclosed modular retractor embodiments.
(27) FIG. **26**B is a top perspective view of a distraction mechanism.
(28) FIG. **26**C is an enlarged top perspective view of a distraction mechanism.
(29) FIG. **26**D is a bottom perspective view of a distraction mechanism.
(30) FIG. **26**E is an enlarged bottom perspective view of a distraction mechanism.
(31) FIG. **27**A is a top down view of a modular retractor coupled to a table mount.
(32) FIG. **27**B is a perspective view of a modular retractor coupled to a table mount.
(33) FIG. **28**A is a perspective view of a table mount rack.
(34) FIG. **28**B is a perspective view of a table mount rack.
(35) FIG. **28**C is an exploded parts view of a table mount rack.
(36) FIG. **29** is a top perspective view of a first module for use with disclosed modular retractor embodiments.
(37) FIG. **30** is a top perspective view of a first module for use with disclosed modular retractor embodiments.
(38) FIG. **31**A is a bottom perspective view of a first module for use with disclosed modular retractor embodiments.
(39) FIG. **31**B is a bottom perspective view of a first module for use with disclosed modular retractor embodiments.
(40) FIG. **32** is an exploded parts view of a first module for use with disclosed modular retractor embodiments.
(41) FIG. **33**A is a perspective view of a first module coupled to a modular retractor.
(42) FIG. **33**B is a perspective view of a first module coupled to a modular retractor.
(43) FIG. **34** is a top down view of a first module coupled to a modular retractor and a plurality of blades.
(44) FIG. **35** is a top perspective view of a second module for use with disclosed modular retractor embodiments.
(45) FIG. **36** is a top perspective view of a second module for use with disclosed modular retractor embodiments.
(46) FIG. **37** is a bottom perspective view of a second module for use with disclosed modular retractor embodiments.
(47) FIG. **38** is a bottom perspective view of a second module for use with disclosed modular retractor embodiments.

(48) FIG. **39** is an exploded parts view of a second module for use with disclosed modular retractor embodiments.
(49) FIG. **40** is a top down view of a second module coupled to a modular retractor and a plurality of blades.
(50) FIG. **41**A is a top perspective view of a third module for use with disclosed modular retractor embodiments.
(51) FIG. **41**B is a bottom perspective view of a third module for use with disclosed modular retractor embodiments.
(52) FIG. **42** is an exploded parts view of a third module for use with disclosed modular retractor embodiments.
(53) FIG. **43** is a perspective view of a third module coupled to a modular retractor.
(54) FIG. **44** is a perspective view of a third module coupled to a modular retractor and a plurality of blades.
(55) FIG. **45**A is a top perspective view of an alternate embodiment of a third module.
(56) FIG. **45**B is a bottom perspective view of an alternate embodiment of a third module.
(57) FIG. **46** is a perspective view of a free hand module coupled to a third module for use with disclosed modular retractor embodiments.
(58) FIG. **47**A is a side view of a free hand module for use with disclosed modular retractor embodiments.
(59) FIG. **47**B is a side view of a free hand module for use with disclosed modular retractor embodiments.
(60) FIG. **48**A is an exploded parts view of a free hand module.
(61) FIG. **48**B is a perspective view with partially removed parts of a free hand module.
(62) FIG. **49**A is a perspective view of a free hand module in a sliding configuration.
(63) FIG. **49**B is a perspective view of a free hand module in a second position.
(64) FIG. **50** is a perspective view of a free hand module and an telescoping blade system.
(65) FIG. **51** is a perspective view of an telescoping blade system.
(66) FIG. **52**A is a perspective view of a blade connection channel.
(67) FIG. **52**B is a perspective view of a blade fastener.
(68) FIG. **53** is a perspective view of a third module coupled to a modular retractor and a free hand module coupled to the third module.
(69) FIG. **54** is a perspective view of a third module coupled to a modular retractor and a free hand module coupled to the third module.
(70) FIG. **55** is a top perspective view of a fourth module for use with disclosed modular retractor embodiments.
(71) FIG. **56** is a bottom perspective view of a fourth module for use with disclosed modular retractor embodiments.
(72) FIG. **57** is an exploded parts view of a fourth module.
(73) FIG. **58** is a top down view of a fourth module coupled to a modular retractor.
(74) FIG. **59** is a perspective view of a fourth module coupled to a modular retractor.
(75) FIG. **60** is a perspective view of a fourth module coupled to a modular retractor and first and second free hand modules coupled to the fourth module.
(76) FIG. **61** is a perspective view of a fourth module coupled to a modular retractor and first and second free hand modules coupled to the fourth module.
(77) FIG. **62** is a top perspective view of a fifth module for use with disclosed modular retractor embodiments.
(78) FIG. **63** is a bottom perspective view of a fifth module for use with disclosed modular retractor embodiments.
(79) FIG. **64** is an exploded parts view of a fifth module.
(80) FIG. **65** is a top perspective view of a fifth module.

(81) FIG. **66** is a top view of a pair of blades for use with disclosed modular retractor embodiments.
(82) FIG. **67** is a bottom view of a pair of blades for use with disclosed modular retractor embodiments.
(83) FIG. **68** is a perspective view of a pair of blades for use with disclosed modular retractor embodiments.
(84) FIG. **69** is an enlarged view of a top portion of a universal blade fastener.
(85) FIG. **70** is a top view of three blades for use with disclosed modular retractor embodiments.
(86) FIG. **71** is a bottom view of three blades for use with disclosed modular retractor embodiments.
(87) FIG. **72** is a perspective view of three blades for use with disclosed modular retractor embodiments.
(88) FIG. **73** is a top view of four blades for use with disclosed modular retractor embodiments.
(89) FIG. **74** is a bottom view of four blades for use with disclosed modular retractor embodiments.
(90) FIG. **75** is a perspective view of four blades for use with disclosed modular retractor embodiments.
(91) FIG. **76** is a top view of a plurality of nested dilators.
(92) FIG. **77**A is a perspective view of a plurality of nesting dilators of FIG. **76** in a non-nested configuration.
(93) FIG. **77**B is a perspective view of a plurality of nesting dilators in a nested configuration.
(94) FIG. **78** is a top view of a dilator.
(95) FIG. **79** is a perspective view of the dilator of FIG. **78**.
(96) FIG. **80**A is a top view of a dilator.
(97) FIG. **80**B is a perspective view of the dilator of FIG. **80**A.
(98) FIG. **80**C is a perspective view of a set of nested and cylindrically shaped dilators.
(99) FIG. **80**D is an elevation view of the various dilators of embodiment of FIG. **80**C.
(100) FIG. **80**E is a perspective view of the various dilators of embodiment of FIG. **80**C.
(101) FIG. **81** is a top down view of the various dilators of embodiment of FIG. **80**C.
(102) FIG. **82** is a perspective view of a modular blade.
(103) FIG. **83** is a perspective view of a modular blade.
(104) FIG. **84** is a perspective view of an extendable blade for coupling to the modular blade of FIGS. **82-83**.
(105) FIG. **85** is a perspective view of an extendable blade for coupling to the modular blade of FIGS. **82-83**.
(106) FIG. **86** is a front view of the modular blade of FIGS. **82-83** and the extendable blade of FIGS. **84-85**.
(107) FIG. **87** is a top down view of the modular blade of FIGS. **82-83** and the extendable blade of FIGS. **84-85**.
(108) FIG. **88** is a perspective view of a modular blade.
(109) FIG. **89** is a perspective view of a modular blade.
(110) FIG. **90** is a perspective view of an extendable blade for coupling to the modular blade of FIGS. **82-83**.
(111) FIG. **91** is a perspective view of an extendable blade for coupling to the modular blade of FIGS. **88-89**.
(112) FIG. **92** is a front view of the modular blade of FIGS. **88-89** and the extendable blade of FIGS. **90-91**.
(113) FIG. **93** is a top down view of the modular blade of FIGS. **88-89** and the extendable blade of FIGS. **90-91**.
(114) FIG. **94** is a perspective view of a modular blade.
(115) FIG. **95** is a perspective view of a modular blade.

(116) FIG. **96** is a perspective view of an extendable blade for coupling to the modular blade of FIGS. **94-95**.
(117) FIG. **97** is a perspective view of an extendable blade for coupling to the modular blade of FIGS. **94-95**.
(118) FIG. **98** is a front view of the modular blade of FIGS. **94-95** and the extendable blade of FIGS. **96-97**.
(119) FIG. **99** is a top down view of the modular blade of FIGS. **94-95** and the extendable blade of FIGS. **96-97**.
(120) FIG. **100** is a perspective view of a modular blade.
(121) FIG. **101** is a perspective view of a modular blade.
(122) FIG. **102** is a perspective view of an extendable blade for coupling to the modular blade of FIGS. **100-101**.
(123) FIG. **103** is a perspective view of an extendable blade for coupling to the modular blade of FIGS. **100-101**.
(124) FIG. **104** is a perspective view of an extendable blade for coupling to the modular blade of FIGS. **100-101**.
(125) FIG. **105** is a front view of the extendable blades of FIGS. **103-105**.
(126) FIG. **106** is a perspective view of the outside surfaces of a modular blade and an extendable blade having a pointed end.
(127) FIG. **107** is a perspective view of the inside surfaces of the modular blade and the extendable blade of FIG. **106**.
(128) FIG. **108**A is a first exploded parts view of the modular blade and extendable blade of FIGS. **106-107**.
(129) FIG. **108**B is a second exploded parts view of the modular blade and extendable blade of FIGS. **106-107**.
(130) FIG. **108**C is a perspective view of the modular blade of FIGS. **106-107**.
(131) FIG. **108**D is a top down view of the modular blade of FIGS. **106-107**.
(132) FIG. **108**E is a perspective view of an impact driver for use with the modular blade and extendable blade of FIGS. **106-107**.
(133) FIG. **109** is a perspective view of a square shaped dilator.
(134) FIG. **110** is a bottom perspective view of a pair of shims for coupling to various blades disclosed herein.
(135) FIG. **111** is a perspective view of a relatively short shim having a pointed pin at a distal end thereof.
(136) FIG. **112** is a perspective view of a relatively tall shim having a pointed pin at a distal end thereof.
(137) FIG. **113** is a perspective view of a relatively tall shim having a blunted distal end.
(138) FIG. **114** is a perspective view of a double-sided shim for coupling to various blades disclosed herein.
(139) FIG. **115**A is a perspective view of a blade adjustment and positioning tool.
(140) FIG. **115**B is an exploded parts view of a blade adjustment and positioning tool.
(141) FIG. **116**A is a perspective view of the blade adjustment and positioning tool engaged with a modular blade and an extendable blade.
(142) FIG. **116**B is a perspective view of the blade adjustment and positioning tool engaged with a modular blade and an extendable blade.
(143) FIG. **117**A is a perspective view of the inside surfaces of a modular blade and an extendable blade having a footed tip at the distal end thereof.
(144) FIG. **117**B is a perspective view of the modular blade and extendable blade of FIG. **117**A.
(145) FIG. **118**A is a perspective view of a quick connect handle.
(146) FIG. **118**B is an exploded parts view of a quick connect handle.

(147) FIG. **118**C is a perspective view of a retractor mount coupler.
(148) FIG. **118**D is a perspective view of the modular and extendable blades of FIGS. **117**A-**117**B coupled to the quick connect handle of FIGS. **118**A-**118**B and the retractor mount coupler of FIG. **118**C.
(149) FIG. **118**E is a perspective view of the modular and extendable blades of FIGS. **117**A-**117**B before being coupled to the quick connect handle of FIGS. **118**A-**118**B.
(150) FIG. **119** is a first perspective view of an additional embodiment of a modular retractor.
(151) FIG. **120** is a second perspective view of the additional embodiment of the modular retractor of FIG. **119**.
(152) FIG. **121**A is a top down view of the embodiment of FIGS. **119-120**.
(153) FIG. **121**B is a bottom perspective view of a blade coupling portion.
(154) FIG. **122**A is an enlarged view of the embodiment of FIGS. **119-121** from a top perspective with the top cover removed for ease of understanding of the internal gear system.
(155) FIG. **122**B is an enlarged view of the embodiment of FIGS. **119-121** from a bottom perspective showing various structural features of a table mount quick connect coupler.
(156) FIG. **123** is a perspective view of various armatures of a quick connect table mount system for supporting various retractor embodiments disclosed herein.
(157) FIG. **124** is a first perspective view of a quick connect coupler for connecting various retractor embodiments to various quick connect table mount systems disclosed herein.
(158) FIG. **125** is a side view of the quick connect coupler of FIG. **124**.
(159) FIG. **126** is a perspective view of a modular retractor system including the quick connect couplers of FIGS. **124-125**.
(160) FIG. **127** is a top down view of the system of FIG. **126**. FIG. **128** is a perspective view of a secondary module that may be coupled and uncoupled with various primary retractor embodiments.
(161) FIG. **129** is a perspective view of the secondary module of FIG. **128** coupled to a primary retractor.
(162) FIG. **130** is a top down view of a modular retractor supporting first and second blades to be slidably coupled to an outermost dilator.
(163) FIG. **131** is a perspective view of the three blades being slidably coupled to an outermost dilator.

DETAILED DESCRIPTION

(164) In one aspect, exemplary embodiments describe a retractor system **100** for use with anterior, lateral, and oblique surgical techniques. At least one use of retractor system **100** is to assist in the preparation of a surgical site to enable a surgeon to access a space between vertebrae of patient's spine. The retractor system **100** may assist a surgeon in accessing a space between vertebrae by enabling highly controlled dilation of the paraspinous muscles with a set of nested dilators and retraction of the various fibers and tissues at the surgical site with the use of a plurality of independently movable and inclinable blades.
(165) Referring generally to FIGS. **1-8** exemplary retractor systems for enabling access to a surgical site are disclosed. FIG. **1** is a perspective view of an exemplary embodiment of a retractor system **100** including a primary retractor assembly **200** and a secondary retractor assembly **300** in accordance with the principles of the disclosure. Retractor system **100** is highly customizable and modular. For example, the primary retractor assembly **200** may be used as a standalone retractor system without the use of secondary retractor assembly **300**. Secondary retractor assembly **300** is configured to couple and uncouple on as needed basis with the primary retractor assembly **200** and secondary retractor assembly **300** can, for example, use one or two arms each having a corresponding blade.
(166) Exemplary embodiments may include a primary retractor assembly **200** configured to open and close a first arm **105** and a second arm **107** along a first path of travel. The first path may be an arcuate path or segment defined by the length and geometry of the arms **105** and **107** and a handle

pivoting mechanism **101***c* (see FIG. **8**) configured to enable first handle **101***a* and second handle **101***b* to open and close. Other paths of travel are contemplated depending upon the geometry of the arms **105**, **107** and the relative location of the handle pivoting mechanism **101***c*. The primary retractor assembly **200** may include a handle assembly having first and second handles **101***a*, **101***b* that are operably coupled to the first and second arms **105**, **107** and configured to open and close the first and second arms **105**, **107**. For example, the first handle **101***a* may be coupled to the first arm **105** and the second handle **101***b* may be coupled to the second arm **107**. The first and second arms **105**, **107** may be operably coupled to first and second pivoting members **105***a*, **107***a* at a distal end thereof, respectively. The first and second pivoting members **105***a*, **107***a* may be configured to operably couple to first and second blades, **205**, **207** (see FIG. **2**), respectively, by a corresponding blade attachment mechanism as will be explained in more detail below during the discussion of FIGS. **9-13**B.

(167) In the exemplary embodiment, a first actuator **105***b* and a second actuator **107***b* are configured to adjust the angulation of first blade **205** and second blade **207**, respectively. For example, the first actuator **105***b* may be configured to actuate the first pivoting member **105***a* to adjust the angulation of first blade **205** with respect to the first arm **105**. Similarly, the second actuator **107***b* may be configured to actuate the second pivoting member **107***a* to adjust the angulation of second blade **207** with respect to second arm **107**. In the exemplary embodiment, the first pivoting member **105***a* may be configured to independently adjust the angulation of first blade **205** with respect to the first arm **105** upon actuation of the first actuator **105***b*. Similarly, the second pivoting member **107***a* may be configured to independently adjust the angulation of the second blade **207** with respect to the second arm **107** upon actuation of the second actuator **107***b*. In disclosed embodiments, the first and second pivoting members **105***a*, **107***a* may each include a corresponding pin and socket mechanism enabling the pivoting members to pivot on a pin aperture **199** (see, e.g., FIG. **8**). Additionally, the first and second pivoting members **105***a*, **107***a* may each include a corresponding blade attachment mechanism at a distal end thereof which will be explained in more detail below when discussing FIGS. **9-13**.

(168) In the exemplary embodiment, the primary retractor assembly **200** may include a primary actuator **102** that is configured to actuate a primary pinion gear mechanism **210** (see FIG. **7**) to provide a precise and controlled mechanical advantage to open and close the first arm **105** and second arm **107**. For example, the primary pinion gear mechanism **210** may include a primary pinion gear **210***a* fixedly coupled to the primary actuator **102** such that the primary actuator **102** may rotationally translate the primary pinion gear **210***a*. The primary pinion gear **210***a* may be engaged with the secondary pinion gear **210***b*, e.g., the primary pinion gear **210***a* and secondary pinion gear **210***b* may be toothed gears that are meshed with one another at a contact location (not illustrated). Furthermore, secondary pinion gear **210***b* may be fixedly coupled to tertiary pinion gear **210***c* which may be axially aligned with secondary pinion gear **210***b* and disposed directly beneath secondary pinion gear **210***b* (see FIG. **8**). For example, secondary pinion gear **210***b* may share an axis of rotation with tertiary pinion gear **210***c* and secondary pinion gear **210***b* may be relatively larger in diameter than tertiary pinion gear **210***c*. This arrangement may resemble a two stage gear box or the like that allows for an increase in applied torque. In other embodiments, primary pinion gear mechanism **210** may be any other similar planetary gear system as would be understood by a person having ordinary skill in the relevant art. For example, those with skill in the relevant art will readily recognize that the particular diameter, tooth sizing, and tooth spacing of the primary pinion gear **210***a* relative to the particular diameter, tooth sizing, and tooth spacing of the secondary pinion gear **210***b* relative to tertiary pinion gear **210***c* may control the amount of force (mechanical advantage or torque) that is applied to open and close the first and second arms **105**, **107**.

(169) In the exemplary embodiment of FIG. **8**, tertiary pinion gear **210***c* may be meshed with a first curved rack portion **210***a***-2** and a second curved rack portion **210***b***-2** disposed opposite the first

curved rack portion **210***a***-2**. First curved rack portion **210***a***-2** may be fixedly coupled to second arm **101***b* and second curved rack portion **210***b***-2** may be fixedly coupled to first arm **101***a*. Each of curved rack portions **210***a***-2** and **210***b***-2** may feature a plurality of teeth extending along the curved body thereof and facing tertiary pinion gear **210***c*. The first curved rack portion **210***a***-2** and second curved rack portion **210***b***-2** may be meshed with the teeth of tertiary pinion gear **210***c* on opposite sides of tertiary pinion gear **210***c*. In this way, when primary actuator **102** is rotated, primary pinion gear **210***a* rotates which in turn rotates secondary pinion gear **210***b* and tertiary pinion gear **210***c*. In turn, tertiary pinion gear **210***c* engages teeth on each of curved rack portions **210***a***-2** and **210***b***-2** and causes handles **101***a*, **101***b* to open or close. In the disclosed embodiment, when tertiary pinion gear **210***c* applies force to first curved rack portion **210***a***-2**, the first curved rack portion **210***a***-2** may extend through first handle **101***a* at a corresponding first handle aperture **210***a***-1**. Similarly, when tertiary pinion gear **210***c* applies force to second curved rack portion **210***b***-2**, the second curved rack portion **210***b***-2** may extend through second handle **101***b* at a corresponding second handle aperture **210***b***-1**.

(170) In disclosed embodiments, the primary pinion gear mechanism **210** may be operably coupled to the first and second handles **101***a*, **101***b* and configured to simultaneously open and close the first and second arms **105**, **107** along a first path of travel. For example, the primary actuator **102** may rotationally translate the primary pinion gear mechanism **210** in a clockwise direction which in turn rotationally translates the first arm **105** and second arm **107** such that they move away from one another, i.e., they open as explained above. Likewise, the primary actuator **102** may rotationally translate the primary pinion gear mechanism **210** in a counter clockwise direction which in turn rotationally translates the first arm **105** and second arm **107** such that they move towards one another, i.e., they close as explained above. Also as explained above, the particular diameter of primary, secondary, and tertiary pinion gears **210***a*, **210***b*, and **210***c* may be adjusted to provide the desired amount of mechanical advantage or torque to open and close first and second arms **101***a*, **101***b*.

(171) In disclosed embodiments, primary retractor assembly **200** may include a primary retention lever **104** disposed between the first and second handles **101***a*, **101***b* that is configured to engage the primary retractor assembly **200** to control opening and closing of the first and second arms **105**, **107** and thereby retain the first and second arms **105**, **107** in a specific position. In the disclosed embodiment, primary retention lever **104** may frictionally engage curved rack portion **210***b***-2** to control opening and closing of the first and second arms. In other embodiments, the primary retention lever **104** may engage the primary pinion gear mechanism **210** at an outside portion of the circumference of the primary pinion gear **210***a* (see FIG. **7**) to thereby control and/or prevent rotation of the primary pinion gear **210***a*. For example, the primary retention lever **104** may lock the primary pinion gear mechanism **210** in place to control opening and closing of the first and second arms. In some embodiments, the primary retention lever **104** may have a biasing element (not illustrated) that causes the primary retention lever **104** to naturally urge an angled tip portion of the body of the primary retention lever **104** against a portion of the primary pinion gear mechanism **210**. For example, a spring may naturally urge an angled tip portion of primary retention lever **104** to engage with a toothed portion of secondary pinion gear **210***b*. Additionally, the primary retention lever **104** may be moved from an engagement position where primary retention lever **104** is in direct contact with the primary pinion gear mechanism **210** to a disengaged position where primary retention lever **104** is not engaged with the primary pinion gear mechanism **210**. For example, an end user such as a surgeon may depress primary retention lever **104** with their thumb to toggle primary retention lever **104** between the engaged position and the disengaged position. Furthermore, some embodiments may have a toggle feature (not illustrated) for maintaining the primary retention lever **104** in either of the engaged or disengaged positions.

(172) In disclosed embodiments, the primary retractor assembly **200** may include a first table mount portion **106***a* disposed adjacent the first handle **101***a* and coupled to a body **200***a* (see FIG.

5) or housing of the primary retractor assembly **200**. Similarly, the primary retractor assembly **200** may include a second table mount portion **106***b* disposed adjacent the second handle **101***b* and coupled to the body or housing of the primary retractor assembly **200**. The first and second table mount portions **106***a*, **106***b* may each be attached to a surgical table (not illustrated) for fixing the primary retractor assembly **200** (and/or the retractor system **100**) in a fixed location in three dimensional space. In example embodiments, the primary retractor assembly **200** may be attached to a surgical table by at least one of the first and second table mount portions **106***a*, **106***b* or by both.

(173) At least one advantage of securing the primary retractor assembly **200** to a surgical table may be for enhanced stability and the even transfer of resultant forces from the primary actuator **102** through the first and second arms **105**, **107** to the first and second blades **205**, **207** and vice versa. For example, when the primary retractor assembly **200** is fixed to the surgical table and the primary actuator **102** is translated to open the first and second arms **105**, **107** the primary pinion gear mechanism **210** may apply a precise controlled amount of force to open the first and second arms **105**, **107** to thereby gently retract the tissue of a patient in a controlled manner. Additionally, when the primary retractor assembly **200** is fixed to the surgical table, it may be easier for an end user to independently move only one of the handles **101***a*, **101***b* with respect to the surgical table. When moving only one of the handles **101***a*, **101***b* the corresponding arm **105**, **107** may move relative to the other. This scenario and functionality may assist a surgeon with precise surgical techniques where it may be desirable to independently move either of the first and second arms **105**, **107** along the first path of travel independently with respect to the other.

(174) Disclosed embodiments described above may be configured to independently open and close the first arm **105** along the first path of travel by movement of the first handle **101***a* relative to the second handle **101***b* and independently open and close the second arm **107** along the first path of travel by movement of the second handle **101***b* relative to the first handle **101***a*. Additionally, because the primary pinion gear mechanism **210** includes a primary gear **210***a* and a secondary gear **210***b* operably coupled to the first and second handles **101***a*, **101***b* disclosed embodiments may be configured to provide a controlled mechanical advantage to open and close the first and second arms **105**, **107** along the first path upon actuation of the primary actuator **102**.

(175) In accordance with disclosed embodiments, a secondary retractor assembly **300** may be configured to couple and uncouple from the primary retractor assembly **200** via a first recessed key portion **220***a* disposed on the first arm **105** and a second recessed key portion **220***b* disposed on the second arm **107** (see FIG. **2**). Each of recessed key portions **220***a*, **220***b* may include a groove having a geometry that facilitates engagement of the primary retractor assembly **200** with the secondary retractor assembly **300** while also operably allowing the opening and closing of arms **105**, **107**. For example, the secondary retractor assembly **300** may have a corresponding outdent (e.g., dovetail) on an underside thereof configured to mate with an indent (e.g., dovetail groove) of the primary retractor assembly **200**. Additionally, secondary retractor assembly **300** may be fixed to primary retractor assembly **200** by turnkey **113**. Turnkey **113** may project from a central portion of the primary retractor assembly **200** through a central aperture **113***a* (see FIG. **6**) of the secondary retractor assembly **300**. In a first position, turnkey **113** may urge the primary retractor assembly **200** and secondary retractor assembly **300** towards each other and maintain direct contact to fixedly engage them to one another. Conversely, in a second position, turnkey **113** may be rotated such that turnkey **113** is aligned with central aperture **113***a* and therefore has no bearing surface to urge the primary retractor assembly **200** and secondary retractor assembly **300** towards each other. Thus, in the second position the primary retractor assembly **200** and secondary retractor assembly **300** may be disengaged from one another. Other embodiments may use alternate means to securely engage the primary retractor assembly **200** with the secondary retractor assembly **300**, e.g., as fasteners, hexagonal grooves, channel locks, magnets, etc. provided that the primary retractor assembly **200** and the secondary retractor assembly **300** are securely engaged with one another such that resultant

forces acting on the retractor system **100** may transfer between primary retractor assembly **200** and secondary retractor assembly **300** and also by extension to a surgical table via table mount portions **106**_a_ and/or **106**_b_.

(176) Secondary retractor assembly **300** may have a body portion **300**_a_ generally defining a first channel **109**_d_ and a second channel **111**_d_. Secondary retractor assembly **300** may be configured to independently extend and contract a third arm **109** and a fourth arm **111**, respectively. Although two channels **109**_d_, **111**_d_ and two arms **109**, **111** are illustrated it is contemplated that secondary retractor assembly **300** may have any number of suitable channels and arms. Additionally, it is contemplated that only a single arm, e.g., third arm **109** or fourth arm **111** will be provided in some surgical settings.

(177) In disclosed embodiments, the secondary retractor assembly **300** may include a first channel **109**_d_ having a curved or arcuate shape for operably retaining third arm **109** therein where third arm **109** has a corresponding curved or arcuate shape. The third arm **109** may be configured to extend outwards from first channel **109**_d_ and contract within first channel **109**_d_. Similarly, secondary retractor assembly **300** may include a second channel **111**_d_ having a curved or arcuate shape for operably retaining fourth arm **111** therein where fourth arm **111** has a corresponding curved or arcuate shape. The fourth arm **111** may be configured to extend outwards from first channel **111**_d_ and contract within second channel **111**_d_. The geometry of the first channel **109**_d_ and third arm **109** may define a second path of travel, e.g., an arcuate path of travel defined by the arcuate shapes of the first channel **109**_d_ and third arm **109**. Similarly, the geometry of the second channel **111**_d_ and fourth arm **111** may define a third path of travel, e.g., an arcuate path of travel defined by the arcuate shapes of the second channel **111**_d_ and fourth arm **111**.

(178) In disclosed embodiments, the secondary retractor assembly **300** may include a third actuator **109**_c_ operably disposed adjacent the first channel **109**_d_ and operably configured to extend and contract the third arm **109** via a pinion gear mechanism (not illustrated) having the same or similar components as primary pinion gear mechanism **210** of primary retractor assembly **200**. For example, a toothed pinion P**1** (see FIG. **7**) may be coupled to actuator **109**_c_ and may operably engage a corresponding rack portion (not illustrated) on an adjacent surface of arm **109** to linearly translate, e.g., curvo-linear, third arm **109** forward and backward, i.e., extend and withdraw or translate away from the operative corridor. Similarly, the secondary retractor assembly **300** may include a fourth actuator **111**_c_ operably disposed adjacent the second channel **111**_d_ and operably configured to extend and contract the fourth arm **111** via a pinion gear mechanism (not illustrated) having the same or similar components as primary pinion gear mechanism **210** of primary retractor assembly **200**. For example, a toothed pinion P**2** (see FIG. **7**) may be coupled to actuator **111**_c_ and may operably engage a corresponding rack portion (not illustrated) on an adjacent surface of arm **111** to linearly translate, e.g., curvo-linear, fourth arm **111** forward and backward, i.e., extend and withdraw or translate away from the operative corridor. For example, actuator **109**_c_ may rotationally translate P**1** in a clockwise direction which in turn linearly translates the third arm **109** arm such that it extends outward from channel **109**_d_. Similarly, actuator **109**_c_ may rotationally translate P**1** in a counter clockwise direction which in turn linearly translates the third arm **109** arm such that it contracts inward into channel **109**_d_. Likewise, actuator **111**_c_ may rotationally translate P**2** in a clockwise direction which in turn linearly translates the fourth arm **111** arm such that it extends outward from channel **111**_d_. Similarly, actuator **111**_c_ may rotationally translate P**2** in a counter clockwise direction which in turn linearly translates the fourth arm **111** such that it contracts inward into channel **109**_d_. Accordingly, in disclosed embodiments, the third arm **109** is configured to independently extend and contract along a second path of travel upon actuation of the third actuator **109**_c_, and the fourth arm **111** is configured to independently extend and contract along a third path of travel upon actuation of the fourth actuator **111**_c_.

(179) In disclosed embodiments, the third and fourth arms **109**, **111** may be operably coupled to third and fourth pivoting members **109**_a_, **111**_a_ at a distal end thereof, respectively. The third and

fourth pivoting members **109***a*, **111***a* may be configured to operably couple to third and fourth blades **209**, **211**, respectively (see FIG. **3**) by a corresponding blade attachment mechanism as will be explained in more detail below during the discussion of FIGS. **9-13**B. In the exemplary embodiment, a fifth actuator **109***b* and a sixth actuator **111***b* are configured to adjust the angulation of third blade **209** and fourth blade **211**, respectively. For example, the fifth actuator **109***b* may be configured to actuate the third pivoting member **109***a* to adjust the angulation of third blade **209** with respect to the third arm **109**. Similarly, the sixth actuator **211***b* may be configured to actuate the fourth pivoting member **211***a* to adjust the angulation of fourth blade **211** with respect to fourth arm **111**. In the exemplary embodiment, the third pivoting member **109***a* may be configured to independently adjust the angulation of third blade **209** with respect to third arm **109** upon actuation of the fifth actuator **109***b*. Similarly, the fourth pivoting member **211***a* may be configured to independently adjust the angulation of fourth blade **211** with respect to the fourth arm **111** upon actuation of the fourth actuator **111***b*.
(180) In disclosed embodiments, the third and fourth pivoting members **209***a*, **211***a* may each include a corresponding pin and socket mechanism enabling the pivoting members **209***a*, **211***a* to pivot on a pin disposed in a corresponding pin aperture **199** (see, e.g., FIG. **8**). Additionally, the third and fourth pivoting members **209***a*, **211***a* may each include a corresponding blade attachment mechanism at a distal end thereof which will be explained in more detail below when discussing FIGS. **9-13**.
(181) In disclosed embodiments, the secondary retractor assembly **300** may include a first retention lever **109***e* configured to engage the third arm **109** to control extension and contraction of the third arm **109** along the second path of travel and a second retention lever **111***e* configured to engage the fourth arm **111** to control extension and contraction of the fourth arm **111** along the third path of travel. First and second retention levers **109***e*, **111***e* may have the same or similar components as described above with respect to primary retention lever **104**.
(182) First retention lever **109***e* and second retention lever **111***e* may frictionally engage with the third arm **109** and fourth arm **111**, respectively, to control and/or prevent the extension and contraction of the third arm **109** and fourth arm **111**. For example, first retention lever **109***e* and second retention lever **111***e* may engage with a rack portion on an outside adjacent surface of the third arm **109** and fourth arm **111**, respectively, through an aperture **302** (see FIG. **8**) projecting through a portion of channels **109***d*, **111***d*, respectively. In some embodiments, first and second retention levers **109***e*, **111***e* may include a biasing element having the same or similar components as explained above with respect to primary retention lever **104**. In some embodiments, first retention lever **109***e* may engage a corresponding pinion gear mechanism operably associated with actuator **109***c* to thereby control and/or prevent rotation of the corresponding pinion gear mechanism. Similarly, second retention lever **111***e* may engage a corresponding pinion gear mechanism operably associated with actuator **109***c* to thereby control and/or prevent rotation of the corresponding pinion gear mechanism.
(183) Referring generally to FIGS. **1**, **7**, and **9-11** the pivoting members **105***a*, **107***a*, **109***a*, and **111***a* may each include the same or similar components and features. For example, pivoting members **105***a*, **107***a*, **109***a*, and **111***a* may each include a corresponding pin and socket mechanism. The pin and socket mechanism of pivoting members **105***a*, **107***a*, **109***a*, and **111***a* may be adjustable by way of actuators **105***b*, **107***b*, **109***b*, and **111***b* such that an inclination of pivoting members **105***a*, **107***a*, **109***a*, and **111***a* may be independently adjustable with respect to arms **105**, **107**, **109**, and **111**, respectively. In some embodiments, translation of actuators **105***b*, **107***b*, **109***b*, and **111***b* may cause a corresponding element, such as an internal pin, set screw or the like, to urge pivoting members **105***a*, **107***a*, **109***a*, and **111***a* to pivot outwards on a corresponding pin within a corresponding socket thereby enabling travel of pivoting members **105***a*, **107***a*, **109***a*, and **111***a* inwards and outwards with respect to arms **105**, **107**, **109**, and **111**, respectively. In some embodiments, pivoting members **105***a*, **107***a*, **109***a*, and **111***a* may pivot outwards, for example,

within a range of 0-25 degrees, and more particularly within a range of 0-15 degrees with respect to arms **105**, **107**, **109**, and **111**.

(184) Pivoting members **105***a*, **107***a*, **109***a*, and **111***a* may include corresponding blade attachment mechanisms **105***f*, **107***f*, **109***f*, and **111***f*, respectively (see FIG. **7**). The blade attachment mechanisms **105***f*, **107***f*, **109***f*, and **111***f*, may each include a dovetail groove having a geometry that facilitates secure engagement with a corresponding one of blades **205**, **207**, **209**, and **211**. For example, blade attachment mechanisms **105***f*, **107***f*, **109***f*, and **111***f*, may have an indent portion on an inside surface thereof facilitating secure engagement with an outdent portion disposed on an outside surface of blades **205**, **207**, **209**, and **211** respectively. In some embodiments, the dovetail grooves of the blade attachment mechanisms **105***f*, **107***f*, **109***f*, and **111***f*, are tapered, and may for example be conically tapered, from one end to the other end to further securely retain blades **205**, **207**, **209**, and **211**. In other embodiments, the blade attachment mechanisms **105***f*, **107***f*, **109***f*, and **111***f*, may take alternate shapes, and have varying configurations provided that the shape thereof can securely engage with a corresponding one of blades **205**, **207**, **209**, and **211**. For example, an indent such as a square channel, hexagonal channel, or the like dimensioned to match to a corresponding outdent. Additionally, the blade attachment mechanisms **105***f*, **107***f*, **109***f*, **111***f* may have an outdent portion (rather than an indent portion as illustrated) and blades **205**, **207**, **209**, and **211** may have an indent portion (rather than an outdent portion as illustrated).

(185) Referring generally to FIGS. **9-13**B exemplary blades, shims, and dilators for use with, e.g., retractor system **100**, are disclosed. Referring to FIGS. **9-11**, an exemplary blade, e.g., first blade **205** is illustrated. It shall be understood that characteristics of first blade **205** may be found throughout each of blades **205**, **207**, **209**, and **211** and the foregoing description is described with respect to first blade **205** solely for convenience of explanation. Moreover, although first blade **205** is illustrated as a relatively long and narrow curved blade **205** it can take any shape suitable for any particular type of surgery application. Indeed, it is contemplated that retractor system **100** is suitable for a multitude of different blades having different lengths, widths, and cross-sectional shapes thereof that can couple and uncouple to secondary blades, tools, and shims. For example, relatively shorter and wider blades having generally planar surfaces are contemplated. Furthermore, blade **205** may feature any number or type of secondary coupling members where shims, for example, may couple thereto. In at least one embodiment, blade **205** may have a relatively narrow portion at one end and fan out to a relatively wider portion at the opposite end, i.e., the blade **205** may have a width that increases along the length thereof from one end to the other end. Additionally, blade **205** may include channels, grooves, indents, outdents, etc. for fixation of secondary members such as shims, light fixtures other diagnostic tools such as endoscopes, electrodes, temperature sensors, suction devices, and etc.

(186) In the exemplary embodiment, blade **205** has a proximate side **205***a*, a distal side **205***b* opposite the proximate side, an outside surface **205***c* and an inside surface **205***d* opposite the outside surface **205***c*. The proximate side **205***a* may be operably coupled to a distal end of pivoting member **105***a* via an engagement feature **205***e* disposed on the outside surface **205***c* of blade **205**, for example. In some embodiments, blade **205** may include an elastic material allowing it to deflect at least partially. Additionally, in some embodiments a blade removal instrument may be required to install and/or remove blade **205** from a blade attachment mechanism.

(187) In the disclosed embodiment, engagement feature **205***e* is the outdent portion of a dovetail groove, i.e., the dovetail. In other embodiments, engagement feature **205***e* may be a lap joint, tongue and groove type joint, a doweled butt joint, etc. In the exemplary embodiment, engagement feature **205***e* features an indent portion **205***f*. Indent portion **205***f* may be a socketed portion facilitating secured engagement and retention with blade attachment mechanism **105***f*. For example, indent portion **205***f* may house a spring clip (not illustrated) to hold blade **205** in secure engagement with blade attachment mechanism **105***f*. In embodiments that include a spring clip, a corresponding release tool or lever may be inserted into the indent portion **205***f* to release the

biasing force of the spring and thereby uncouple the blade **205** from blade attachment mechanism **105***f*. In other embodiments, engagement feature **205***e* may have an aperture for running a diagnostic tool such as an electrode or endoscope there through. In some embodiments, blade **205** may be conductive such that it may communicate with an external diagnostic tool (not illustrated). For example, blades may include a conductive material such as a metal like copper and be conductive and/or have terminals for electrical conduction between conductive pads placed external to retractor system **100**. In some embodiments, blade **205** may include partially conductive features, e.g., a semiconductor and/or other passive electrical devices such as resisters, diodes, and etc. In other embodiments, blade **205** may be an insulator such that it does not interfere with electrical signal processing of the aforementioned electrical devices.

(188) In the exemplary embodiment, first blade **205** may include a longitudinal groove **205***g* extending longitudinally along the inside surface **205***d* that is sized accordingly to house and retain a corresponding pin **205***p* therein. In at least one embodiment, pin **205***p* may securely attach to a vertebra of a patient's spine by socketing in to the vertebrae or screwing into the vertebrae. In some embodiments, pin **205***p* may be a conductive pin having a sensor at a distal end thereof or pin **205***p* may be a hollow pin that houses electrical components and wiring therein. In other embodiments pin **205***p* is purely mechanical in nature. In at least one embodiment, pin **205***p* may be used to facilitate attachment of a shim **205***s* to an inside surface **205***d* of blade **205**. Shim **205***s* may laterally extend from a side surface of the blade **205** and include a gripping portion at a proximate side thereof. Shim **205***s* may also extend from the blade **205** to increase the operative length thereof and/or extend laterally to increase the operative width thereof. In some embodiments, the first, second, third, and fourth blades **105**, **107**, **109**, **111** are each configured to operably couple to a corresponding first, second, third, and fourth shim laterally projecting from a side portion thereof. In other embodiments, diagnostic tools such as an electrode, endoscope, fiber optic, light emitting diode or the like may extend along groove **205***g*. In other embodiments still, a second groove (not illustrated) similar to groove **205***g* may be provided so that a combination of the above described features may be used. For example, groove **205***g* may house a corresponding pin **205***p* and the second groove (not illustrated) may enable a diagnostic tool or the like to extend along the second groove (not illustrated).

(189) Referring to FIG. **12** an exemplary set of nested dilators **400** is illustrated. Exemplary dilators **400** may include a neuro monitoring sensor or the like to help guide insertion of the dilators through muscle fibers. The set of nested dilators **400** may include a series of dilators having alternating circular and ellipsis (oval) cross sectional shapes or oblong cross-sectional shapes. For example, a first dilator **401** having a relatively small circular cross section is surrounded by a second dilator **403** having an ellipsis, or oval shaped cross section. The size and shape of the circular cross section of the first dilator **401** may be defined by a radius extending from a center point thereof and the shape of the ellipsis cross section may be defined by a major axis and a minor axis extending perpendicularly with respect to one another from a center point thereof.

(190) In the exemplary embodiment, the second dilator **403** may, for example, have an ellipsis or elliptical cross section, or other cross sections, for example bi-convex or elongated and substantially flat sides with convex ends, and may have a curvature but may not be circular or elliptical, some such embodiments having a minor axis roughly corresponding to the radius of the circular cross section of first dilator **401**. For example, the minor axis of the ellipsis cross section of the second dilator **403** may only be slightly larger than the radius of the circular cross section of the first dilator **401**, and the major axis of the ellipsis cross section of the second dilator **403** may be relatively larger than the radius of the circular cross section of the first dilator **401** and the minor axis of the ellipsis cross section of the second dilator **403**. In some embodiments, the major axis of the ellipsis cross section of second dilator **403** may be roughly twice as large as the radius of the circular cross section of first dilator **401**. In some embodiments, the major axis of the ellipsis cross section of the second dilator **403** may be twice as large as the minor axis of the ellipsis cross

section of the second dilator **403**. At least one advantage to this arrangement of alternating cross sections is that the second dilator **403** may be insert around the first dilator **401** between fibers of a muscle, e.g., the paraspinous muscle, such that the major axis of the second dilator **403** is initially arranged parallel with the fibers of the paraspinous muscle and can therefore be insert around the first dilator **401**. Once inserted around the first dilator **401**, second dilator **403** can be rotated such that the major axis of second dilator **403** is perpendicular to the orientation of the fibers of the paraspinous muscle thereby gently separating the fibers by orienting the second dilator **403** such that the major axis area of the second dilator **403** gently and controllably applies pressure to separate the fibers.

(191) A third dilator **405** having a circular cross section may be insert around the second dilator **403**. The size and shape of the circular cross section of the third dilator **405** may be defined by a radius extending from a center point thereof. For example, the third dilator **405** may have a circular cross-sectional shape having a radius roughly corresponding to the major axis of the second dilator **403**. The third dilator **405** can freely rotate around the second dilator **403** and features a circular cross section having a radius that is only slightly larger than the cross-sectional major axis of the second dilator **403**. A fourth dilator **407** having an ellipsis cross section (oval) may be insert around the third dilator **405**. The fourth dilator **407** may be defined by an ellipsis cross section having a minor axis that is only marginally larger than the cross sectional radius of the third dilator **405**, i.e., the cross sectional minor axis of the fourth dilator roughly corresponds to the cross sectional radius of the third dilator **405**. Additionally, the cross-sectional major axis of the fourth dilator **407** is relatively larger than the cross sectional radius of the third dilator **405** and the cross sectional minor axis of the fourth dilator. In some embodiments, the major axis of the ellipsis cross section of fourth dilator **407** may be roughly twice as large as the radius of the circular cross section of third dilator **405**. In some embodiments, the major axis of the ellipsis cross section of the fourth dilator **407** may be twice as large as the minor axis of the ellipsis cross section of the fourth dilator **407**. At least one advantage to this arrangement of alternating cross sections is that the fourth dilator **407** may be insert around the third dilator **405** between fibers of a muscle, e.g., the paraspinous muscle, such that the major axis of the fourth dilator **407** is initially arranged parallel with the fibers of the paraspinous muscle and can therefore be insert around the third dilator **405**. Once inserted around the third dilator **405**, fourth dilator **407** can be rotated such that the major axis of fourth dilator **407** is perpendicular to the orientation of the fibers of the paraspinous muscle thereby gently separating the fibers by orienting the fourth dilator **407** such that the major axis area of the fourth dilator **407** gently and controllably applies pressure to separate the fibers.

(192) FIG. **13**A is a top down view of the set of nested dilators **400** as explained above. As illustrated a set of nested dilators **400** that may sequentially gently separate fibers of a muscle are illustrated. The set of nested dilators **400** may be insert sequentially and rotated on an as needed basis to gently dilate an anatomical feature. FIG. **13**B is a top down view of blades **205**, **207**, **209**, and **211**. As illustrated blades **205**, **207** are relatively larger in width than blades **209**, and **211**.

(193) FIGS. **14-19** illustrate various positions and modes of operation of retractor system **100** in use with the set of nested dilators **400**. For example, in FIG. **14**, retractor system **100** is shown in a closed position where arms **105**, **107** are closed and surround, at least partially, the set of nested dilators **400**. Additionally, arms **109**, **111** are fully extended and surround, at least partially, the set of nested dilators **400**. In FIG. **14**, the inside surfaces of blades **205**, **207**, **209**, and **211** (not labelled in FIG. **14**) together surround and contact an outside surface of a fourth dilator **407** (not labelled in FIG. **14**). For example, the blades **205**, **207**, **209**, and **211** surround and contact a set of nested dilators **400**. For example still, a side surface of each of blades **205**, **207**, **209**, and **211** contacts an adjoining side surface of a different adjacent blade of the blades **205**, **207**, **209**, and **211** thereby forming a closed shape. FIG. **17** is a side view of the arrangement of FIG. **14**.

(194) In FIG. **15**, the set of nested dilators **400** is removed and the retractor system **100** is adjusted to a first partially opened position where arms **105**, **107** are partially opened and arms **109**, **111** are

partially contracted. FIG. **18** is a side view of the first partially opened arrangement of FIG. **15**. In FIG. **16**, the retractor system is adjusted to a second partially opened position where arms **105**, **107** are further opened and arms **109**, **111** are further contracted. FIG. **18** is a side view of the second partially opened arrangement of FIG. **16**. FIG. **19** shows the angulation of each blade being adjusted outward approximately 15 degrees from the side view of FIG. **18**.

Additional Retractor Embodiments

(195) Referring generally to FIGS. **20-81** an example modular retractor system including a modular retractor **500** and various add on retractor modules **600**, **700**, **800**, **900**, **1000**, and **1100** for use with modular retractor **500** are disclosed. In some embodiments, modular retractor **500** may include the same, substantially the same, and/or similar components and functionality as primary retractor **100** and the associated blades, dilators, and secondary retractor assembly **300**. Accordingly, those with skill in the art will understand the general principles, modes of operation, and associated methods of each example embodiment may be combined and/or modified in view of the skill of a person of ordinary skill in the art.

(196) With reference to FIGS. **20-28**C a modular retractor **500** for enabling access to a surgical site, an adjustment tool **10**, a table mount **70**, and a table mount rack module **60** are disclosed. FIGS. **20-21** are perspective views of a modular retractor **500** and FIG. **22** is a top down view of the modular retractor **500** showing various axes and directions of operation. FIG. **23** is a perspective view of an adjustment tool **10** for use with disclosed modular retractor **500** embodiments. FIGS. **24-25** are exploded parts views of a modular retractor **500**. FIGS. **26**A-**26**E are various views of a distraction mechanism **50** for use with disclosed modular retractor **500** embodiments. FIGS. **27**A and **27**B are various views of a modular retractor **500** coupled to a table mount **70**. FIGS. **28**A-**28**C are various views of a table mount rack module **60**.

(197) Modular retractor **500** is highly customizable and may be considered modular for reasons that will be readily apparent and explained in further detail below. For example, the modular retractor **500** may be used as a standalone retractor system without the use of additional add on modules or modular retractor **500** may be used with any of the disclosed modules discussed herein unless the context clearly suggests otherwise.

(198) Modular retractor **500** may be configured to distract and retract a first arm **505** along a path of travel and a second arm **507** along a different path of travel. The various paths of travel may be an arcuate path or segment defined by the length and geometry of the arms **505** and **507**, respectively, and a handle pivoting mechanism **515** (see FIG. **26**D). Handle pivoting mechanism **515** may be configured to enable first handle **501***a* and second handle **501***b* to open and close, for example. Handle pivoting mechanism **515** may be a pin, screw, or the like, for example. Other paths of travel than those specifically shown are contemplated and those paths of travel may depend upon the geometry of the arms **505**, **507** and the relative location of the handle pivoting mechanism **515**. The modular retractor **500** may include a handle assembly having first and second handles **501***a*, **501***b* that are removably coupled to the first and second arms **505**, **507** and configured to open and close the first and second arms **505**, **507**. For example, the first handle **501***a* may be coupled to the first arm **505** and the second handle **501***b* may be coupled to the second arm **507**. Additionally, the arms **505**, **507** may extend through side channels of the body **503**, respectively, and/or be pivotable relative to body **503** and/or be operably coupled to body **503**. In various embodiments, the first handle **501***a* and second handle **501***b* may be removed and are held in place by first handle connection pin **508***a* and second handle connection pin **508***b*, for example. In various embodiments, the connection pins **508***a*, **508***b* may be a pin, screw, knob, turnkey, and/or retaining fastener that a surgeon may quickly remove to uncouple the handle **501***a*, **501***b*, for example. Furthermore retractor **500** may include a table mount **506** extending in the lateral direction from body **503**. At least one advantage of having the first and second handles **501***a*, **501***b* be removable is greater freedom in performing a surgery due to the reduced structure adjacent a target surgical location, for example. For example still, after a surgeon has retracted a patient tissue,

the surgeon may remove the handles **501**_a_, **501**_b_ to prevent bumping into them.
(199) In various embodiments, the first and second arms **505**, **507** may be coupled to first and second pivoting members **505**_a_, **507**_a_ at a distal end thereof, respectively. The first and second pivoting members **505**_a_, **507**_a_ may be configured to operably couple to first and second blades, **40** (see FIG. **22**), respectively, by a corresponding blade attachment mechanism **505**_c_, **507**_c_ as will be explained in more detail below. In the example embodiment, a first actuator **505**_b_ and a second actuator **507**_b_ are configured to adjust the angulation of first blade **40** and second blade **40**, respectively. For example, the first actuator **505**_b_ may be configured to actuate the first pivoting member **505**_a_ to adjust the angulation of first blade **40** with respect to the first arm **505**. Similarly, the second actuator **507**_b_ may be configured to actuate the second pivoting member **507**_a_ to adjust the angulation of second blade **40** with respect to second arm **507**. In the example embodiment, the first pivoting member **505**_a_ may be configured to independently adjust the angulation of first blade **40** with respect to the first arm **505** upon actuation of the first actuator **505**_b_. Similarly, the second pivoting member **507**_a_ may be configured to independently adjust the angulation of the second blade **40** with respect to the second arm **507** upon actuation of the second actuator **507**_b_. In disclosed embodiments, the first and second pivoting members **505**_a_, **507**_b_ may each include a corresponding pin and socket mechanism enabling the pivoting members to pivot on a pin aperture **199** (see, e.g., FIG. **8**).
(200) As shown in FIG. **22**, modular retractor **500** may extend in a longitudinal direction from a proximal end **500**_p_ to a distal end **500**_d_ in a longitudinal direction (or proximal-to-distal direction) parallel to longitudinal axis A-A. Additionally, modular retractor **500** may extend in a lateral direction (or widthwise direction) parallel to lateral axis B-B. The longitudinal axis A-A may be perpendicular to the lateral axis B-B and intersect at body **503** at a medial location of retractor **500**, for example. In various embodiments, and as shown by the Cartesian coordinate system in FIG. **22**A, the longitudinal direction may be understood as the X direction and the lateral direction may be understood as the Y direction. Furthermore, a depth and/or thickness of modular retractor may be understood as the Z direction or vertical direction when viewed in a plan view.
(201) FIG. **23** is a perspective view of an adjustment tool **10** for use with disclosed modular retractor **500** embodiments. In the example illustration, adjustment tool **10** may include a drive end **11** and a handle end **12**, for example. Drive end **11** may have a size and shape configured to rotate various actuators of modular retractor **500**, for example. In various embodiments, drive end **11** may take the shape of a hexolobular drive end, a hex drive end, a torx drive end, a polygonal drive end, a square drive end, or the like. Similarly, actuators **502**, **507**_b_, **505**_b_ may take any corresponding shape, for example.
(202) FIG. **24** is a top down exploded parts view of a modular retractor **500** and FIG. **25** is a perspective exploded parts view of a modular retractor **500**. In the example embodiment, arm **505** may include a rack portion **505**_d_ at a distal end thereof and arm **507** may include a rack portion **507**_d_ at a distal end thereof, for example. In various embodiments, rack portions **505**_d_, **507**_d_ may be curved and be disposed at different relative distances from the distal end of the respective handle **505**, **507**, for example. Additionally rack portions **505**_d_, **507**_d_ may be meshed with and movable by distraction mechanism **50**, for example. Distraction mechanism **50** may be operably drivable by actuator **502**, for example. Distraction mechanism **50** may include a plurality of gears to provide a mechanical advantage to open and close the arms **505**, **507** as will be explained in further detail below.
(203) FIGS. **26**A-**26**E are various views of a distraction mechanism **50** for providing a mechanical advantage to distract and retract arms **505**, **507**. Distraction mechanism **50** may principally be formed of a plurality of spur gears **51**, **52**, **54**, **55**, and a partial spur gear **57** that are meshed together and sized appropriately for providing a mechanical advantage to distract and/or retract arms **505**, **507**. For example, primary actuator **502** may be connected to first spur gear **51** and second spur gear **52** by shaft **53**, for example. In the example embodiment, primary actuator **502**,

spur gears **51**, **52**, and shaft **53** are coaxially aligned in the vertical direction. Additionally, a partial spur gear **57** may attached to shaft **53**. Partial spur gear **57** may be understood as a portion and/or slice of a relatively large spur gear having a central axis of rotation coincident with shaft **53**, for example. In the example embodiment, partial spur gear **57** may have an axis of rotation coincident with shaft **53**, for example. Additionally, first spur gear **51** may be meshed with third spur gear **54**. In turn, third spur gear **54** may be connected to fourth spur gear **55** by shaft **56**. Third spur gear **54**, shaft **56**, and fourth spur gear **55** may be coaxially aligned. In the example embodiment, third spur gear **54** is a relatively large spur gear and fourth spur gear **55** is a relatively small spur gear. Those with skill in the art will understand this arrangement may be advantageous for providing a relatively great mechanical advantage to perform distraction and/or retraction of arms **505**, **507**, for example. In the example embodiment, fourth spur gear **55** may be meshed with partial spur gear **57**. In this way, distraction mechanism **50** may comprise a plurality of spur gears having various teeth and recesses that are meshed and/or interconnected to one another.

(204) FIG. **26**B is a top perspective view of a distraction mechanism **50** and FIG. **26**C is an enlarged top perspective view of distraction mechanism **50** with some parts removed for ease of understanding. In the example embodiment, third spur gear **54** may include teeth **54***a* symmetrically radially disposed on a side surface around the circumference of third spur gear **54** and a rack **54***b* may be radially disposed on a top surface of third spur gear **54** proximate the edge of spur gear **54**, for example. Primary pawl **504** may be configured to engage circular rack **54***b* to allow spur gear **54** to rotate in a first direction (counter clockwise direction) and prevent third spur gear **54** from rotating in a second direction (clockwise direction). For example, primary pawl **504** may be disposed on a pivoting hinge and be biased such that a hook portion may be pushed downward against rack **54***b* such that the hook portion is meshed within a valley between any pair of the teeth of rack portion **54***b*, for example. In operation, an end user may rotate primary actuator **502** (via tool **10**, e.g.) counter clockwise such that primary pawl **504** moves in and out of the various valleys between teeth of rack portion **54***b*. Notably, due to pawl **504** being biased against rack **54***b*, pawl **504** may prevent third spur gear **54** from rotating in the clockwise direction. For example, as arms **505**, **507** are opened patient tissue may apply a closing force attempting to push arms **505**, **507** back towards a closed position and pawl **504** may prevent and/or suppress arms **505**, **507** from moving into a closed position. Additionally, in various embodiments pawl **504** may be depressible at a lateral end thereof opposite the hook portion that is engaged with rack **54***b* such that the hook portion of pawl **504** is moved upward in the vertical direction and prevented from engaging with rack **54***b* such that arms **505**, **507** may be closed if and when desired. Furthermore, in FIG. **26**C it is shown that spur gear **52** is meshed with rack portion **505***d* of arm **505** and rack portion **507***d* of arm **507**. For example, rack portion **507***d* is meshed with a distal side of spur gear **52** and rack portion **505***d* is meshed with a proximate side of spur gear **52**. Accordingly, rotation of spur gear **52** in a first direction will cause arms **505**, **507** to distract outward by an equal amount and rotation of spur gear **52** in a second direction opposite the first direction will cause arms **505**, **507** to retract inward by an equal amount. Alternatively, an end user may squeeze handles **501***a*, **501***b* to cause distraction and/or retraction by an equal amount which will also cause rotation of the various gears of distraction mechanism **50**.

(205) FIG. **26**D is a bottom perspective view of distraction mechanism **50** and FIG. **26**E is an enlarged bottom perspective view of distraction mechanism **50**. In the example embodiment, the underside of partial spur gear **57** is shown as being meshed with spur gear **55** and being rotatably engaged with drive shaft **53**. Additionally, suitable cutout portions **505***z*, **507***z* may be provided in the first handle **505** and second handle **507** that allow partial spur gear **57** to rotate a suitable distance when expanding arms **505**, **507** such that partial spur gear **57** is fully contained within body **503** and does not clash with handles **505**, **507**, for example.

(206) FIG. **27**A is a top down view of a modular retractor **500** coupled to a table mount rack module **60** which is in turn coupled to a table mount **70**. FIG. **27**B is a perspective view of a

modular retractor **500** coupled to a table mount rack module **60** which is in turn coupled to a table mount **70**. In the example embodiment, the table mount **70** may be connected to and rigidly supported by a surgeons table via table mount portion **73**, for example. Arms **72** and **71** may be adjustable by way of adjustment knob **74** to position table rack module **60** at a suitable location, for example.

(207) FIGS. **28**A and **28**B are perspective views of a table mount rack module **60**. FIG. **28**C is an exploded parts view of table mount rack module **60**. In the example embodiment, table mount rack module **60** may include an aperture **64** having a size and shape that corresponds to a size and shape of table mount arm **506** of modular retractor **500**, for example. Depressible lever **65** may be used to lock table mount arm **506** when table mount arm **506** is insert inside of aperture **64**, for example as shown in FIGS. **27**A and **27**B. Additionally, table mount arm **506** may slide in and out of aperture **64** to facilitate positioning modular retractor **500**, for example. Table mount module **60** may include a connection arm **63**, which may be insert into a corresponding aperture of table mount **70**, for example as shown in FIGS. **27**A and **27**B to secure table mount rack module **60** to table mount **70**. Connection arm **63** may be rigidly secured to body portion **66**, for example. Additionally, extendable arm **67** may slide forward and backward through body **66** by a rack and pinion mechanism. For example, actuators **61**, **62** may be securely coupled to body **66** and may each have pinion portions **61***a*, **62***a* having teeth that engage with rack portion **67***a* of extendable arm **67**. Accordingly, rotation of actuator **61** and/or actuator **62** may rotate pinion portions **61***a* and/or **62***a* such that teeth of pinion portions **61***a*, **62***a* cause extendable arm **67** to move forward and/or backward depending on the direction actuators **61** and/or **62** are rotated. Additionally, table mount rack module **60** may include a pawl **68** having a first hook portion **68***a* and/or a second hook portion **68***b*, for example. Pawl **68** may be pivotally coupled to body portion **66** at a pivot location **66***b* by a pin, for example. Pivot location **66***b* may enable pawl **68** to be toggled between a first position where pawl **68** allows extendable arm **67** to move forward but prevents extendable arm **67** from moving backward in the opposite direction. Similarly, in various embodiments, pawl **68** may be toggled to a second position where pawl **68** allows extendable arm **67** to move backward but prevents extendable arm **67** from moving forward. In some embodiments, pawl **68** may be moved to a third position, in the middle of the first position and second position, where pawl **68** prevents extendable arm **67** from moving forward and backwards. For example, in some embodiments, and in a third position pawl **68** may lock extendable arm **67** from relative motion in the forward and backwards direction. Other embodiments may utilize a locking element (not illustrated) to secure extendable arm **67** in an appropriate position. In this way, table rack module **60** may facilitate the relative motion of modular retractor **500** forward and backward in a direction defined by axis D-D of extendable arm **67**. Additionally, table rack module **60** may facilitate the relative motion of modular retractor **500** from side to side in a direction defined by an extension direction C-C of table mount **506** (see FIG. **22**), for example.

(208) Referring generally to FIGS. **29-34** a first module **600** is disclosed. FIGS. **29** and **30** are top perspective views of a first module **600** and FIGS. **31**A and **31**B are bottom perspective views of a first module **600**. FIG. **32** is an exploded parts view of a first module **600** and FIGS. **33**A-**34** are various perspective views of first module **600** coupled to modular retractor **500**.

(209) In accordance with disclosed embodiments, first module **600** may be configured to couple and uncouple from modular retractor **500** at connection points **503***a*, for example (see FIG. **20**). In various embodiments, the first module **600** may have at least one corresponding connection point **603***a* on an underside thereof (see FIG. **31**A) configured to couple, connect, and/or mate with a connection point **503***a* of the modular retractor **500**. In the example embodiment, connection points **503***a* are indented apertures and connection points **603***a* are outdented posts having a corresponding size and shape to one another, respectively. In some embodiments, connection points **503***a*, **603***a*, may have slotted rails and/or grooves to facilitate a connection and/or prevent rotation of first module **600** relative to modular retractor **500**, for example. Similarly, and in the example

embodiment, one connection point of connection points **603***a* may be shaped like a circular post and the other connection point **603***a* may be shaped like an oval post to facilitate mating the first module **600** with modular retractor **500** in an appropriate orientation. Additionally, first module **600** may be locked to modular retractor **500** by lock **513** (see FIG. **20**). Lock **513** may be pivotable such that in a locked position a flange portion of lock **513** may pivot into a locking aperture **603***e* of first module **600**, for example. Similarly, in an unlocked position the flange portion of lock **513** may be unseated from aperture **603***e*. Other embodiments may use alternate means to securely engage the modular retractor **500** with the first module **600**, e.g., as fasteners, hexagonal grooves, channel locks, magnets, etc. provided that the modular retractor **500** and the first module **600** are securely engaged with one another such that resultant forces acting on the modular retractor **500** may transfer between modular retractor **500** and first module **600**.

(210) First module **600** may include a first arm **605** and a second arm **607** that extend through body **603**. First arm **605** may extend through body **603** through a first contoured channel **603***b* and second arm **607** may extend through body **603** through a second contoured channel **603***c*, for example (see FIG. **32**). In various embodiments, contoured channels **603***b*, **603***c* may be L shaped channels. First module **600** may be configured to independently extend first arm **605** along a first path of travel and independently extend second arm **607** along a second path of travel by independent rack and pinion mechanisms, for example. The first path and second path may be an arcuate path or segment defined by the length and geometry of the arms **605** and **607**, for example. In various embodiments, the first path and second path may symmetrically fan out with respect to one another. Other paths of travel than those specifically shown are contemplated, e.g., a linear path.

(211) First module **600** may include a table mount **606** extending laterally from a side surface thereof. Table mount **606** may facilitate the relative motion of first module **600** (and/or modular retractor **500** when coupled thereto) from side to side in a direction defined by an extension direction E-E of table mount **606** (see FIG. **34**), for example. Table mount **606** may be securely coupled to sliding frame **608**. Sliding frame **608** may be configured to slide forward and backward through sliding frame aperture **603***d* of body **603**, for example (see FIG. **32**). Additionally, in various embodiments, sliding frame **608** may be configured to support first and second arms **605**, **607** at a bottom surface of first and second arms **605**, **607** proximate first pivoting member **605***a* and second pivoting member **607***a*, respectively (see FIGS. **31**A and **31**B). In various embodiments, support portion **609** may be pivotable relative to sliding frame **608** by pivot point **609***a*, for example. In various embodiments, the first arm **605** may include first post **605***f* and second arm **607** may include second post **607***f* that extend through corresponding slotted apertures **609***b*, respectively, of support portion **609**. In this way, and due in part to the size and geometry of the slotted apertures **609***b*, support portion **609** may support both first arm **605** and second arm **607** while also enabling first and second arms **605**, **607** to be independently movable relative to one another, for example. In some embodiments, pivot point **609***a* may be replaced by a non pivoting fastener such that first arm **605** and second arm **607** are not independently movable relative to one another (not illustrated) and distract and retract by equal amounts.

(212) First module **600** may be configured to extend first arm **605** by activation of actuator **601**, e.g., by rotation of actuator **601**. Actuator **601** may be securely attached to body portion **603** and include a pinion portion **601***a* (pinion gear and/or spur gear) having teeth that engage with and are meshed with curved rack portion **605***d* disposed on a side surface of first arm **605**, for example. Accordingly, rotation of actuator **601** may rotate pinion portion **601***a* such that teeth of pinion portion **601***a* causes first arm **605** to move forward and/or backward depending on the direction actuator **601** is rotated. Additionally, first module **600** may include a first pawl **604***a* that may be configured to engage the curved rack portion **605***e* disposed on a top surface of first arm **605**, for example. First pawl **604***a* may be configured to allow pinion portion **601***a* to rotate in a first direction (counter clockwise direction) and prevent pinion portion **601***a* from rotating in a second

direction (clockwise direction). For example, first pawl **604***a* may be disposed on a pivoting hinge and be biased by a spring or the like such that a hook portion may be pushed downward against rack **605***e* such that the hook portion is meshed within a valley between any pair of the teeth of rack portion **605***e*, for example. In operation, an end user may rotate actuator **601** (via tool **10**, e.g.) counter clockwise such that pawl **604***a* moves in and out of the various valleys between teeth of rack portion **605***e* while first arm **605** extends outward away from body **603**. Notably, due to pawl **604***e* being biased against rack portion **605***e*, pawl **604***a* may prevent first arm **605** from being pushed in an opposite direction. For example, as arm **605** is distracted outward patient tissue may apply a closing force attempting to push arm **605** back towards body **603** and pawl **604***a* may prevent and or suppress this closing force. Additionally, in various embodiments pawl **604***a* may be depressible at a lateral end thereof opposite the hook portion that is engaged with rack **605***e* such that the hook portion of pawl **604***a* is moved upward in the vertical direction and prevented from engaging with rack **605***e* such that arm **605** may be closed if and when desired.

(213) First module **600** may be configured to extend second arm **607** by activation of actuator **602**, e.g., by rotation of actuator **602**. Actuator **602** may be securely attached to body portion **603** and include a pinion portion **602***a* (pinion gear and/or spur gear) having teeth that engage with and are meshed with curved rack portion **607***d* disposed on a side surface of second arm **607**, for example. Accordingly, rotation of actuator **602** may rotate pinion portion **602***a* such that teeth of pinion portion **602***a* causes second arm **607** to move forward and/or backward depending on the direction actuator **602** is rotated. Additionally, first module **600** may include a second pawl **604***b* that may be configured to engage the curved rack portion **607***e* disposed on a top surface of second arm **607**, for example. Second pawl **604***b* may operate in the same, substantially the same, and/or similar manner as explained above with respect to first pawl **604***a*. Accordingly, duplicative description will be omitted.

(214) In various embodiments, the first and second arms **605**, **607** may be coupled to first and second pivoting members **605***a*, **607***a* at a distal end thereof, respectively. The first and second pivoting members **605***a*, **607***a* may be configured to operably couple to third blade **45** and fourth blade **45**, respectively, by a corresponding blade attachment mechanism **605***c*, **607***c*. In the example embodiment, a first blade actuator **605***b* and a second blade actuator **607***b* are configured to adjust the angulation of blades **45** respectively (see FIG. **34**). For example, the first blade actuator **605***b* may be configured to actuate the first pivoting member **605***a* to adjust the angulation of blade **233** with respect to the first arm **605**. Similarly, the second actuator **607***b* may be configured to actuate the second pivoting member **607***a* to adjust the angulation of blade **234** disposed therein with respect to second arm **607**. In the example embodiment, the first pivoting member **605***a* may be configured to independently adjust the angulation of a blade with respect to the first arm **605** upon actuation of the first actuator **605***b*. Similarly, the second pivoting member **607***a* may be configured to independently adjust the angulation of a second blade with respect to the second arm **607** upon actuation of the second actuator **607***b*. In disclosed embodiments, the first and second pivoting members **605***a*, **607***a* may each include a corresponding pin and socket mechanism enabling the pivoting members to pivot, for example.

(215) Referring generally to FIGS. **35-40** a second module **700** for use with modular retractor **500** is disclosed. FIGS. **35-36** are various top perspective views of a second module **700** and FIGS. **36-37** are various bottom perspective views of a second module **700** for use with disclosed modular retractor **500** embodiments. FIG. **39** is an exploded parts view of a second module **700** and FIG. **40** is a top down view of a second module coupled to modular retractor **500** and a plurality of blades.

(216) In accordance with disclosed embodiments, second module **700** may be configured to couple and uncouple from modular retractor **500** at connection points **503***a*, for example (see FIG. **20**). For example, the second module **700** may have at least one corresponding connection point **703***a* on an underside thereof (see FIG. **38**) configured to couple, connect, and/or mate with a connection point **503***a* of the modular retractor **500** in the same, similar, and/or substantially the same manner as

explained above. Accordingly, duplicative description will be omitted. Additionally, second module **700** may be locked to modular retractor **500** by lock **513** (see FIG. **20**). Lock **513** may be pivotable such that in a locked position a flange portion of lock **513** may pivot into a locking aperture **703***e* of second module **700**, in the same, similar, and/or substantially the same manner as explained above. Accordingly, duplicative description will be omitted.

(217) Second module **700** may include an arm **705** that extends through body **703**. Arm **705** may extend through body **703** through a first contoured channel **703***b*. Second module **700** may be configured to extend arm **705** along a path of travel by a rack and pinion mechanism, for example. The path of travel may be an arcuate path or segment defined by the length and geometry of arms **705**, for example. Other paths of travel than those specifically shown are contemplated, e.g., a linear path.

(218) Second module **700** may include a table mount **706** extending laterally from a side surface thereof. Table mount **706** may facilitate the relative motion of second module **700** (and/or modular retractor **500** when coupled thereto) from side to side in a direction defined by an extension direction F-F of table mount **706** (see FIG. **40**), for example. Table mount **706** may be securely coupled directly to arm **705** (see FIG. **39**), for example. Second module **700** may be configured to extend arm **705** by activation of actuator **701**, e.g., by rotation of actuator **701**. Actuator **701** may be securely attached to body portion **703** and include a pinion portion **701***a* (pinion gear and/or spur gear) having teeth that engage with and are meshed with curved rack portion **705***d* disposed on a side surface of arm **705**, for example. Accordingly, rotation of actuator **701** may rotate pinion portion **701***a* such that teeth of pinion portion **701***a* cause arm **705** to move forward and/or backward depending on the direction actuator **701** is rotated. Additionally, second module **700** may include a first pawl **704** that may be configured to engage the curved rack portion **705***e* disposed on a top surface of arm **705**, for example. First pawl **704** may be configured to allow pinion portion **701***a* to rotate in a first direction (counter clockwise direction) and prevent pinion portion **701***a* from rotating in a second direction (clockwise direction) in the same, similar, and/or substantially the same manner as previously explained. Accordingly, duplicative description will be omitted.

(219) In various embodiments, arm **705** may be coupled to pivoting member **705***a* at a distal end thereof. Pivoting member **705***a* may be configured to operably couple to a blade **35** by blade attachment mechanism **705***c*. In the example embodiment, blade actuator **705***b* may be configured to adjust the angulation of blade **35** (see FIG. **40**). For example, the blade actuator **705***b* may be configured to actuate the first pivoting member **705***a* to adjust the angulation of blade **35** with respect to arm **705**. In disclosed embodiments, the first pivoting member **705***a* may include a corresponding pin and socket mechanism enabling pivot member **705***a* to pivot, for example.

(220) Referring generally to FIGS. **41**A-**44** a third module **800** for use with the modular retractor **500** is disclosed. FIG. **41**A is a top perspective view of a third module **800** and FIG. **41**B is a bottom perspective view of a third module **800**. FIG. **42** is an exploded parts view of a third module **800**. FIG. **43** is a perspective view of a third module **800** coupled to a modular retractor **500** and FIG. **44** is a perspective view of a third module **800** coupled to a modular retractor **500** and a plurality of blades.

(221) In accordance with disclosed embodiments, third module **800** may be configured to couple and uncouple from modular retractor **500** at connection points **503***a*, for example (see FIG. **20**). For example, the third module **800** may have at least one corresponding connection point **803***a* on an underside thereof (see FIG. **41**B) configured to couple, connect, and/or mate with a connection point **503***a* of the modular retractor **500** in the same, similar, and/or substantially the same manner as previously explained. Accordingly, duplicative description will be omitted. Additionally, third module **800** may be locked to modular retractor **500** by lock **513** (see FIG. **20**). Lock **513** may be pivotable such that in a locked position a flange portion of lock **513** may pivot into a locking aperture **803***e* of third module **800**, in the same, similar, and/or substantially the same manner as previously explained. Accordingly, duplicative description will be omitted.

(222) Third module **800** may include an arm **805** that includes a straight portion **810** and a C shaped curved portion **811**. Straight portion **810** of arm **805** may extend through body **803** and move forward and backward in a longitudinal direction, for example. As seen best in FIG. **43**, when third module **800** is coupled to modular retractor **500** the C shaped curved portion **811** extends laterally outward in a lateral direction B-B farther than the farthest lateral edge of arm **807**. For example, the C shaped curved portion **811** does not obscure a surgeons viewing area and/or access to a surgical site. Furthermore, third module **800** may orient and/or support a blade **35** such that the blade faces the body portion **803** of third module **800**, the body portion of modular retractor **500**, and is also symmetrically disposed relative to the first arm **505** and second arm **507** of modular retractor **500**. For example, the C shaped curved portion **811** may support a blade **35** at a distal most position that is aligned in the longitudinal axis A-A of modular retractor **500** (see FIG. **43**). The straight portion **810** of arm **805** may extend through body **803** through a first contoured channel. In various embodiments, the contoured channel **803***b* may be an L shaped channel, for example. Third module **800** may be configured to extend arm **805** along a path of travel by a rack and pinion mechanism, for example. The path of travel may be linear path, for example. Other paths of travel than those specifically shown are contemplated, e.g., an arcuate path.
(223) Third module **800** may include a table mount **806** extending laterally from a side surface thereof in a direction defined by an extension direction G-G of table mount **806** (see FIG. **43**), for example. Table mount **806** may facilitate the secure placement of third module **800** such that third module **800** remains fixed in 3D space and/or facilitate the relative motion of third module **800** (and/or modular retractor **500** when coupled thereto) in any direction when moving table mount **70**, for example. Third module **800** may be configured to extend arm **805** by activation of actuator **801**, e.g., by rotation of actuator **801**. Actuator **801** may be securely attached to body portion **803** and include a pinion portion **801***a* (pinion gear and/or spur gear) having teeth that engage with and are meshed with straight rack portion **805***d* disposed on a side surface of arm **805**, for example. Accordingly, rotation of actuator **801** may rotate pinion portion **801***a* such that teeth of pinion portion **801***a* cause arm **805** to move forward and/or backward depending on the direction actuator **801** is rotated in the same, similar, and/or substantially the same manner as previously explained. Accordingly, duplicative description will be omitted. Additionally, third module **800** may include a first pawl **804** that may be configured to engage rack portion **805***e* disposed on a top surface of arm **805**, for example. First pawl **804** may be configured to allow pinion portion **801***a* to rotate in a first direction (counter clockwise direction) and prevent pinion portion **801***a* from rotating in a second direction (clockwise direction) in the same, similar, and/or substantially the same manner as previously explained. Accordingly, duplicative description will be omitted.
(224) In various embodiments, curved arm portion **811** of arm **805** may be coupled to blade attachment mechanism **805***c* at a distal most end. The curved arm portion **811** may support blade attachment mechanism **805***c* such that it faces modular retractor **500** and is aligned with the longitudinal axis A-A of modular retractor **500** (see FIG. **43**). In the example embodiment, blade attachment mechanism **805***c* is fixed and a corresponding blade **35** does not pivot and/or angulate. However in other embodiments, third module **800** may include a first blade actuator (not illustrated) that is configured to adjust the angulation of a corresponding blade and a corresponding pivoting member with the same, substantially the same, and/or similar structural and characteristics as explained herein with respect to other embodiments.
(225) Third module **800** may include a table mount **806** extending in a first lateral direction along axis G-G from arm **805** and a module mount **809** extending in a second lateral direction along axis H-H from arm **805**. i.e., in an opposite lateral direction (see FIG. **43**). For example, table mount **806** may extend to the left direction and module mount **809** may extend to the right direction. Additionally, straight portion **810** of arm **805** may be supported by body **803** on the left side of the longitudinal axis A-A of modular retractor **500**. In this configuration, the module mount **809** may cross over the longitudinal axis A-A, for example. Module mount **809** may support a free hand

module **900**, as will explained in further detail below.
(226) Referring generally to FIGS. **45**A-**45**B an alternative third module **800***a* embodiment is disclosed. Third module **800***a* may include the same, substantially the same, and/or similar components and functionality as third module **800**. Accordingly, duplicative description will be omitted. In the example embodiment, third module **800***a* may be modified such that table mount **806** and module mount **809** are aligned. For example, table mount **806** and module mount **809** each extend from arm **805** in opposite directions and are aligned on the same common extension axis. For example still, axis G-G of table mount **806** and axis H-H of module mount **809** are aligned and extend in opposite directions.
(227) Alternative third module **800***a* may include a locking actuator **850**, for example. Locking actuator **850** may be rotatably secured within body portion **803** and be disposed above straight portion **810** of arm **805**, for example. In various embodiments, locking actuator **850** may include an outside thread pattern corresponding to an inside thread pattern of body **803** (not illustrated). In various embodiments, locking actuator **850** may be rotated in a first direction such that locking actuator **850** advances towards straight portion **810** of arm **805**. As locking actuator **850** advances, a bottom portion of locking actuator **850** may contact an upper surface of straight portion **810** of arm **805** and apply a downward force to straight portion **810**. In this way, locking actuator **850** may provide a frictional force against straight portion **810** of arm **805** thereby preventing and/or suppressing arm **805** from moving forward and backward. For example, the greater the downward force applied to straight portion **810**, the greater the frictional force between the underside of locking actuator **850** and the upper surface of straight portion **810**. At least one advantage of locking actuator **850** may be that arm **805** may be locking in position such that it is fixed and is prevented from moving forward and backward, for example. In various embodiments, this may assist a surgeon in placement of third module **800** and/or modular retractor **500**. For example, a surgeon may lock arm **805** via locking actuator **850** and position modular retractor **500** and third module **800** as desired while arm **805** remains in place. Thereafter, the surgeon may release locking actuator **850** and extend arm **805** to distract patient tissue or retract arm **805**. Additionally, in some surgical settings, it may be advantageous to allow third module **800** to remain in a distracted position (while third module **800** is coupled to a table mount via table mount arm **806**) and remove modular retractor **500** while the surgical site remains distracted, or at least partially distracted, by third module **800**, for example. Additionally, any of the various disclosed modules may include a locking actuator **850** rotatably disposed in a corresponding body portion above a corresponding arm and work in the same, substantially the same, and/or similar manner as explained above.
(228) In other embodiments, locking actuator **850** may be rotated between a locked position and an unlocked position. For example, in various embodiments, locking actuator **850** may include at least one locking tooth (not illustrated) that is disposed within locking cutout **850***a* of arm **805**. For example, at least one locking tooth may jam with rack portion **805***d* and prevent arm **805** from moving, for example. In other embodiments, locking actuator **850** may include at least one locking tooth that jams with pinion portion **801***a*, for example. In other embodiments, locking actuator **850** may lock pawl **804** such that pawl **804** is engaged with rack portion **805***e* and prevented from pivoting up and down relative to rack portion **805***e*. For example, by locking pawl **804** in place such that pawl **804** is engaged with rack portion **805***e*, arm **805** may be prevented from moving forward and backward. Moreover, the above described embodiments and functionality of locking actuator **850** are broadly applicable to all of the disclosed embodiments herein. For example, any of the various modules disclosed herein may include a locking actuator **850** having at least one locking tooth that jams with a corresponding rack portion of an arm, and/or a pinion portion of an actuator as explained above.
(229) Referring generally to FIGS. **46-54** a free hand module **900** and a telescoping blade **20** for use with the modular retractor **500** and/or free hand module **900** is disclosed. FIG. **46** is a perspective view of a free hand module **900** and FIGS. **47**A and **47**B are side views of a free hand

module **900** for use with disclosed modular retractor **500** embodiments. FIG. **48**A is an exploded parts view of a free hand module **900** and FIG. **48**B is a removed parts view of free hand module **900**. FIGS. **49**A-**49**B are various perspective views of a free hand module **900** in various configurations. FIGS. **50-51** are various perspective views of a free hand module **900** and a telescoping blade system **20**. FIG. **52**A is a perspective view of a blade connection channel **905***d* and FIG. **52**B is a perspective view of a blade fastener. FIGS. **53-54** are various perspective views of a third module **800** coupled to a modular retractor **500** and a free hand module **900** coupled to the third module **800**.

(230) In accordance with disclosed embodiments, free hand module **900** may be configured to couple and uncouple from third module **800** (see FIG. **46**). For example, the free hand module **900** may be configured to couple, connect, and/or mate with module mount **809**. In the example embodiment, gripping arms **916** may grip onto module mount **809**, for example. Additionally, gripping arms **916** may include a plurality of rails and channels extending in the lateral direction on an inside surface thereof. The rails of gripping arms **916** may have a size and shape corresponding to rails and channels of module mount **809**, for example. Accordingly, the gripping arms **916** may securely mate with module mount **809** by seating rails of gripping arms **916** in the channels of module mount **809** and seating the rails of module mount **809** in the channels of gripping arms **916**. Furthermore, the gripping arms **916** may provide a clamping force against module mount **809** securely coupling the free hand module **900** to third module **800**, for example.

(231) In various embodiments, free hand module **900** may be configured to enable a surgeon to freely extend blade **20** forward and backward in the longitudinal direction along longitudinal axis A-A, for example. Free hand module **900** may not include a rack and pinion mechanism to extend the blade **20** and may rely on the manual operability of a surgeon, for example. In some surgical contexts, a free hand module **900** may afford a surgeon greater freedom in installation and facilitate the surgeon in retracting delicate patient tissue by hand. For example, when performing a retraction step with free hand module **900**, patient tissue may resist the retraction and/or opening of a surgical access site. The degree of resistance of the patient tissue may be sensed by the surgeon as a form of haptic feedback informing the surgeon how much pressure has been applied to the patient tissue. In this way, the surgeon can sense and or prevent applying to much retraction force to a patient tissue and/or applying just the right amount of retraction force in delicate situations. Similarly, a free hand module **900** may be relatively easier for a surgeon to manipulate than a rack and pinion type of motion. This may allow the surgeon to quickly retract specific patient tissue with greater freedom in operation. Additionally, a length and/or height of telescoping blade **20** may be adjustable. Accordingly, a surgeon can retract various layers of patient tissue that are below (or above) the patient tissue which has been previously retracted by the other blades.

(232) Free hand module **900** may include a handle **901** at a proximal end and a blade attachment mechanism **905***c* at a distal end, for example. Handle **901** may be rigidly secured to a shaft **905** and shaft **905** may define a longitudinal axis of free hand module **900**, for example. Free hand module **900** may include a moving mechanism **910**. As illustrated best in FIGS. **48**A and **48**B, moving mechanism **910** may include various components that enable an end user to toggle a lever **911** to enable the forward and backward movement of handle **901**, shaft **905**, and blade attachment mechanism **905***c* relative to moving mechanism **910** and module mount **809**, for example. Moving mechanism **809** may include a body portion **913** having an aperture **913** extending therethrough. Shaft **905** may extend through aperture **913***a* and slotted aperture **915***b* of gripper body **915**, for example. An upper portion of lever support **912** may be disposed above body **913** and be operably coupled to lever **911** while a lower portion including an annular channel **912***b* may be disposed within body **913**. For example, lever support **912** may be securely attached to lever **911** by laterally extending posts **912***a* that extend through corresponding apertures **911***a* of lever **911**. In this way, lever **911** may be pivotable about posts **912***a* and when depressed an upper surface of body **913** may act as a support surface such that depressing lever **911** pulls lever support **912** upward. For

example, lever support **912** may be pivotable up and down in the vertical direction by depressing and/or rotating lever **911**. For example still, pressing down on lever **911** may pull lever support **912** upward relative to body **913**. Additionally, the lower portion of lever support **912** disposed within body **913** may prevent the over rotation of lever support **912** due to suitable retaining rails of body **913** being inset within annular ring **912***b* such that lever support **912** is fixedly retained by body **913**, for example.
(233) As shown best in FIGS. **48**A-**48**B, an uppermost coupling portion **915***a* of gripper body **915** may be secured within a lower cavity of lever support **912**. In this way, when lever **911** is actuated and pulls lever support **912** upwards, lever support **912** also pulls gripper body **915** upwards. In various embodiments, a stop block **914** may be disposed within body **913** at a bottom portion thereof. Stop block **914** may be disposed beneath shaft **905**, for example. Additionally, stop block **914** may include inclined surfaces that may bias gripping arms **916** inwards (towards one another) to provide a gripping force against module mount **809**, for example. In operation, an end user may actuate lever **911** such that gripper body **915** is pulled upwards and gripping arms **916** are biased inwards towards one another to securely couple to module mount **806** via clamping force.
(234) In various embodiments, free hand module **900** via lever **911** may be adjustable and/or fixed in three modes of operation, for example. In a first mode of operation, and when lever **911** is in a first position, shaft **905** is extendable forward and backward through body **913** and gripping arms **916** are in an open position (see FIG. **49**A). When gripping arms **916** are in an open position free hand module **900** may be positioned in place around and/or above module mount **809**. In the first mode of operation, moving mechanism **910** and gripping arms **916** are both fully open, for example. In a second mode of operation, and when lever **911** is in a second position, shaft **905** is extendable forward and backward through body **913** and gripping arms **916** are in a closed position whereby gripping arms **916** provide a suitable clamping force to module mount **809**. In the second mode of operation, moving mechanism **910** is movable in the longitudinal direction and free hand module **900** is securely coupled to module mount **809** due to gripping arms **916** being in the closed position, for example. In a third mode of operation, and when lever **911** is in a third position, shaft **905** is not extendable forward and backward through body **913** and gripping arms **916** are in a closed position (see FIG. **49**B). In the third mode of operation, moving mechanism **910** is fixed relative to shaft **905** and free hand module **900** is fixed in 3D space due to gripping arms **916** being in the closed position and securely clamped on to module mount **809** (see FIGS. **53-54**).
(235) With reference to FIGS. **50-52**B, a telescoping blade **20** is disclosed. Telescoping blade **20** may securely connect to blade attachment mechanism **905***c* of free blade module **900**, for example. Additionally, telescoping blade **20** may securely connect to any of the other blade attachment mechanisms disclosed herein. Telescoping blade **20** may include a first blade **22** and a second blade **24** that is extending along axis Z-Z, for example. First blade **22** may include a channel **23** extending longitudinally down a length thereof from proximal end **20***p* to about the distal end **20***d*. Similarly, second blade **24** may include a rail **25** extending longitudinally down a length thereof from proximal end **20***p* to about distal end **20***d*. In various embodiments, the channel **23** and/or rail **25** may stop and/or terminate before the distal end **20***d* to prevent the second blade **24** from extending too far. In various embodiments, the second blade **24** may slide upward and downward in a proximal-to-distal direction, shown by axis Z-Z in FIG. **50**. Additionally, an outside surface of blade **22** may include an engagement feature **26** for securely coupling to blade attachment mechanism **905***c*, for example. Engagement feature **26** may include two spring loaded tabs **27** that are flexible towards one another and naturally biased away from one another, for example. In various embodiments, an end user may slide engagement feature **26** down into channel **905***d* of blade attachment mechanism **905***c* from above and the two spring loaded tabs **27** may push outward against side surfaces of channel **905***d* to frictionally retain engagement feature **26** therein. Additionally, channel **905***d* may include a stop feature **905***e* adjacent a bottom surface thereof. In various embodiments, the stop feature **905***e* may be a curved bottom surface corresponding to the

geometry of the spring loaded tabs **27**, for example. In other embodiments, the two spring loaded tabs **27** may seat into corresponding channels or indents of blade attachment mechanism **905***c* (not illustrated). Furthermore, in other embodiments the engagement feature **26** may be rotated about 180 degrees such that the blade **20** may be insert into blade engagement mechanism **905***c* from below.

(236) FIGS. **53-54** illustrate a modular retractor **500** with a third module **800** coupled thereto and a free hand module **900** coupled to the third module **800**. In the example embodiment, the telescoping blade **20** is attached to a distal end of free hand module **900** and blade **30** is attached to the distal end of third module **800**. Additionally, a centerline of telescoping blade **20** and a centerline of blade **30** are aligned with longitudinal axis A-A of modular retractor **500** (see FIG. **22**). However, it shall be appreciated that free hand module **900** is slidable along module arm **809** and can be positioned alternately than shown. Furthermore, the curved arm **811** curves out laterally farther than arm **507** of modular retractor **500**. As illustrated, blades **30**, **40**, and **20** form an opening for a surgical access location and/or a surgical access site.

(237) FIGS. **55-56** are various perspective views of a fourth module **1000** for use with disclosed modular retractor **500** embodiments. FIG. **57** is an exploded parts view of a fourth module **1000**. FIGS. **58-59** are various views of a fourth module **1000** coupled to a modular retractor **500** and FIGS. **60-61** are various views of a fourth module **1000** coupled to a first free hand module **900** and a second free hand module **900**.

(238) Fourth module **1000** may include the same, substantially the same, and or similar components as third module **800**. Accordingly, duplicative disclosure will be omitted and/or minimized. Fourth module **1000** may be configured to couple and uncouple from modular retractor **500** at connection points **503***a*, for example (see FIG. **20**). For example, the fourth module **1000** may have at least one corresponding connection point **1003***a* on an underside thereof (see FIG. **56**) that is configured to couple, connect, and/or mate with a connection point **503***a* of the modular retractor **500** in the same, substantially the same, and or similar manner as explained above. Additionally, fourth module **1000** may be locked to modular retractor **500** by lock **513** (see FIG. **20**). Lock **513** may be pivotable such that in a locked position a flange portion of lock **513** may pivot into a locking aperture **1003***e* of fourth module **1000**, in the same, substantially the same, and or similar manner as explained above.

(239) Fourth module **1000** may include an arm **1005** that includes a straight portion **1010** and a C shaped curved portion **1011**. Straight portion **1010** of arm **1005** may extend through body **1003** and move forward and backward in a longitudinal direction, for example. As seen best in FIG. **58**, when fourth module **1000** is coupled to modular retractor **500** the C shaped curved portion **1011** extends laterally outward in a lateral direction farther than the farthest lateral edge of arm **507** of modular retractor **500**. For example, the C shaped curved portion **1011** does not obscure a surgeons viewing area and/or access to a surgical site. The straight portion **1010** of arm **1005** may extend through body **1003** through an L shaped contoured channel **1003***b*, for example. Fourth module **1000** may be configured to extend arm **1005** along a path of travel by a rack and pinion mechanism, for example. The path of travel may be linear path, for example.

(240) Fourth module **1000** may include a table mount **1006** extending laterally from a side surface thereof in a direction defined by an extension direction H-H of table mount **1006** (see FIG. **58**), for example. Table mount **1006** may facilitate the secure placement of fourth module **1000** such that fourth module **1000** remains fixed in 3D space and/or facilitate the relative motion of fourth module **1000** (and/or modular retractor **500** when coupled thereto) in any direction when moving table mount **70**, for example. Fourth module **1000** may be configured to extend arm **1005** by activation of actuator **1001**, e.g., by rotation of actuator **1001**. Actuator **1001** may be securely attached to body portion **1003** and include a pinion portion **1001***a* (pinion gear and/or spur gear) having teeth that engage with and are meshed with straight rack portion **1005***d* disposed on a side surface of arm **1005**, in the same, substantially the same, and or similar manner as explained above.

Additionally, fourth module **1000** may include a first pawl **1004** that may be configured to engage the rack portion **1005***e* disposed on a top surface of arm **1005**, for example. First pawl **1004** may be configured to allow pinion portion **1001***a* to rotate in a first direction (counter clockwise direction) and prevent pinion portion **1001***a* from rotating in a second direction (clockwise direction) in the same, substantially the same, and or similar manner as explained above.

(241) Fourth module **1000** may include a table mount **1006** extending in a lateral direction along axis H-H away from arm **1005** and longitudinal axis A-A. Fourth module **1000** may include a proximal module mount **1009** extending along axis I-I in a lateral direction away from arm **1005** towards longitudinal axis A-A. For example, table mount **1006** may extend to the left direction and proximal module mount **1009***p* may extend to the right direction. Additionally, in various embodiments, the C shaped curved portion **1011** may include a distal module mount **1009***d* that extends along axis J-J from a side surface of curved arm portion **1011** such that it crosses over longitudinal axis A-A of modular retractor **500**. The distal module mount **1109***d* and proximal module mount **1009***p* may be symmetrically disposed relative to one another with respect to longitudinal axis A-A, for example (see FIG. **58**). Additionally, straight portion **1010** of arm **1005** may be supported by body **1003** on the left side of the longitudinal axis A-A of modular retractor **500**. In this configuration, module mounts **1009***p*, **1009***d* may cross over the longitudinal axis A-A, for example. Module mounts **1009***p*, **1009***d* may each independently support a free hand module **900**, in the same, similar, and/or substantially the same manner as explained previously. For example, as shown in FIGS. **60-61** proximal module mount **1009***p* supports a free hand module **900** in a proximal position and distal module mount **1009***d* supports a free hand module **900** in a distal position.

(242) Referring generally to FIGS. **62-65** a fifth module **1100** for use with the modular retractor **500** is disclosed. FIGS. **62-63** are various perspective views of a fifth module **1100** for use with disclosed modular retractor **500** embodiments. FIG. **64** is an exploded parts view of a fifth module **1100** and FIG. **65** is a top perspective view of a fifth module **1100** coupled to a modular retractor **500**.

(243) Fifth module **1100** may include the same, substantially the same, and or similar components as third module **800** and/or fourth module **1000**. Accordingly, duplicative disclosure will be omitted and/or minimized. Fifth module **1100** may be configured to couple and uncouple from modular retractor **500** at connection points **503***a*, for example (see FIG. **20**). For example, the fifth module **1100** may have at least one corresponding connection point **1103***a* on an underside thereof (see FIG. **63**) that is configured to couple, connect, and/or mate with a connection point **503***a* of the modular retractor **500** in the same, substantially the same, and or similar manner as explained above. Additionally, fifth module **1100** may be locked to modular retractor **500** by lock **513** (see FIG. **20**). Lock **513** may be pivotable such that in a locked position a flange portion of lock **513** may pivot into a locking aperture **1103***e* of fifth module **1100**, in the same, substantially the same, and or similar manner as explained above. Similarly, in an unlocked position the flange portion of lock **513** may be unseated from aperture **1103***e*.

(244) Fifth module **1100** may include an arm **1105** that includes a straight portion **1110** and a C shaped curved portion **1111**. Straight portion **1110** of arm **1105** may extend through body **1103** and move forward and backward in a longitudinal direction, for example. As seen best in FIG. **65**, when fifth module **1100** is coupled to modular retractor **500** the C shaped curved portion **1111** extends laterally outward in a lateral direction farther than the farthest lateral edge of arm **1105**. For example, the C shaped curved portion **1111** does not obscure a surgeon's viewing area and/or access to a surgical site. The straight portion **1110** of arm **1105** may extend through body **1103** through an L shaped contoured channel **1103***b*. Fifth module **1100** may be configured to extend arm **1105** along a path of travel by a rack and pinion mechanism, for example. The path of travel may be linear path, for example.

(245) Fifth module **1100** may include a table mount **1106** extending laterally from a side surface of

arm **1105** adjacent a junction of curved portion **1111** and straight portion **1110**. Table mount **1106** may extend along axis H-H in a direction defined by an extension direction of table mount **1106** (see FIG. **65**), for example. In the example embodiment, table mount **1106** extends in a perpendicular direction to longitudinal axis A-A and/or a dominant extension direction of straight portion **1110**. Table mount **1106** may facilitate the secure placement of fifth module **1100** such that fifth module **1100** remains fixed in 3D space and/or facilitate the relative motion of fifth module **1100** (and/or modular retractor **500** when coupled thereto) in any direction when moving table mount **70**, for example. Fifth module **1100** may be configured to extend arm **1105** by activation of actuator **1101**, e.g., by rotation of actuator **1101**. Actuator **1101** may be securely attached to body portion **1103** and include a pinion portion **1101***a* (pinion gear and/or spur gear) having teeth that engage with and are meshed with straight rack portion **1105***d* disposed on a side surface of straight portion **1110** of arm **1105**, in the same, substantially the same, and or similar manner as explained above. Additionally, fifth module **1100** may include a pawl **1104** that may be configured to engage the rack portion **1105***e* disposed on a top surface of straight portion **1110** of arm **1105**, for example. Pawl **1104** may be configured to allow pinion portion **1101***a* to rotate in a first direction (counter clockwise direction) and prevent pinion portion **1101***a* from rotating in a second direction (clockwise direction) in the same, substantially the same, and or similar manner as explained above.

(246) Fifth module **1100** may include a body **1103** having a curved body portion **1107** extending away from longitudinal axis A-A. In the example embodiment, curved body portion **1107** curves away in an opposite direction from arm **1105** and defines the distal most portion of body **1103**. Curved body portion **1107** may support and orient proximal modular mount **1109** such that it extends in a lateral direction towards arm **1105**, and crosses over longitudinal axis A-A. For example, table mount **1106** may extend to the left direction from a left side of arm **1105** and proximal module mount **1109***p* may extend along axis K-K to the left direction from a left side of curved body portion **1107** and cross over longitudinal axis A-A. Additionally, in various embodiments, the C shaped curved portion **1111** may include a distal module mount **1109***d* that extends from a side surface of curved arm portion **1111** such that it crosses over longitudinal axis A-A of modular retractor **500**. The distal module mount **1109***d* and proximal module mount **1109***p* may be disposed opposite one another and each cross over longitudinal axis A-A, for example. Additionally, straight portion **1110** of arm **1105** may be supported by body **1103** on the left side of the longitudinal axis A-A of modular retractor **500**. Module mounts **1109***p*, **1109***d* may each independently support a free hand module **900**, as explained previously. Furthermore, in various embodiments, module mount **1109***p* may be relatively shorter than module mount **1109***d*.

(247) Referring generally to FIGS. **66-75** various blades for use with the modular retractor **500** and any of the various modules disclosed herein are disclosed. FIG. **66** is a top view of a pair of blades **30**, FIG. **67** is a bottom view of a pair of blades **30**, and FIG. **68** is a perspective view of a pair of blades **30** for use with disclosed modular retractor **500** embodiments. Blades **30** may be shaped like a half circle, for example. Accordingly, in various embodiments when blades **30** adjoin one another they may form a common circle in a fully closed position. Additionally, blades **30** may include an arcuate channel **31** extending along an inside surface thereof from a proximal end (see FIG. **66**) to a distal end (see FIG. **67**), for example. Arcuate channel **31** may have a size and shape corresponding to a size and shape of an arcuate outdent of a dilator, for example arcuate outdent **90***a* of dilator **90** shown in FIGS. **80**A, **80**B. Alternatively, arcuate channel **31** may have a size and shape corresponding to a size and shape of an arcuate outdent of a shim (not illustrated). Additionally, blades **30** may include an aperture **32** extending through a top surface of blade **30** at the proximal end and penetrating the inside surface of blade **30** thereby providing access to the surgical access opening created by blades **30**, for example. Aperture **32** may provide access for light fixtures and other diagnostic tools such as endoscopes, electrodes, temperature sensors, suction devices, and etc. that may be insert therein and be protected while extending through blade **30**, for example.

(248) FIG. **69** is an enlarged view of a top portion of a universal blade fastener **33**. Universal blade fastener **33** may be similar to blade fastener **26** of telescoping blade **20** (see FIG. **52**B) but in reverse. For example, blade fastener **33** may be configured for top loading blade **30** to a blade receiving mechanism. Blade fastener **33** may include a pair of spring loaded tabs **34** adjacent the upper surface of blade **30** and a curved support surface **35** therebelow. For example, spring loaded tabs **34** may be disposed at an upper region of blade fastener **33** and curved support surface **35** may be disposed at a lower portion of blade fastener. In this way, an end user can insert the support surface **35** within a blade receiving mechanism from above and the spring loaded tabs **34** can help retain blade **30** therein by a biasing force applied to sidewalls of a blade receiving mechanism. Furthermore, any other blade disclosed herein may include the same, similar, or substantially the same blade fastener **26**.

(249) FIG. **70** is a top view of various blades **40** and **35** and FIG. **71** is a bottom view of the three blades **40** and **35** for use with disclosed modular retractor **500** embodiments. FIG. **72** is a perspective view of blades **35**, **40** for use with disclosed modular retractor **500** embodiments. In the example embodiment, a first blade **40**, second blade **40**, and a third blade **35** may form an oval shape. For example, when blades **40**, **35** are closed together such that they adjoin one another they may form an oval like shape. Blades **40** may include two arcuate channels **41** and an aperture **42**. Similarly, blade **35** may include two arcuate channels **36** and an arcuate channel **37**. Arcuate channels **41**, **37** may have a size and shape corresponding to a size and shape of an arcuate outdent of a dilator, for example arcuate outdent **81** of dilator **81** shown in FIG. **76**. Additionally, in the fully closed position where blades **40**, **35** adjoin one another, the six arcuate outdents of FIG. **76** may be disposed in a corresponding relative position and have a corresponding size and shape to the six arcuate channels **36**, **37** shown in the three blade configuration of FIG. **70**.

(250) Furthermore, blades **40** may include an aperture **42** extending through a top surface of blade **40** at the proximal end and penetrating the inside surface of blade **40** and blade **35** may include an aperture **37** extending through a top surface of blade **35** at the proximal end and penetrating the inside surface of blade **35**. Apertures **37** and **42** may provide access for light fixtures and other diagnostic tools such as endoscopes, electrodes, temperature sensors, suction devices, and etc. that may be insert therein and be protected while extending through blades **35** and **40**, for example.

(251) FIG. **73** is a top view of four blades **40**, **45** and FIG. **74** is a bottom view of the four blades for use with disclosed modular retractor **500** embodiments. FIG. **75** is a perspective view of the four blades **40**, **45** for use with disclosed modular retractor **500** embodiments. In the closed position, blades **40**, **45** may form an oval like shape. Blade **45** may include an arcuate channel **46** for securing to an arcuate outdent of a dilator having the same, similar, and or substantially the same attributes and purposes as explained above. Additionally blade **45** may include an aperture **47** extending through a top surface of blade **45** at the proximal end and penetrating the inside surface of blade having the same, similar, and or substantially the same attributes and purposes as explained above.

(252) Referring generally to FIGS. **76-81** various dilators for use with the modular retractor **500** and the various blade embodiments disclosed herein are illustrated. FIG. **76** is a top view of a plurality of nested dilators **80** and FIG. **77**A is a perspective view of the plurality of nested dilators **80** in a non-nested configuration and FIG. **77**B is a perspective view of the plurality of nested dilators **80** in a nested configuration. In the example embodiment, five dilators are illustrated having progressively increasing sizing. A first dilator **85** may have a circular shape and a relatively narrow diameter for initiating a dilation process. An outside perimeter of the second dilator **84** may have an oval like shape and an inside diameter of dilator **84** may have a circular like shape corresponding to the outer diameter of first dilator **85**. An outside perimeter of the third dilator **83** may have an oval like shape and an inside perimeter of the third dilator **83** may have an oval like shape corresponding to the outer perimeter of second dilator **84**. Similarly, an outside perimeter of the fourth dilator **82** may have an oval like shape and an inside perimeter of the fourth dilator **82**

may have an oval like shape corresponding to the outer perimeter of third dilator **83**. Similarly, an outside perimeter of the fifth dilator **81** may have an oval like shape and an inside perimeter of the fifth dilator **81** may have an oval like shape corresponding to the outer perimeter of fourth dilator **82**. In various embodiments, the dilators may be successively nested within one another to dilate a patient tissue before use of the various disclosed retractor embodiments. Additionally, fifth dilator **81** may include a plurality of arcuate outdents **81***a* (e.g., an arcuate rail or the like) extending along an outside surface thereof. The arcuate outdent **81***a* may mate with an arcuate channel of various blades as disclosed above.

(253) FIG. **78** is a top view of a dilator **90** having an oval like outer perimeter and an oval like inner perimeter and FIG. **79** is a perspective view of dilator **90**. Dilator **90** may include a plurality of arcuate outdents **91***a* (e.g., an arcuate rail or the like) extending along an outside surface thereof. In the example embodiment, arcuate outdents **91***a* are disposed along roughly half of the available radial outer surface and extend in a proximal to distal direction, e.g., about half of the available perimeter includes arcuate outdents **91***a* that extend from the proximal end to distal end. The arcuate outdents **91***a* may mate with an arcuate channel of various blades in the same, similar, and/or substantially the same manner as explained above. FIG. **80**A is a top view of a dilator **95** and FIG. **80**B is a perspective view of dilator **95**. Dilator **95** may have a circular outer diameter and a circular inner diameter. Dilator **95** may include a plurality of arcuate outdents **95***a* symmetrically radially disposed along the outer surface. The arcuate outdents **95***a* may mate with an arcuate channel of various blades as disclosed above.

(254) FIGS. **80**C-**80**E show various perspective and elevation views of a set of nested and cylindrically shaped dilators **99**. In the example embodiment, an innermost dilator **98** may be the thinnest and the longest dilator of the set, while the outermost dilator **94** may be the widest and the shortest dilator of the set. Of course the relative length and width of any dilator of the set of dilators **99** may be adjusted consistent with the particular surgery being performed. Additionally, there may be any number and size dilators in between the innermost dilator **98** and outermost dilator **94**, for example first inner dilator **97** and second inner dilator **96**. With reference to FIGS. **80**D and **80**E, it is seen that the outside circumferential surface of outermost dilator **94** has a plurality of rail portions **94**A that extend down its length in a proximal to distal direction. The rail portions **94**A generally have a size and shape corresponding to channel portions of various blades disclosed herein. For example, these rail portions **94**A may be disposed in particular locations along the outside circumferential surface of the outermost dilator **94** that takes into account the particular surgical approach employed by the surgeon and the location of the corresponding channel portions of the chosen blades, for example.

(255) As seen best in the top down view of FIG. **81**, rail portions **94**A may be shaped like circular, oval, or arcuate outdents, for example. Additionally, pairs of adjacent rails **94**A may form coupling locations for any of the example blade embodiments disclosed herein. For example, as shown in FIG. **81** blade **1** and blade **2** may couple to respective pairs of rails **94**A in a first region (approximately upper half area of FIG. **81**) and blade **3** may couple to the remaining respective pair of rails **94**A in a second region (approximately lower half area of FIG. **81**). The illustrated spacing arrangement of rails **94**A takes into account a specific surgical approach chosen by the surgeon and the functionality of disclosed retractor embodiments, e.g., relative movement of retractor arms in a linear, arcuate, ratcheting, and/or pivoting motion, the types of blades and their relative locations, among other things. Further discussion regarding an example method of use of disclosed retractor and retractor module embodiments and surgical approaches utilizing the outer dilator **94** is shown in the top down view of FIG. **130** and the perspective view of FIG. **131**, among other places.

(256) Referring generally to FIGS. **82-87** a modular blade **120** and an extendable blade **130** for coupling to modular blade **120** is disclosed. FIGS. **82** and **83** are various perspective views of a modular blade **120** and FIGS. **84** and **85** are various perspective views of an extendable blade **130** for coupling to modular blade **120**. FIG. **86** is a front view of modular blade **120** and extendable

blade **130** side by side and FIG. **87** is a top down view of modular blade **120** and extendable blade **130**. In various embodiments, the modular blade **120** may be referred to as modular because it may couple to various extendable blades **130** such that extendable blades **130** may extend relative to modular blade **120**, e.g., blade **120** and blade **130** may be configured as a telescoping blade system.

(257) Modular blade **120** may extend from a proximal end **120***p* to a distal end **120***d* in a proximal-to-distal direction (may also be referred to as longitudinal direction). The proximal end **120***p* may include an engagement feature **126** having spring loaded tabs **127** for coupling to a blade engagement mechanism in the same, similar, and/or substantially the same way as explained above. The distal end **120***d* may include a tip portion **121**. In the example embodiment, tip portion **121** comprises a substantially planar outer surface that tapers towards a centerline of modular blade **120** and terminates as a blunt chisel shaped end having a relatively smaller thickness than the remaining portions of modular blade **120**, for example. Modular blade **120** may include a pair of rails **124** that extend from proximal end **120***p* towards distal end **120***d*. For example, a first rail **124** may extend along a first side of blade **120** in the proximal-to-distal direction and a second rail **124**, opposite the first rail **124**, may extend along a second side of blade **120** in the proximal-to-distal direction. In various embodiments, rails **124** may define a receiving channel for receiving extendable blade **130** as will be explained in further detail below.

(258) Additionally, modular blade **120** may include an aperture **122** extending through a top surface of blade **120** at the proximal end **120***p* and penetrating through the inside surface of blade **120** at oval shaped opening **122***a*, for example. In various embodiments, aperture **122** may comprise a passageway (in a cross section view) that is inclined away from the outside surface of blade **120** and towards the inside surface of blade **120** such that the passageway forms an oval shaped opening **122***a* on the inside surface of blade **120**. In cross section, the passageway of aperture **122** may resemble a circle, oval, pentagon, square, rectangle, and/or any combination thereof. Aperture **122** may provide access for light fixtures and other diagnostic tools such as endoscopes, electrodes, temperature sensors, suction devices, and etc. that may be insert therein.

(259) Modular blade **120** may include a contoured channel **123** for connecting with extendable blade **130** and facilitating the forward and backward relative motion of extendable blade **130** in the proximal-to-distal direction, for example. As shown best in FIG. **83**, contoured channel **123** may include a relatively large central arcuate channel portion **123***a* having a pair of relatively smaller arcuate channels **123***b* on opposite sides of channel portion **123***a*, for example. Additionally, contoured channel **123** may include a plurality of indentations **125** extending in a proximal-to-distal direction, for example. In various embodiments, indentations **125** may be circular shaped indentations, oval shaped indentations, hexagonal shaped indentations, parallelogram shaped indentions, and/or any combination thereof. A distal end of contoured channel **123** may include a stop feature **129** for preventing extendable blade **130** from extending too far in the proximal-to-distal direction.

(260) Extendable blade **130** may extend from a proximal end **130***p* to a distal end **130***d* in a proximal-to-distal direction (also referred to as a longitudinal direction). The distal end may include a tip portion **131** tapering towards a centerline of extendable blade **130** and terminating as a blunt chisel shaped end having a relatively smaller thickness than the remaining portion of extendable blade **130**, for example. In the example embodiment, an outside surface of extendable blade **130** may include an engagement feature **134** for connecting with contoured channel **123**, for example. Engagement feature **134** may include a proximal engagement rail **135** having a size and shape generally corresponding to a size and shape of contoured channel **123**. For example, proximal engagement rail **135** may have a size and shape generally corresponding to the relatively large central arcuate channel portion **123***a* and the pair of relatively smaller arcuate channels **123***b*, for example. Additionally, engagement feature **134** may include a medial engagement rail **136** having a width approximately corresponding to the relatively large central arcuate channel portion **123***a* of modular blade **120**, for example. In various embodiments, an exposed surface of medial

engagement rail **136** may be substantially planar although in other embodiments the exposed surface may be arcuately shaped to correspond and/or approximate the geometrical profile of contoured channel **123**, for example.

(261) In various embodiments, engagement feature **134** may include at least one protrusion **133** having a size and shape generally corresponding to a size and shape of indentation **125**. For example, protrusion **133** may selectively be seated within any one of indentations **125** to secure extendable blade **130** in any one position of the plurality of positions defined by indentations **125**. In various embodiments, protrusion **133** may be a circular shaped protrusion, oval shaped protrusion, hexagonal shaped protrusion, parallelogram shaped protrusion, and/or any combination thereof. In various embodiments, protrusion **133** may extend away from extendable blade **130** in a direction perpendicular to the proximal-to-distal direction a distance that is relatively farther out than medial engagement rail **136** and/or proximal engagement rail **135**, for example. In some embodiments, protrusion **133** may be spring loaded and/or biased. In other embodiments, protrusion **133** may be a rigid non movable structure.

(262) In various embodiments, engagement feature **134** may include a distal engagement rail **137** having a size and shape generally corresponding to a size and shape of contoured channel **123**. For example, distal engagement rail **137** may have a size and shape generally corresponding to the relatively large central arcuate channel portion **123***a* and the pair of relatively smaller arcuate rails **123***b*, for example. Additionally, engagement feature **134** may include a stop feature **138** that may abut against stop feature **129** of modular blade **120** to prevent extendable blade **130** from disengaging with modular blade **120**, for example. For example, in a fully extended position, stop feature **138** of extendable blade may directly contact stop feature **129** of modular blade **120** and prevent extendable blade **130** from extending too far that engagement feature **134** becomes unseated from contoured channel **123**.

(263) With reference to FIG. **86**, the inside surface of modular blade **120** and the outside surface of extendable blade **130** is illustrated. In various embodiments, extendable blade **130** may operably couple to modular blade **120** by inserting engagement feature **134** into channel **123**. As explained above, extendable blade **130** may move forward and backward in a proximal-to-distal direction within contoured channel **123**. For example, extendable blade **130** may extend forward and backward within contoured channel **123** and protrusion **133** may be seated within any one of indentations **125**. For example, when modular blade **120** and extendable blade **130** are coupled together as a system, they may be referred to as a telescoping blade system.

(264) With reference to FIG. **87**, a top down view of modular blade **120** and extendable blade **130** is illustrated. In the example embodiment, it is shown that rails **124** define a cavity and/or channel for receiving extendable blade **130**. For example, extendable blade **130** has a width in a lateral direction that corresponds to a distance between rails **124** and a thickness of extendable blade **130** corresponds to a depth of the cavity and/or channel between and defined by rails **124**. In various embodiments, the outside lateral edges **1301** of extendable blade **130** may be inset within the receiving cavity defined by rails **124** such that they frictionally engage and slide across the interior side surfaces of modular blade **120**, for example. In this way, rails **124** may provide a bearing surface for retaining extendable blade **130** therein while also allowing extendable blade **130** to move forward and backward in the proximal-to-distal direction. Additionally, it is shown that engagement feature **134** has a size and shape corresponding to contoured channel **123**. For example, the curved surfaces of proximal engagement rail **135** may be inset within (mated within) contoured channel **123** and frictionally engage and slide across the interior surfaces defined by the relatively large central arcuate channel portion **123***a* and/or pair of relatively smaller arcuate channels **123***b* on opposite sides of channel portion **123***a*, for example.

(265) Referring generally to FIGS. **88-93** a modular blade **320** and an extendable blade **330** for coupling to modular blade **320** is disclosed. FIGS. **88** and **89** are various perspective views of a modular blade **320** and FIGS. **90** and **91** are various perspective views of an extendable blade **330**

for coupling to modular blade **320**. FIG. **92** is a front view of modular blade **320** and extendable blade **330** side by side and FIG. **93** is a top down view of modular blade **320** and extendable blade **330**. In various embodiments, modular blade **320** and extendable blade **330** may be configured as a telescoping blade system.

(266) Modular blade **320** may extend from a proximal end **320***p* to a distal end **320***d* in a proximal-to-distal direction (may also be referred to as longitudinal direction). The proximal end **320***p* may include an engagement feature **326** having spring loaded tabs **327** for coupling to a blade engagement mechanism in the same, similar, and/or substantially the same way as explained above. The distal end **320***d* may include a tip portion **321**. In the example embodiment, tip portion **321** comprises a substantially planar outer surface that tapers towards a centerline of modular blade **320** and terminates as a blunt chisel shaped end having a relatively smaller thickness than the remaining portions of modular blade **320**, for example. Modular blade **320** may include a pair of rails **324***a* and **324***b* that extend from proximal end **320***p* towards distal end **320***d*. For example, a first rail **324***a* may extend along a first lateral side of blade **320** in the proximal-to-distal direction and a second rail **324***b*, opposite first rail **324***a*, may extend along a second lateral side of blade **320** in the proximal-to-distal direction. First rail **324***a* may extend laterally away from extendable blade **320** farther than second rail **324***b*, for example. For example still, second rail **324***b* may be inset towards a center of modular blade **320** relative to first rail **324***a* and **324***a* may be outset relative to second rail **324***b* (see FIG. **93**). First rail **324***a* may define a first receiving cavity **324***y* and second rail **324***z* may define a second receiving cavity **324***z*, for example. Additionally, modular blade may include a channel **319** extending along the outside surface of modular blade **320** in the proximal-to-distal direction and/or from a proximal end to a distal end. Channel **319** may have a size and shape generally corresponding to a size and shape of channel **339** of extendable blade **330**, for example. In various embodiments, a stability pin may be positioned within channels **319** and **339**, for example. In various embodiments, rails **324***a*, **324***b*, and channel **319** may define a contoured receiving channel for receiving extendable blade **330**, as will be explained in further detail below.

(267) Modular blade **320** may include an aperture **322** extending through a top surface of blade **320** at the proximal end **320***p* and penetrating through the inside surface of blade **320** at oval shaped opening **322***a*, for example. Aperture **322** may have the same, similar, and/or substantially the same features and functionality of aperture **122**. Accordingly, duplicative description will be omitted. Modular blade **320** may include a contoured channel **323** for connecting with extendable blade **330** and facilitating the forward and backward relative motion of extendable blade **330** in the proximal-to-distal direction, for example. Contoured channel may include a relatively large central arcuate channel portion **323***a* having a pair of relatively smaller arcuate channels **323***b* on opposite sides of channel portion **323***a*, for example. Additionally, contoured channel **323** may include a plurality of indentations **325** extending in a proximal-to-distal direction, for example. In various embodiments, indentations **325** may be circular shaped indentations, oval shaped indentations, hexagonal shaped indentations, parallelogram shaped indentions, and/or any combination thereof. A distal end of contoured channel **323** may include a stop feature **329** for preventing extendable blade **330** from extending too far in the proximal-to-distal direction.

(268) Extendable blade **330** may extend from a proximal end **330***p* to a distal end **330***d* in a proximal-to-distal direction (also referred to as a longitudinal direction). The distal end may include a tip portion **331** tapering towards a centerline of extendable blade **330** and terminating as a blunt chisel shaped end having a relatively smaller thickness than the remaining portion of extendable blade **330**, for example. In the example embodiment, an outside surface of extendable blade **330** may include an engagement feature **334** for connecting with contoured channel **323**, for example. Engagement feature **334** may include a proximal engagement rail **335** having a size and shape generally corresponding to a size and shape of contoured channel **323**. For example, proximal engagement rail **335** may have a size and shape generally corresponding to the relatively large central arcuate channel portion **323***a* and the pair of relatively smaller arcuate channels **323***b*,

for example. Additionally, engagement feature **334** may include a medial engagement rail **336** having a width approximately corresponding to the relatively large central arcuate channel portion **323***a* of modular blade **320**, for example. In various embodiments, an exposed surface of medial engagement rail **336** may be substantially planar although in other embodiments the exposed surface may be arcuately shaped to correspond and/or approximate the geometrical profile of contoured channel **323**, for example.

(269) In various embodiments, engagement feature **334** may include at least one protrusion **333** having a size and shape generally corresponding to a size and shape of indentation **325**. For example, protrusion **333** may selectively be seated within any one of indentations **325** to secure extendable blade **330** in any one position of the plurality of positions defined by indentations **325**. In various embodiments, protrusion **333** may be a circular shaped protrusion, oval shaped protrusion, hexagonal shaped protrusion, parallelogram shaped protrusion, and/or any combination thereof. In various embodiments, protrusion **333** may extend away from extendable blade **330** in a direction perpendicular to the proximal-to-distal direction a distance that is relatively farther out than medial engagement rail **336** and proximal rail **335**, for example. In some embodiments, protrusion **333** may be spring loaded and/or biased. In other embodiments, protrusion **333** may be a rigid non movable structure.

(270) In various embodiments, engagement feature **334** may include a distal engagement rail **337** having a size and shape generally corresponding to a size and shape of contoured channel **323**. For example, distal engagement rail **337** may have a size and shape generally corresponding to the relatively large central arcuate channel portion **323***a* and the pair of relatively smaller arcuate rails **323***b*, for example. Additionally, engagement feature **334** may include a stop feature **338** that may abut against stop feature **329** of modular blade **320** to prevent extendable blade **330** from disengaging with modular blade **320** as explained above, for example.

(271) With reference to FIG. **91**, the inside surface of modular blade **320** and the outside surface of extendable blade **330** is illustrated. In various embodiments, extendable blade **330** may operably couple to modular blade **320** by inserting engagement feature **334** into channel **323**. As explained above, extendable blade **330** may move forward and backward in a proximal-to-distal direction within contoured channel **323**. For example, extendable blade **330** may extend forward and backward within contoured channel **323** and protrusion **333** may be seated within any one of indentations **325**. For example, when modular blade **320** and extendable blade **330** are coupled together as a system, they may be referred to as a telescoping blade system.

(272) With reference to FIG. **92**, a top down view of modular blade **320** and extendable blade **330** is illustrated. In the example embodiment, it is shown that rails **324***a*, **324***b* and channel **319** define a cavity and/or channel for receiving extendable blade **330**. For example, extendable blade **330** has a width in a lateral direction that corresponds to a distance between rails **324***a*, **324***b* and a thickness of extendable blade **330** corresponds to a depth of the cavity and/or channel between and defined by rails **324***a* and **324***b*. In various embodiments, the outside lateral edge **3301** of extendable blade **330** may be mated within the receiving cavity **324***y* defined by rail **324***a* and an outside lateral rail **332** of extendable blade **330** may be mated within receiving cavity **324***z*, for example. In various embodiments, outside lateral rail **332** of extendable blade **330** may extend along the outside lateral edge of extendable blade **330** in the proximal-to-distal direction until about the tip portion **331**, for example. Additionally, channel **319** of extendable blade **330** may be mated within channel **319** of modular blade **320**. In this way, rails **324***a* and **324***b* may provide a bearing surface for retaining extendable blade **330** therein while also allowing extendable blade **330** to move forward and backward in the proximal-to-distal direction. Additionally, it is shown that engagement feature **334** has a size and shape corresponding to contoured channel **323**. For example, the curved surfaces of proximal engagement rail **335** may be inset within contoured channel **323** and frictionally engage and slide across the interior surfaces defined by the relatively large central arcuate channel portion **323***a* and/or pair of relatively smaller arcuate channels **323***b*

on opposite sides of channel portion **323***a*, for example.
(273) Referring generally to FIGS. **94-99** a modular blade **420** and an extendable blade **430** for coupling to modular blade **420** is disclosed. FIGS. **94** and **95** are various perspective views of a modular blade **420** and FIGS. **96** and **97** are various perspective views of an extendable blade **430** for coupling to modular blade **420**. FIG. **98** is a front view of modular blade **420** and extendable blade **430** side by side and FIG. **99** is a top down view of modular blade **420** and extendable blade **430**. In various embodiments, modular blade **420** and extendable blade **430** may be configured as a telescoping blade system.
(274) Modular blade **420** may extend from a proximal end **420***p* to a distal end **420***d* in a proximal-to-distal direction (may also be referred to as longitudinal direction). The proximal end **420***p* may include an engagement feature **426** having spring loaded tabs **427** for coupling to a blade engagement mechanism in the same, similar, and/or substantially the same way as explained above. The distal end **420***d* may include a tip portion **421**. In the example embodiment, tip portion **421** comprises a substantially planar outer surface that tapers towards a centerline of modular blade **420** and terminates as a blunt chisel shaped end having a relatively smaller thickness than the remaining portions of modular blade **420**, for example. As best seen in FIG. **95**, in some embodiments tip portion **421** may curve inward and/or arc inward in various embodiments, for example. Modular blade **420** may include a pair of rails **424***a* and **424***b* that extend from proximal end **420***p* towards distal end **420***d*. For example, a first rail **424***a* may extend along a first lateral side of blade **420** in the proximal-to-distal direction and a second rail **424***b*, opposite first rail **424***a*, may extend along a second lateral side of blade **420** in the proximal-to-distal direction. In various embodiments, modular blade **420** may be symmetrical on either side of a centerline extending in the proximal-to-distal direction, for example.
(275) In various embodiments, first rail **424***a* may define a first receiving cavity **424***y* and second rail **424***b* may define a second receiving cavity **424***z*, for example (see FIG. **99**). Additionally, modular blade **420** may include a first channel **419***a* and second channel **419***b* extending along the inside surface of modular blade **420** in the proximal-to-distal direction and/or from a proximal end to a distal end, for example. Channels **419***a*, **419***b* may have a size and shape generally corresponding to a size and shape of channels **439***a* and **439***b* of extendable blade **430**, for example. In various embodiments, rails **424***a*, **424***b*, and channels **419***a*, **419***b* may define a contoured receiving channel for receiving extendable blade **430**, as will be explained in further detail below.
(276) Modular blade **420** may include at least one aperture **422** extending through a top surface of blade **420** at the proximal end **420***p* and penetrating through the inside surface of blade **420** at oval shaped opening **422***a*, for example. Apertures **422** may have the same, similar, and/or substantially the same features and functionality of aperture **122**. Accordingly, duplicative description will be omitted. Modular blade **420** may include a contoured channel **423** for connecting with extendable blade **430** and facilitating the forward and backward relative motion of extendable blade **430** in the proximal-to-distal direction, for example. Contoured channel may include a relatively large central arcuate channel portion **423***a* having a pair of relatively smaller arcuate channels **423***b* on opposite sides of channel portion **423***a*, for example. Additionally, contoured channel **423** may include a plurality of indentations **425** extending in a proximal-to-distal direction, for example. In various embodiments, indentations **425** may be circular shaped indentations, oval shaped indentations, hexagonal shaped indentations, parallelogram shaped indentions, and/or any combination thereof. A distal end of contoured channel **423** may include a stop feature **429** for preventing extendable blade **430** from extending too far in the proximal-to-distal direction.
(277) Extendable blade **430** may extend from a proximal end **430***p* to a distal end **430***d* in a proximal-to-distal direction (also referred to as a longitudinal direction). The distal end may include a tip portion **431** and extendable blade **430** may be generally shaped like a rectangle (in a plan view). In the example embodiment, an outside surface of extendable blade **430** may include an engagement feature **434** for connecting with contoured channel **423**, for example. Engagement

feature **434** may include a proximal engagement rail **435** having a size and shape generally corresponding to a size and shape of contoured channel **423**. For example, proximal engagement rail **435** may have a size and shape generally corresponding to the relatively large central arcuate channel portion **423***a* and the pair of relatively smaller arcuate channels **423***b*, for example. Additionally, engagement feature **434** may include a medial engagement rail **436** having a width approximately corresponding to the relatively large central arcuate channel portion **423***a* of modular blade **420**, for example. In various embodiments, an exposed surface of medial engagement rail **436** may be substantially planar although in other embodiments the exposed surface may be arcuately shaped to correspond and/or approximate the geometrical profile of contoured channel **423**, for example.

(278) In various embodiments, engagement feature **434** may include at least one protrusion **433** having a size and shape generally corresponding to a size and shape of indentation **425**. For example, protrusion **433** may selectively be seated within any one of indentations **425** to secure extendable blade **430** in any one position of the plurality of positions defined by indentations **425**. In various embodiments, protrusion **433** may be a circular shaped protrusion, oval shaped protrusion, hexagonal shaped protrusion, parallelogram shaped protrusion, and/or any combination thereof. In various embodiments, protrusion **433** may extend away from extendable blade **430** in a direction perpendicular to the proximal-to-distal direction a distance that is relatively farther out than medial engagement rail **436** and proximal engagement rail **435**, for example. In some embodiments, protrusion **433** may be spring loaded and/or biased. In other embodiments, protrusion **433** may be a rigid non movable structure.

(279) In various embodiments, engagement feature **434** may include a distal engagement rail **437** having a size and shape generally corresponding to a size and shape of contoured channel **423**. For example, distal engagement rail **437** may have a size and shape generally corresponding to the relatively large central arcuate channel portion **423***a* and the pair of relatively smaller arcuate channels **423***b*, for example. Additionally, engagement feature **434** may include a stop feature **438** that may abut against stop feature **429** of modular blade **420** to prevent extendable blade **430** from disengaging with modular blade **420** as explained above, for example.

(280) With reference to FIG. **98**, the inside surface of modular blade **420** and the outside surface of extendable blade **430** is illustrated. In various embodiments, extendable blade **430** may operably couple to modular blade **420** by inserting engagement feature **434** into channel **423**. As explained above, extendable blade **430** may move forward and backward in a proximal-to-distal direction within contoured channel **423**. For example, extendable blade **430** may extend forward and backward within contoured channel **423** and protrusion **433** may be seated within any one of indentations **425**.

(281) With reference to FIG. **99**, a top down view of modular blade **420** and extendable blade **430** is illustrated. In the example embodiment, it is shown that rails **424***a*, **424***b* and channels **419***a*, **419***b* define a cavity and/or channel for receiving extendable blade **430**. For example, extendable blade **430** has a width in a lateral direction that corresponds to a distance between rails **424***a*, **424***b* and a thickness of extendable blade **430** corresponds to a depth of the cavity and/or channel between and defined by rails **424***a* and **424***b*. In various embodiments, the outside lateral rail **432***a* of extendable blade **430** may be mated within the receiving cavity **424***y* defined by rail **424***a* and an outside lateral rail **432***b* of extendable blade **430** may be mated within receiving cavity **424***z*, for example. In various embodiments, outside lateral rail **432***a*, **432***b* of extendable blade **430** may extend along the outside lateral edge of extendable blade **430** in the proximal-to-distal direction until about the tip portion **431**, for example. Additionally, channels **439***a*, **439***b* of extendable blade **430** may be mated within channels **419***a*, **419***b* of modular blade **420**. In this way, rails **424***a* and **424***b* may provide a bearing surface for retaining extendable blade **430** therein while also allowing extendable blade **430** to move forward and backward in the proximal-to-distal direction. Additionally, it is shown that engagement feature **434** has a size and shape corresponding to

contoured channel **423**. For example, the curved surfaces of proximal engagement rail **435** may be inset within contoured channel **423** and frictionally engage and slide across the interior surfaces defined by the relatively large central arcuate channel portion **423***a* and/or pair of relatively smaller arcuate channels **423***b* on opposite sides of channel portion **423***a*, for example.

(282) Referring generally to FIGS. **100-105** a modular blade **440** and various extendable blades **450***a*, **450***b*, and **450***c* for coupling to modular blade **440** is disclosed. FIGS. **100-101** are various perspective views of a modular blade **440** and FIGS. **102-104** are various perspective views of extendable blades **450***a*, **450***b*, and **450***c* for coupling to modular blade **440**. FIG. **105** is a front view of extendable blades **450***a*, **450***b*, and **450***c*. In various embodiments, modular blade **440** and extendable blades **450***a*, **450***b*, and **450***c* may be configured as a telescoping blade system. In various embodiments, the extendable blades **450***a*, **450***b*, and **450***c* may have a relatively long and narrow tip section that may be advantageous for distracting soft tissues of a patient, for example.

(283) Modular blade **440** may extend from a proximal end **440***p* to a distal end **440***d* in a proximal-to-distal direction (may also be referred to as longitudinal direction). The proximal end **440***p* may include an engagement feature **446** having spring loaded tabs **447** for coupling to a blade engagement mechanism in the same, similar, and/or substantially the same way as explained above. The distal end **440***d* may include a tip portion **441**. In the example embodiment, tip portion **441** comprises a substantially planar outer surface that tapers towards a centerline of modular blade **440** and terminates as a blunt chisel shaped end having a relatively smaller thickness than the remaining portions of modular blade **440**, for example. Modular blade **440** may include a pair of rails **444** that extend from proximal end **440***p* towards distal end **440***d*. For example, a first rail **444** may extend along a first side of blade **440** in the proximal-to-distal direction and a second rail **444**, opposite the first rail **444**, may extend along a second side of blade **440** in the proximal-to-distal direction. In various embodiments, rails **444** may define a receiving channel for receiving any one of extendable blades **450***a*, **450***b*, and **450***c*, for example.

(284) Modular blade **440** may include a contoured channel **443** for connecting with extendable blades **450***a*, **450***b*, and **450***c* and facilitating the forward and backward relative motion of extendable blades **450***a*, **450***b*, and **450***c* in the proximal-to-distal direction, for example. As shown best in FIG. **83**, contoured channel **443** may include a relatively large central arcuate channel portion **443***a* having a pair of relatively smaller arcuate channels **443***b* on opposite sides of channel portion **443***a*, for example. Additionally, contoured channel **443** may include a plurality of indentations **445** extending in a proximal-to-distal direction, for example. In various embodiments, indentations **445** may be circular shaped indentations, oval shaped indentations, hexagonal shaped indentations, parallelogram shaped indentions, and/or any combination thereof. A distal end of contoured channel **443** may include a stop feature **449** for preventing extendable blades **450***a*, **450***b*, and **450***c* from extending too far in the proximal-to-distal direction.

(285) Extendable blades **450***a*, **450***b*, and **450***c* may extend from a proximal end **450***p* to a distal end **450***d* in a proximal-to-distal direction (also referred to as a longitudinal direction). The distal end may include a relatively long tip portion **451** that tapers near a medial portion of extendable blades **450***a*, **450***b*, and **450***c* and then extends towards distal end **450***d* at the same, similar, and/or substantially the same width. Relatively long tip portion **451** may terminate as an arcuate curved end with chamfered surfaces, for example. As seen best in FIG. **105**, extendable blades **450***a*, **450***b*, and **450***c* are similar and have differently sized tip portions **451**. For example, extendable blade **450***a* has a relatively wider tip portion **451** than extendable blades **450***b* and **450***c*, for example. Extendable blade **450***b* has a relatively narrower tip portion **451** than extendable blade **450***a* and a relatively wider tip portion **451** than extendable blade **450***c*, for example. Extendable blade **450***c* has a relatively narrow tip portion **451** than extendable blades **450***a* and **450***b*, for example. The other remaining features and components may be the same, substantially the same, and or similar.

(286) In the example embodiment, an outside surface of extendable blades **450***a*, **450***b*, and **450***c* may include an engagement feature **454** for connecting with contoured channel **443**, for example.

Engagement feature **454** may include a proximal engagement rail **455** having a size and shape generally corresponding to a size and shape of contoured channel **443**. For example, proximal engagement rail **455** may have a size and shape generally corresponding to the relatively large central arcuate channel portion **443***a* and the pair of relatively smaller arcuate channels **443***b*, for example. Additionally, engagement feature **454** may include a medial engagement rail **456** having a width approximately corresponding to the relatively large central arcuate channel portion **443***a* of modular blade **440**, for example. In various embodiments, an exposed surface of medial engagement rail **456** may be substantially planar although in other embodiments the exposed surface may be arcuately shaped to correspond and/or approximate the geometrical profile of contoured channel **443**, for example.

(287) In various embodiments, engagement feature **454** may include at least one protrusion **453** having a size and shape generally corresponding to a size and shape of indentation **445**. For example, protrusion **453** may selectively be seated within any one of indentations **445** to secure extendable blades **450***a*, **450***b*, and **450***c* in any one position of the plurality of positions defined by indentations **445**. In various embodiments, protrusion **453** may be a circular shaped protrusion, oval shaped protrusion, hexagonal shaped protrusion, parallelogram shaped protrusion, and/or any combination thereof. In various embodiments, protrusion **453** may extend away from extendable blades **450***a*, **450***b*, and **450***c* in a direction perpendicular to the proximal-to-distal direction a distance that is relatively farther out than medial engagement rail **456** and/or proximal engagement rail **455**, for example. In some embodiments, protrusion **453** may be spring loaded and/or biased. In other embodiments, protrusion **453** may be a rigid non movable structure.

(288) In various embodiments, engagement feature **454** may include a distal engagement rail **457** having a size and shape generally corresponding to a size and shape of contoured channel **443**. For example, distal engagement rail **457** may have a size and shape generally corresponding to the relatively large central arcuate channel portion **443***a* and the pair of relatively smaller arcuate channels **443***b*, for example. Additionally, engagement feature **454** may include a stop feature **458** that may abut against stop feature **449** of modular blade **440** to prevent extendable blades **450***a*, **450***b*, and **450***c* from disengaging with modular blade **440**, for example. For example, in a fully extended position, stop feature **449** of extendable blade may directly contact stop feature **458** of extendable blades **450***a*, **450***b*, and **450***c* and prevent extendable blades **450***a*, **450***b*, and **450***c* from extending too far that engagement feature **454** becomes unseated from contoured channel **443**.

(289) In various embodiments, extendable blades **450***a*, **450***b*, and **450***c* may operably couple to modular blade **440** by inserting engagement feature **454** into channel **443**. As explained above, extendable blades **450***a*, **450***b*, and **450***c* may move forward and backward in a proximal-to-distal direction within contoured channel **443**. For example, extendable blades **450***a*, **450***b*, and **450***c* may extend forward and backward within contoured channel **443** and protrusion **453** may be seated within any one of indentations **445**. For example, when modular blade **440** and any one of extendable blades **450***a*, **450***b*, and **450***c* are coupled together as a system, they may be referred to as a telescoping blade system and such system may be particularly advantageous for distracting and retracting various soft patient tissue, for example.

(290) In the example embodiment, rails **444** may define a cavity and/or channel for receiving any one of extendable blades **450***a*, **450***b*, and **450***c*. For example, extendable blades **450***a*, **450***b*, and **450***c* may have a width in a lateral direction that corresponds to a distance between rails **444** and a thickness of each extendable blades **450***a*, **450***b*, and **450***c* may correspond to a depth of the cavity and/or channel between and defined by rails **444**, for example. In various embodiments, any one corresponding pair of outside lateral edges of extendable blades **450***a*, **450***b*, and **450***c* may be inset within the receiving cavity defined by rails **444** such that a pair of lateral edges frictionally engages and slides across the interior side surfaces of modular blade **440**, for example. In this way, rails **444** may provide a bearing surface for retaining any one of extendable blades **450***a*, **450***b*, and **450***c* therein while also allowing any inserted blade to move forward and backward in the proximal-to-

distal direction. Additionally, in various embodiments engagement feature **454** has a size and shape corresponding to contoured channel **443**. For example, the curved surfaces of proximal engagement rail **455** may be inset within (mated within) contoured channel **443** and frictionally engage and slide across the interior surfaces defined by the relatively large central arcuate channel portion **443***a* and/or pair of relatively smaller arcuate channels **443***b* on opposite sides of channel portion **443***a*, for example.

Additional Retractor Embodiments

(291) Referring generally to FIGS. **106-108**D a modular blade **140** and an extendable blade **150** having a pointed end **151** is disclosed. In some embodiments, extendable blade **150** may be referring to as an "impact blade" on account of being configured with a pointed end **151** that may be driven into a disc space, for example. FIG. **106** is a front view of the modular blade **140** and extendable blade **150** slidably coupled together and FIG. **107** is a rear view of the modular blade **140** and extendable blade **150** slidably coupled together. FIGS. **108**A and **108**B are various exploded parts views of the modular blade **140** and extendable blade **150**. FIG. **108**C is a perspective view of the modular blade **140** and FIG. **108**D is a top down view of the modular blade **140**.

(292) In the example embodiment, modular blade **140** may include an engagement feature **146** having similar functional attributes to blade engagement feature **126** explained above with respect to blade **120**. However, in this embodiment, the engagement feature **146** of modular blade **140** does not include spring loaded tabs **127**, for example. Rather, as best seen in FIGS. **108**B, **108**C, and **108**D, engagement feature **146** comprises a raised rail **146**B having an arcuately shaped and/or curved shaped uppermost surface **146**A, for example. The raised rail portion **146**B may be offset from the outside surface of modular blade **140** by platform **146**D. In the example embodiment, a thickness or dimension of platform **146**D in a lateral direction is less than a thickness or dimension of raised rail **146**B in the lateral direction. In the example embodiment, channel portions **146**C are formed on opposite sides of platform **146**D and are located between the outside surface of modular blade **140** and the adjacent inside surface of raised rail **146**B, for example. In this way, engagement feature **146** may be configured to slidably connect to a corresponding blade coupling portion of an arm of the variously disclosed blade coupling portions having corresponding male/female features. In at least one embodiment, modular blade **140** may be securely coupled to blade coupling portion **535** shown in FIGS. **119-121**B by sliding the modular blade **140** from beneath blade coupling portion **535** upwards into blade coupling portion **535**. For example, modular blade **140** may be configured for bottom loading as will be explained in further detail below. Additionally, any blade disclosed herein may be configured with the same, similar, or substantially the same type of engagement feature **146**. However, consistent with the disclosure herein, modular blade and engagement feature **146** may also be reversed for top loading.

(293) As seen best in FIGS. **108**B, **108**C, and **108**D, modular blade **140** may comprise a pair of channels **143** extending along the interior surface thereof from a proximal end **140**P to a distal end **140**D. In various embodiments, the interior surface of modular blade **140** may be a curved surface **148**. Additionally, the extendable blade **150** may comprise a pair of outdented rail portions **153** extending along the side surfaces thereof from a proximal end **150**P to a distal end **150**D thereof. In the example embodiment, the blade surface of extendable blade **150** has a curved sidewall surface **158** having a size and shape generally corresponding to the interior curved surface **148** of modular blade **140**, for example. In use, the extendable blade **150** may be configured to couple to the modular blade **140** by sliding the outdented rails **153** into the interior channels **143** of modular blade **140**, for example. In this way, extendable blade **150** may be configured to slidably couple to modular blade **140** in an operable way, for example. However, it shall be understood that other embodiments may rely on a single rail **153** and a single channel **143** and that channels **143** and rails **153** may take various shapes, for example oblong, square, trapezoidal, dovetail, tongue and groove, etc.

(294) FIG. **108**E is a perspective view of a driver **149** for use with the modular blade **140** and extendable blade **150**, for example. In some embodiments, driver **149** may be a referred to as an impact driver on account of being suitable for sustaining an impact force to drive extendable blade **150** forward, for example. In the example embodiment, driver **149** may extend in a longitudinal direction from a proximal end to a distal end. For example, driver **149** may include a proximal end comprising a striking end or surface **149**A having a relatively flat or smooth top surface and a circumferential side surface **149**B having various texturing. In the example embodiment, the texturing of side surface **149**B extends in a proximal to distal direction along the outside side surface of the proximal end of driver **149** as raised rails and indented valleys therebetween. The texturing may assist a surgeon in rotating driver **149** within channel **143** and in some embodiments, rotating driver **149** may be used to rotate a threaded pin (not illustrated). In some embodiments, the contouring and/or texturing may correspond to a torx head or a similar driver end, for example. In various embodiments, a shaft **149**C may couple to or be integrally formed together with the proximal end and distal end, for example. In the example embodiment, shaft **149**C may have a diameter substantially corresponding in size and shape to a diameter of channel **143**, for example. Additionally, a distal end of shaft **149**C may comprise a blunt distal end **149**D. In operation, the blunt end **149**D may contact the proximal end of extendable blade **150** for pushing extendable blade **150** forward. Additionally, a first and second driver **149** may be used together to push extendable blade **150** forward within both of channels **143**, for example.
(295) FIG. **109** is a perspective view of a rectangular shaped dilator **160**. In the example embodiment, dilator **160** extends in a longitudinal direction from a proximal end **160**P to a distal end **160**D. The proximal end **160**P may include a pair of opposing curvilinear indents **165** for gripping dilator **160**, for example. In various embodiments, dilator **160** may comprise an aperture **163** or opening extending from proximal end **160**P to distal end **160**D through dilator **160**, for example. In various embodiments, dilator **160** may have planar side surfaces **161** extending in a proximal-to-distal direction. In the example embodiment, dilator **160** may further include a chiseled end or inclined end defining the distal end **160**D surfaces. For example, planar side surfaces **161** may terminate into inclined surfaces **162** which may facilitate insertion of dilator **160** into an operative corridor for example. In the example embodiment, dilator **160** is rectangular shaped and in other embodiments dilator **160** may be square shaped. Dilator **160** may be used with any type of blade disclosed herein. Dilator **160** may be particularly advantageous for use with a relatively flat planar blade such as blade **130** shown in FIG. **84** and/or the footed tip blades disclosed below. At least one surgical configuration may comprise the utilization of a four-blade configuration comprising four substantially planar blades that generally surround the rectangular shaped dilator **160**, for example.
(296) Referring generally to FIGS. **110-114** various example shims **170**, **180** are disclosed. FIG. **110** is a bottom perspective view of a pair of shims **170** for coupling to various blades disclosed herein. FIG. **111** is a perspective view of a relatively short shim **170** having a pointed pin **173** at a distal end thereof and FIG. **112** is a perspective view of a relatively tall shim **170** having a pointed pin **173** at a distal end thereof. FIG. **113** is a perspective view of a relatively tall shim **170** having a blunted distal end. FIG. **114** is a perspective view of a double-sided shim **180** for coupling to various blades disclosed herein. In the example embodiments, shim **170** may extend in a longitudinal direction from a proximal end **170**P to a distal end **170**D. The proximal end may include a tab **172** for gripping shim **170** and pushing shim **170** downward or pulling shim **170** upward, for example. As seen best in FIG. **110**, shim **170** may comprise an arcuate rail **171** having a size and shape generally corresponding to a channel of a blade, for example channel **143** of modular blade **140**. Additionally, in various embodiments, tab **172** may comprise a relatively smooth planar upper surface that is strong enough to sustain an impact for driving or tapping of shim **170**. For example, a surgeon may provide an impact force to tab **172** by a mallet or hammer which drives shim **170** forward while remaining partially constrained within a corresponding

channel of a blade. In striking tab **172**, the shim **170** may be thrust forward or in a distal direction thereby inserting pin **173** into patient anatomy such as a bone or disc space, for example. Each shim **170** may have various dimensioned side surfaces for abutting against patient tissue. As seen in FIG. **111**, some shim **170** embodiments may include a working surface **175** extending for a relatively short distance in the longitudinal direction and for a relatively great distance in a lateral direction substantially perpendicular to the longitudinal direction of shim **170**, for example. As seen in the example embodiment of FIG. **112**, some shim **170** embodiments may include a working surface **176** extending for a relatively long distance in a longitudinal direction and for a relatively short distance in a lateral direction substantially perpendicular to the longitudinal direction of shim **170**, for example. In the example embodiment of FIG. **112**, working surface **176** extends in the longitudinal direction for slightly less than half the length of the shim **170** in the longitudinal direction. As seen in the example embodiment of FIG. **113**, some shim **170** embodiments may include a working surface **177** extending for a relatively long distance in a longitudinal direction and for a relatively short distance in a lateral direction substantially perpendicular to the longitudinal direction of shim **170**, for example. In the example embodiment of FIG. **113**, working surface **177** extends in the longitudinal direction for more than half the length of the shim **170** in the longitudinal direction.

(297) FIG. **114** is an example embodiment of a double-sided shim **180**. In this embodiment, shim **180** includes a pair of tabs **182**, and a pair of rails **181**. In this way, shim **180** may slidably couple to a pair of corresponding channels of a blade, for example channels **143** of modular blade **140**. In the example embodiment of FIG. **114**, shim **180** comprises a first working surface **184** extending away from shim **180** in a first lateral direction perpendicular to the longitudinal direction and a second working surface **185** extending away from shim **180** in a second lateral direction perpendicular to the longitudinal direction. In this embodiment, working surfaces **184**, **185** are disposed on opposite sides of a centerline **189** of shim **180**.

(298) Referring generally to FIGS. **115**A-**116**B a blade adjustment and positioning tool **250** is disclosed. FIG. **115**A is a perspective view of a blade adjustment and positioning tool **250** and FIG. **115**B is an exploded parts view of the blade adjustment and positioning tool **250**. FIG. **116**A is an outside surface perspective view of the blade adjustment and positioning tool engaged with a modular blade and an extendable blade and FIG. **116**B is an inside surface perspective view of the blade adjustment and positioning tool engaged with a modular blade and an extendable blade, for example. In the example embodiment, tool **250** may extend in a longitudinal direction from a proximal end **250**P to a longitudinal end **250**D, for example. In the example embodiment, the proximal end may be defined by a rotatable turnkey **251** and the distal end may be defined by a tab **256**.

(299) In the example embodiment, the first portion **250**A may comprise a gripping portion **255** having a plurality of gripping indentations extending along a length thereof, for example. Additionally, the gripping portion may include a centrally disposed shaft extending therethrough in the longitudinal direction between proximal aperture **257**A and medial aperture **257**B, for example. Additionally, the second portion may include a matting rail **258** having a size and shape that corresponds to a size and shape of a channel of modular blade **120**, for example channel **123** shown in FIG. **83**. However, it shall be understood that reference to channel **123** is by example only, and that matting rail **258** and the corresponding channel of modular blade **120** does not necessarily need indentations **125** and arcuate channel portions **123**B, for example. In various embodiments, the distal end of first portion **250**A may be defined by tab **256**. In the example embodiment, tab **256** is offset laterally from an extension axis extending through proximal aperture **257**A and medial aperture **257**B, for example.

(300) Second portion **250**B may include a turnkey **251** and/or a knob at a proximal end thereof. Turnkey **251** may be coupled to or monolithically formed with primary shaft **252** and extension shaft **253**. In various embodiments, extension shaft **243** may comprise a drive feature or driving

head **254** at a distal end thereof. In operation, second portion **250**B may be insert inside of first portion **250**A by inserting the driving head **254**, extension shaft **253**, and primary shaft **252** through proximal aperture **257**A. Due to the particular design of this embodiment, the primary shaft **252** may be rotatably disposed within the central shaft of the first portion and primary shaft **252** may have a size and shape generally corresponding to a size and shape of the central shaft of the first portion, e.g., substantially the same diameter and a length substantially the same as a distance between proximal aperture **257**A and medial aperture **257**B. Extension shaft **253** may be partially mated to and/or disposed within an open channel **258**C of matting rail **258** such that it may freely rotate and so can driving end **254**.

(301) With reference to FIGS. **116**A and **116**B, tool **250** may couple to a modular blade **120** by inserting matting rail **258** with channel **123**. Additionally, as seen best in FIG. **116**B, due to the offset nature of tab **256** an inside surface of tab **256** may be directly adjacent to and/or directly contact an inside surface of extendable blade **130**. In this way, tool **250** may provide a fulcrum or handle to manipulate the modular blade **120** and extendable blade **130**. At least one particularly advantageous use of tool **250** may be when modular blade **120** and extendable blade **130** are coupled to a free hand module, as explained above, which may not have actuators to cause pivoting and/or angulation, e.g., free hand module **900** as shown in FIG. **49**B. Additionally, in some embodiments, an end user may initially mate first portion **250**A to modular blade **120** and extendable blade **130**, then insert second portion into first portion, and slide second portion forward in a distal direction such that it pushes extendable blade **130** forward. In some embodiments, a chiseled end of second portion, e.g., drive feature **254**, may unseat a protrusion of extendable blade **130** from a corresponding indentation of modular blade **120**, e.g., protrusion **133** and indentations **125** (see FIGS. **83-84**). In this way, an end user may utilize tool **250** to extend a position of extendable blade **130** via second portion **250**B and may use tool **250** as a fulcrum or handle for applying a mechanical advantage as a fulcrum to modular blade **250** and extendable blade **230**, for example. Additionally, in at least some embodiments, because drive end **254** may be rotatable, it may facilitate the unseating of the protrusion of the extendable blade **130** from the corresponding indentation of modular blade **120**.

(302) Referring generally to FIGS. **117**A-**118**E, various views of a modular blade **260** and an extendable blade **262** having a footed tip **263**, a quick connect handle **270**, and a retractor mount coupler **280** are disclosed. FIG. **117**A is a perspective view of the inside surfaces of the modular blade **260** and extendable blade **262** and FIG. **117**B is a perspective view of the outside surfaces of the modular blade **260** and extendable blade **262**. In the example embodiment, the extendable blade **262** has a footed tip **263** and is slidably coupled to the modular blade **260** similarly as explained above. Accordingly, duplicative description is omitted or only briefly described again. In this embodiment, modular blade **260** comprises an attachment rail **264** on the outside surface thereof adjacent the proximal end. Attachment rail **264** may include various surface texturing on the outside surface thereof, e.g., rail like peaks and channel like valleys therebetween extending in a proximal to distal direction around the outside curved surface of attachment rail **264**. In at least some embodiments, attachment rail **264** is integrally formed with modular blade **260** and in others it may be removably coupled thereto. In various embodiments, attachment rail **264** may include attachment shaft **265** extending from the proximal end of modular blade **260**, for example. The proximal most portion of attachment shaft **265** may comprise a generally cylindrical extension shaft having a planar indent **267**, a necked down portion **268**, and an end **266** that is wider than the necked down portion **268**, for example. In various embodiments, the attachment shaft **265** may quickly couple to and uncouple from a quick connect handle **270**, for example.

(303) FIG. **118**A is a perspective view of a quick connect handle **270** and FIG. **118**B is an exploded parts view of the quick connect handle **270**. In the example embodiment, quick connect handle **270** extends in a longitudinal direction from a proximal end **270**P to a distal end **270**D. The distal end **270**D may comprise a coupling aperture **269** for connecting to an attachment shaft **265** of a

modular blade **260** when attachment shaft **265** is inserted therein, for example. Quick connect handle **270** may include a main body portion **275** or handle and the distal end **270**D may comprise a coupling mechanism having various mating features comprising a size and shape generally corresponding to a size and shape attachment shaft **265**, for example. In the example embodiment, the pin **272** and mating features **274** are actuated by actuator **271**. Quick connect handle **270** may couple to modular blade **260** by depressing actuator **271** and sliding attachment shaft **265** into aperture **269** such that sliding barrel **276** lockingly engages attachment shaft **265**, for example. In various embodiments, barrel **276** may be biased towards the proximal end **270**D by set pins **279** and springs **278**. In various embodiments, upon activation of actuator **271**, e.g., by depressing actuator **271** button, barrel **276** may linearly translate forward to securely couple to modular blade **260**.

(304) FIG. **118**C is a perspective view of a retractor mount coupler **280**. Retractor mount coupler **280** may have many of the same, similar, and/or substantially the same components and functionality as free hand module **900** of FIGS. **47**B and **48**A, for example. Accordingly, duplicative description will be omitted and/or only briefly described. In this embodiment, retractor mount coupler **280** may include a pair of gripping arms **916** for gripping on to the outside textured surface of rail **264**, for example. Additionally, retractor mount coupler **280** may include a lever **911** and a body **913** having an aperture **913**A. Lever **911** may function in the same or substantially the same way as previously explained with respect to free hand module **900**. As seen best in FIG. **129**, retractor mount coupler **280** may couple and couple to a rod, pole, table mount extension, and/or lateral arm **1201** of a secondary module **1200**, for example. FIG. **118**D is a perspective view of the modular blade **260** and extendable blade **262** of FIGS. **117**A-**117**B coupled to the quick connect handle **270** of FIGS. **118**A-**118**B and the retractor mount coupler **280** of FIG. **118**C. FIG. **118**E is a perspective view showing the quick connect handle **270** uncoupled from the attachment shaft **265** of modular blade

(305) Referring generally to FIGS. **119-122** an additional embodiment of a modular retractor **530** is disclosed. Modular retractor **530** may have the same, similar, and or substantially the same components and functionality as explained above with respect to modular retractor **500** and modular retractor **530** may be used with any of the various add on retractor modules **600**, **700**, **800**, **900**, **1000**, and **1100** that are disclosed herein and shown in the various views of FIGS. **20-81**, for example. Accordingly, significant duplicative description will be omitted although some aspects will be repeated for ease of explanation. FIGS. **119** and **120** are various perspective views of modular retractor **530**. FIG. **121**A is a top down view of modular retractor **530** and FIG. **121**B is a bottom perspective view of a blade attachment mechanism **535**. FIG. **122**A is an enlarged view of the embodiment of FIGS. **119-121** with the top cover removed for ease of understanding of the internal gear system. FIG. **122**B is an enlarged view of the embodiment of FIGS. **119-121** from a bottom perspective showing various structural features of a table mount quick release coupler **533**.

(306) In the example embodiment, modular retractor **530** may include handles **501***a*, **501***b* and arms **505** and **507**. The handles and/or actuator **502** may serve to open the retractor **530** by spreading the arms **505**, **507** apart from one another as explained previously. Modular retractor **530** may differ from retractor **500** in a few ways. For example, the blade attachment mechanism **535** may be configured for bottom loading rather than top loading, the blade release actuator **537** may be disposed on a side surface of blade attachment mechanism **535** rather than a top surface, a release mechanism **531** may be relied upon rather than pawl **504**, and a table mount quick release connection **533** may be provided rather than table mount arm **506**, for example.

(307) As seen best in FIGS. **120** and **121**B, blade attachment mechanism **535** may be configured for bottom loading of various blade engagement features, for example blade engagement feature **146** shown in FIGS. **108**B, **108**C, and **108**D. Generally, blade attachment mechanism **535** may have a size and shape generally corresponding to a size and shape of a corresponding blade engagement feature **146**. In the example embodiment, blade attachment mechanism **535** includes a channel

535B that is open to the bottom and closed at the top by a curved top surface **535**A, for example. The curved top surface may have a curvature generally corresponding to a curvature of the curved uppermost surface **146**A and the channel **535**B may have a width, length, and height generally corresponding to a width, length, and height of raised rail portion **146**B, for example. In some embodiments, the curved top surface **535**A may be referred to as a stop surface and/or stopping wall. In various embodiments, channel **535**B may be flanked by supports **535**C, for example. In use, when blade engagement feature **146** is securely coupled to blade attachment mechanism **535** the side surfaces of platform **146**D may contact the side surfaces **535**D of supports **535**C such that the channel portions **146**C are mated with supports **535**C, for example. Additionally, in various embodiments the side surfaces **535**D may be chamfered and/or inclined, for example as seen best in FIG. **121**B. This arrangement may facilitate insertion of a blade thereon, for example. Furthermore, in various embodiments an outside surface of a corresponding blade and/or platform **146**D may contact the outermost surface of supports **535**C. Further still, blade release mechanism **537** may securely couple and uncouple a blade to blade attachment mechanism **535** when actuated.

(308) As seen best in FIG. **122**A, modular retractor **530** may include a distraction mechanism **50**. In this embodiment, spur gear **54** includes a plurality of teeth on a side surface thereof but may not include a plurality of teeth on a top surface thereof like the example modular retractor **500** embodiment. Additionally, a release mechanism **531** may include a tooth **531**A or tip at an end thereof having a size and shape generally corresponding to a valley between adjacent teeth of spur gear **54**. Release mechanism **531** may be biased by a spring tab or leaf spring **531**B which naturally urges tooth **531**A into a meshed arrangement with the teeth of spur gear **54** such that the spur gear **54** is prevented from rotating in a direction which would cause the arms of modular retractor **530** to collapse or close. Additionally, because release mechanism **531** may pivot in and out of a meshed arrangement with spur gear **54** an end user may cause expansion or distraction between arms **505**, **507** of modular retractor **530** without needing to actuate release mechanism **531**. In this way, release mechanism **531** functions similarly to a pawl preventing the collapse of arms **505**, **507** while simultaneously allowing, for example, an uninhibited expansion of arms **505**, **507**.

(309) As also seen best in FIGS. **122**A and **122**B, modular retractor **530** may include a quick connect table mount **533**. Quick connect table mount **533** may include an aperture **533**Z and a tightening knob **534**. Aperture **533**Z may have a size and shape corresponding to a square or polygonal driver, for example a drive end of a wrench such as the egg wrench **10** illustrated in FIG. **23**. As seen best in FIG. **121**A, quick connect table mount **533** may be generally disposed in a central position of the main retractor body and when viewed in a plan view may be aligned along a longitudinal axis bisecting the retractor body. This arrangement may facilitate a symmetrical load distribution, for example. However, it shall be understood that quick connect table mount **533** may be alternately disposed, for example on a side surface on the left side, medial or central area, and/or right side of the retractor body (with respect to plan view of FIG. **121**A). Additionally, a plurality of quick connect table mounts **533** may be disposed in any viable region of modular retractor **530** and the various add on modules disclosed herein. As seen best in FIG. **122**B, quick connect table mount **533** may be configured to receive a corresponding post **363** and/or rail **362** of a quick connect arm **360** (see FIGS. **124-125**). In the example embodiment, quick connect table mount **533** may include a centrally disposed mating aperture **533**C accessible from a bottom side of modular retractor **530**, for example. In some embodiments, mating aperture **533**C is coaxially aligned with aperture **533**Z although this is not a requirement. In various embodiments, mating aperture **533**C may include a circumferential ring surface having a relatively greater diameter than the central portion of aperture **533**C to facilitate seating of post **363** (see FIGS. **124-125**) in an arrangement similar to concentric circles of varying depths. Additionally, various counter torque mating features may be disposed around and/or surround aperture **533**C, for example. In the example embodiment, a first groove **533**A extends in a direction that is substantially parallel with the longitudinal axis of modular retractor **530** and a second groove **533**B extends in a direction that is substantially perpendicular

with the longitudinal axis of modular retractor **530**, e.g. second groove **533**B extends in a lateral direction with respect to modular retractor **530**. In the example embodiment, the first and second grooves **533**A, **533**B may resemble a cross shape and/or an X shape. Additionally, the ends of grooves **533**A, **533**B may be open or closed, for example one side of groove **533**B is closed and has an arcuate end surface which ensures proper alignment quick connect arm **360**, for example. In various embodiments, the rail **363** of quick connect arm **360** may nest within at least one of grooves **533**A, **533**B. Accordingly, in this embodiment an orientation of quick connect arm **360** is adjustable between a direct head on orientation type and a side or lateral orientation type, for example. At least one advantage of this configuration may be providing flexibility in orientation to a surgeon depending on different types of procedures being performed and or changes in orientation mid-procedure.

(310) FIG. **123** is a perspective view of a table mount system **340** adapted for use with various retractor components disclosed herein. For example, various armatures of a quick connect table mount system may be used for supporting and manipulating various retractor embodiments disclosed herein. In the example embodiment, table mount system **340** may include a first armature **340**A and a second armature **340**B. The first armature **340**A may be slidably connected to the second armature **340**B by armature connection mechanism **345**. In at least one embodiment, second armature **340**B may include a table mount channel **349** and a table mount clamp **350**. In use the second armature **340**B may be rigidly and removably secured to an operating table by tightening clamp **350** such that table mount channel **349** is tightened to the table and arm **348** extends in a vertical direction with respect to a horizontal surface or plane of a table (not illustrated). Thereafter, the first armature **340**A may be coupled to arm **348** by positioning arm **348** within the aperture of armature connection mechanism **345** and tightening turnkey **346** such that a movable platform **345**B clamps down on to armature **348** by closing and/or reducing the size of the aperture, for example. In the example embodiment, movable platform **345**B has a channel for seating the curved surfaces of arm **348** and in some embodiments may have grooving or other texturing to facilitate a relatively strong connection.

(311) First armature portion **340**A may include a first arm **341**A and a second arm **341**B that are hingedly connected together by hinge mechanism **342**, for example. In various embodiments, hinge mechanism **342** may allow for a full 360 degree rotation, or a subset thereof. At least one embodiment may include corresponding teeth that may mesh together when tightened or clamped together by a tightening knob **342**A that urges the corresponding teeth into corresponding valleys, for example. In various embodiments, second arm **341**B may be movably coupled to armature connection mechanism **345** by a ball and socket joint **343**, for example. Additionally, first armature **341** may be coupled to a snap on connector **347** by a ball and socket joint **343**, for example. Consistent with the disclosure herein, it shall be understood that any connection between the various armatures of disclosed table mount systems may be a rotatable hinge like connection, a sliding connection, and/or a ball and joint connection. Additionally, these connection types may be readily swapped and our substituted. For example, post **351** may be inset within a hollow interior of any armature end to change the connection type and/or functionality depending solely on the particular needs of an end user.

(312) FIG. **124** is a first perspective view of a quick connect coupler **360** for connecting various retractor embodiments to various quick connect table mount systems disclosed herein. FIG. **125** is a side view of the quick connect coupler **360**. Quick connect coupler **360** may include an arm **361** supporting a post **363** and rail **362** on a first end thereof. In various embodiments, the arm **361** may follow a diagonal, straight, and/or curved profile, for example. On an opposite end, quick connect coupler **360** may include an armature coupler **365**, for example. Armature coupler **365** may include a post having an inclined, chamfered, and/or dimpled end **366**, for example. Additionally, armature coupler **365** may include a grooved portion **367** to facilitate a rigid and secure engagement with a quick connect coupler of a table mount system, for example connector **347** shown in FIG. **123**.

Furthermore, a base portion of quick connect coupler **360** may include a counter torque surface **368** for resisting a rotation of quick connect coupler **360**, for example surface **368** may directly contact a corresponding counter torque surface **347**B of connector **347** (see FIG. **123**). It shall be appreciated that armature coupler **365** may take any shape and have any form and type of various indentations, outdents, apertures, posts, slots, and etc. to facilitate attachment to a table mount arm whether in a snap on quick connect style as illustrated in the corresponding FIGS. or by, for example, a clamp on ratcheting style or even a mushroom expansion style.

(313) FIG. **126** is a perspective view of a modular retractor system including the quick connect couplers of FIGS. **124-125**. FIG. **127** is a top down view of the system of FIG. **126**. Consistent with the disclosure herein, modular retractor **530** is securely coupled to a secondary module, e.g., module **1200**. Module **1200** may have the same, similar, and/or substantially the same features and functionality as the various other secondary modules discussed above. However, in this embodiment, secondary module **1200** is capable of linearly extending a centrally disposed first arm and a C shaped second arm, for example. In this embodiment, the C shaped second arm is supporting a free hand module **900** and the first arm is securely connected to a quick connect arm **360** via a table mount quick release coupler **533**, for example. Additionally, a body portion of module **1200** includes a table mount quick release coupler **533** and the second C shaped arm includes a table mount quick release coupler **533**. Additionally, it is shown that modular retractor **530** is securely connected to a quick connect coupler **360** at the table mount quick release coupler **533**. Accordingly, various modular retractor systems may comprise a plurality of quick release couplers **533** whether they be on the primary retractor **530** or secondary module **1200**, for example. In this way, a surgeon has maximum flexibility in attaching the modular retractor system to a table mount. FIG. **128** is a perspective view of module **1200** in an uncoupled position with respect to modular retractor **530**. FIG. **129** is a perspective view of module **1200** coupled to modular retractor **530**. In the example embodiment, retractor mount coupler **280** is secured to attachment rail **264** of the modular blade **260** and extendable blade **262**. Additionally, the retractor mount coupler **280** is coupled to lateral arm **1201** of retractor module **1200**.

(314) FIG. **130** is a top down view of modular retractor **530** supporting first and second blades and module **1200** supporting a third blade. FIG. **131** is a perspective view of three blades being slidably coupled to a dilator **94**. With reference back to the set of dilators **99** disclosed in FIGS. **80**C, **80**B, **80**E, and FIG. **81** an example method of use will be disclosed. In a first step, a surgeon may insert an initial dilator or pin, e.g., innermost dilator **98**. In some embodiments, and depending on the particular surgical approach dilator **98** may be insert into a patient from a lateral, anterior, or trans psoas approach, e.g. Once the initial dilator **98** is insert in the patient, a dilator having a relatively wider size may be insert over the initial dilator **98**, e.g., dilator **97**. After dilator **97** is slipped over innermost dilator **98**, a dilator having a relatively wider size than dilator **97** may be slipped over dilator **97**, e.g., dilator **96**. Any number of successive and iteratively increasing in size dilators may be slipped over one another in this process. Thereafter, an outermost dilator **94** having a plurality of rail portions **94**A may be slipped over the immediately prior dilator, e.g., dilator **96**.

(315) Next, a surgeon may position modular retractor **530** and retractor module **1200** over the outermost dilator **94**. For example, a surgeon may install first and second blades to the first and second arms of modular retractor **530** and a third blade may be installed on the proximal arm of retractor module **1200**. The three blades may be collapsed such that edge portions contact one another and a circular void space is formed by the interior surfaces of the three blades. Next, the surgeon may slip the three blades over the outermost dilator **94** such that the corresponding channel portions of the blades slidably couples to the rail portions **94**A of the outermost dilator, see FIG. **81**. Thereafter, the surgeon may move the modular retractor **530** and retractor module **1200** such that the blades slide down along the length of outermost dilator and into the operative corridor. Once the surgeon has moved the three blades into the operative corridor, and the blades are supporting adjacent tissue, the surgeon may remove the outermost dilator **94**. After the outermost dilator **94**

has been removed, the surgeon can freely manipulate any one of the three blades in any manner or relative movement as previously explained to enlarge the operative corridor.
(316) It should be understood that various aspects disclosed herein may be combined in different combinations than the combinations specifically presented in the description and accompanying drawings. For example, features, functionality, and components from one embodiment may be combined with another embodiment and vice versa unless the context clearly indicates otherwise. Similarly, features, functionality, and components may be omitted unless the context clearly indicates otherwise. It should also be understood that, depending on the example, certain acts or events of any of the processes or methods described herein may be performed in a different sequence, may be added, merged, or left out altogether (e.g., all described acts or events may not be necessary to carry out the techniques).
(317) Unless otherwise specifically defined herein, all terms are to be given their broadest possible interpretation including meanings implied from the specification as well as meanings understood by those skilled in the art and/or as defined in dictionaries, treatises, etc. It must also be noted that, as used in the specification and the appended claims, the singular forms “a,” “an” and “the” include plural referents unless otherwise specified, and that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof.

Claims

1. A retractor system for enabling access to a surgical site, comprising: a modular retractor having a longitudinal axis extending in a longitudinal direction and a lateral axis extending from a first lateral end to a second lateral end in a lateral direction, the modular retractor including: a first body portion that houses a distraction mechanism; a first arm and a second arm pivotally coupled together, a first handle coupled to the first arm and a second handle coupled to the second arm; a first pivoting member coupled to a distal end of the first arm and a second pivoting member coupled to a distal end of the second arm; a first blade attachment mechanism coupled to the first pivoting member and a second blade attachment mechanism coupled to the second pivoting member, the first and second blade attachment mechanisms being configured to couple to first and second blades, respectively; a first actuator operably coupled to the distraction mechanism for opening and closing the first arm and the second arm; a second actuator for adjusting an angulation of the first pivoting member; and a third actuator for adjusting an angulation of the second pivoting member, wherein the first body portion comprises at least one table mount quick release coupler.
2. The retractor system of claim 1, wherein the first body portion further comprises a connection point for connecting to at least one retractor module.
3. The retractor system of claim 1, wherein the at least one table mount quick release coupler is disposed on the first body portion such that the longitudinal axis crosses over the at least one table mount quick release coupler.
4. The retractor system of claim 1, wherein the at least one table mount quick release coupler comprises a centrally disposed mating aperture and a tightening knob.
5. The retractor system of claim 1, wherein the first body portion further comprises at least one channel adjacent the at least one table mount quick release coupler.
6. The retractor system of claim 1, wherein the first body portion further comprises a first channel adjacent the at least one table mount quick release coupler and a second channel adjacent the at least one table mount quick release coupler.
7. The retractor system of claim 6, wherein the first channel extends substantially in the longitudinal direction and the second channel extends substantially in the lateral direction.
8. The retractor system of claim 1, further comprising at least one table mount arm configured to

releasably couple to the at least one table mount quick release coupler.
9. The retractor system of claim 8, wherein the at least one table mount arm comprises a post.
10. The retractor system of claim 8, wherein the at least one table mount arm comprises at least one rail.
11. The retractor system of claim 1, further comprising at least one table mount arm configured to releasably couple to the at least one table mount quick release coupler, wherein the table mount arm comprises a post and a rail.
12. The retractor system of claim 1, further comprising a third blade, wherein at least one of the first blade and second blade is a modular blade and the third blade is slidably coupled to the modular blade.
13. The retractor system of claim 1, further comprising an extendable blade, wherein the extendable blade comprises at least one rail that is slidably disposed within at least one channel of the first blade.
14. The retractor system of claim 13, wherein the extendable blade comprises a footed tip.
15. The retractor system of claim 14, further comprising a rectangular dilator.
16. The retractor system of claim 14, wherein the first and second blades comprise substantially planar working surfaces.
17. The retractor system of claim 1, further comprising an adjustable armature for supporting the retractor system, wherein: the adjustable armature comprises a first armature portion coupled to a second armature portion, the first armature portion is configured to couple to an operating table having a horizontal surface, the first armature portion having a first armature extending in a vertical direction substantially opposite a plane defined by the horizontal surface, the second armature portion is slidably coupled to the first armature, at least one table mount arm is coupled to the second armature, and the at least one table mount arm is releasably coupled to the at least one table mount quick release coupler.
18. The retractor system of claim 17, wherein the first armature portion comprises a ball and socket joint.
19. The retractor system of claim 17, wherein the second armature portion comprises a second armature and a third armature that are hingedly connected.
20. The retractor system of claim 17, wherein the at least one table mount arm is coupled to the second armature at a ball and socket joint.
21. A method of forming an operative corridor in a patient, comprising: providing a modular retractor and at least one retractor module for coupling to the modular retractor, the modular retractor comprising: a first body portion that houses a distraction mechanism; a first arm and a second arm pivotally coupled together, a first handle coupled to the first arm and a second handle coupled to the second arm; a first pivoting member coupled to a distal end of the first arm and a second pivoting member coupled to a distal end of the second arm; a first blade attachment mechanism coupled to the first pivoting member and a second blade attachment mechanism coupled to the second pivoting member, the first and second blade attachment mechanisms being configured to couple to first and second blades, respectively; a first actuator operably coupled to the distraction mechanism for opening and closing the first arm and the second arm; a second actuator for adjusting an angulation of the first pivoting member; a third actuator for adjusting an angulation of the second pivoting member, wherein the first body portion comprises at least one table mount quick release coupler; the at least one retractor module comprising: a third arm supporting a third pivoting member and a third blade attachment mechanism at a distal end thereof, the third blade attachment mechanism being configured to couple to a third blade; a fourth actuator operably coupled to the at least one retractor module for extending and contracting the third arm; a fifth actuator for for adjusting an angulation of the third pivoting member; attaching the first blade to the first arm, the second blade to the second arm, and the third blade to the third arm; sequentially inserting at least two dilators into a patient, the at least two dilators including an

outermost dilator and an innermost dilator; inserting a first dilator into a patient, wherein the outermost dilator forms an operative corridor; positioning the first blade, second blade, and third blade directly above the outermost dilator; sliding the first blade, second blade, and third blade over the outermost dilator and into the operative corridor.

22. The method of claim 21, wherein sliding the first blade, second blade, and third blade over the at least one second dilator further comprises mating respective channel portions of the first blade, second blade, and third blade with corresponding rail portions of the outermost dilator.