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(54) **SURGICAL END EFFECTOR WITH TWO SEPARATE COOPERATING OPENING FEATURES FOR OPENING AND CLOSING END EFFECTOR JAWS**

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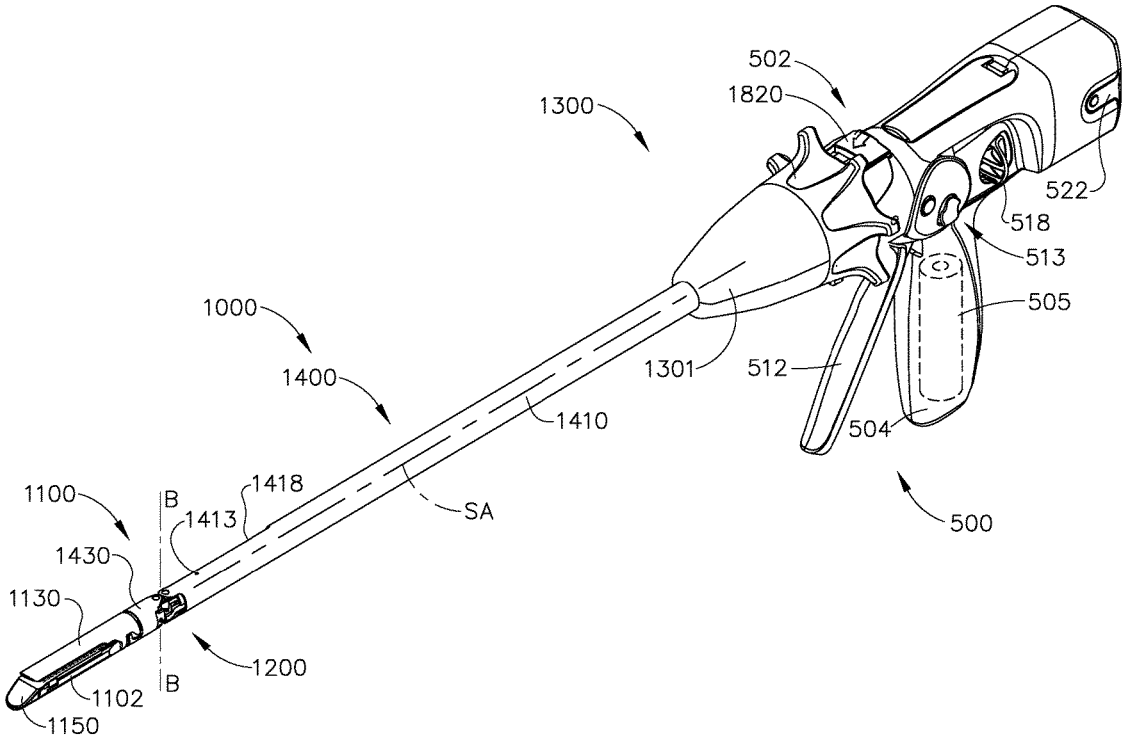
(52) **U.S. Cl.**
CPC .. ***A61B 17/072*** (2013.01); *A61B 2017/07278* (2013.01); *A61B 2017/07257* (2013.01)

(57) **ABSTRACT**

A surgical tool assembly that includes first and second jaws. The second jaw includes a second jaw body portion and a second jaw mounting portion that is movably coupled to the first jaw. A closure member that has at least one opening cam formed thereon is axially movable in response to closing and opening motions. The opening cam is configured to movably engage a corresponding cam surface that is formed on the second jaw body portion to move the second jaw to an open position.



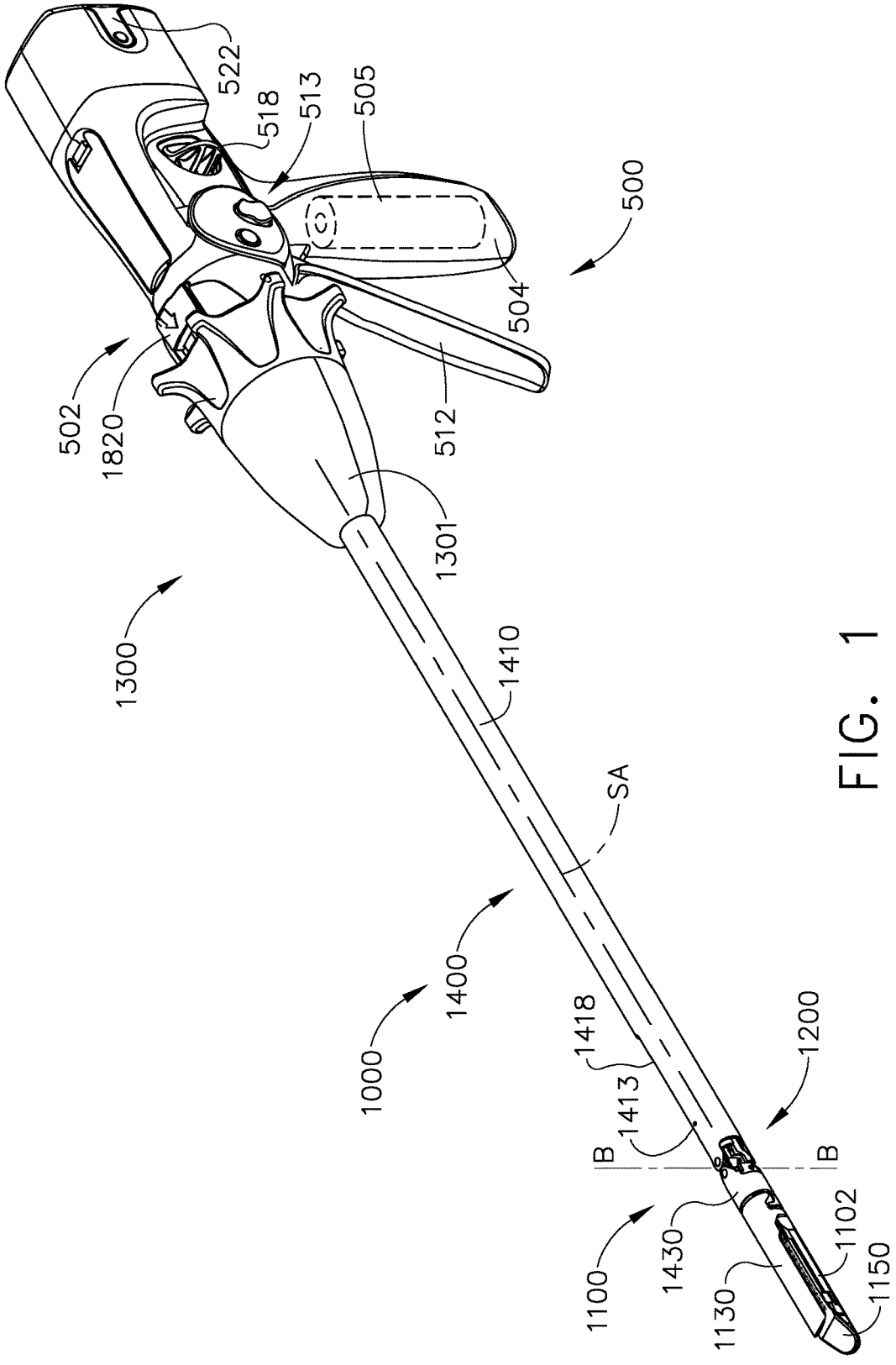

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FIG. 1

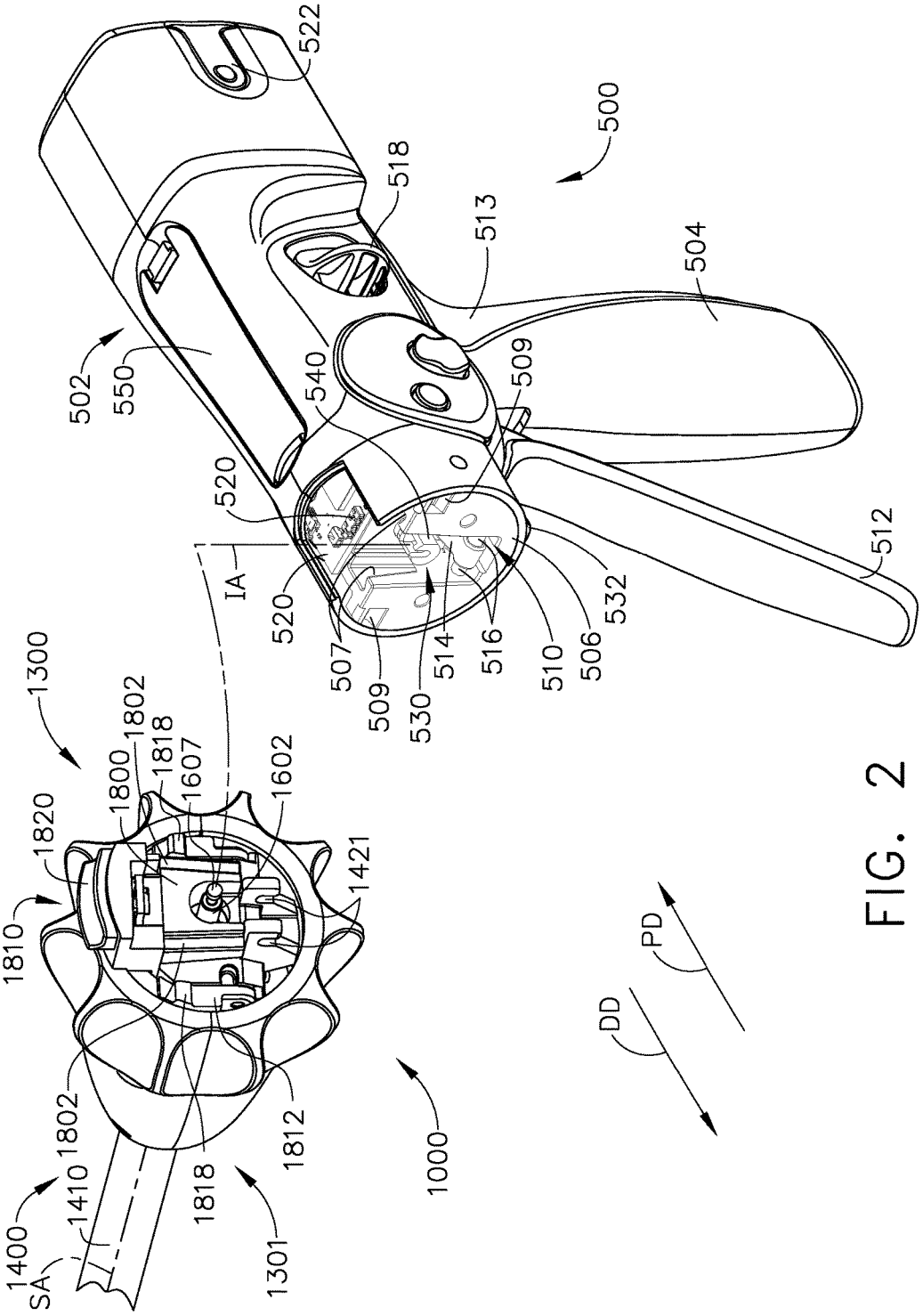
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FIG. 2

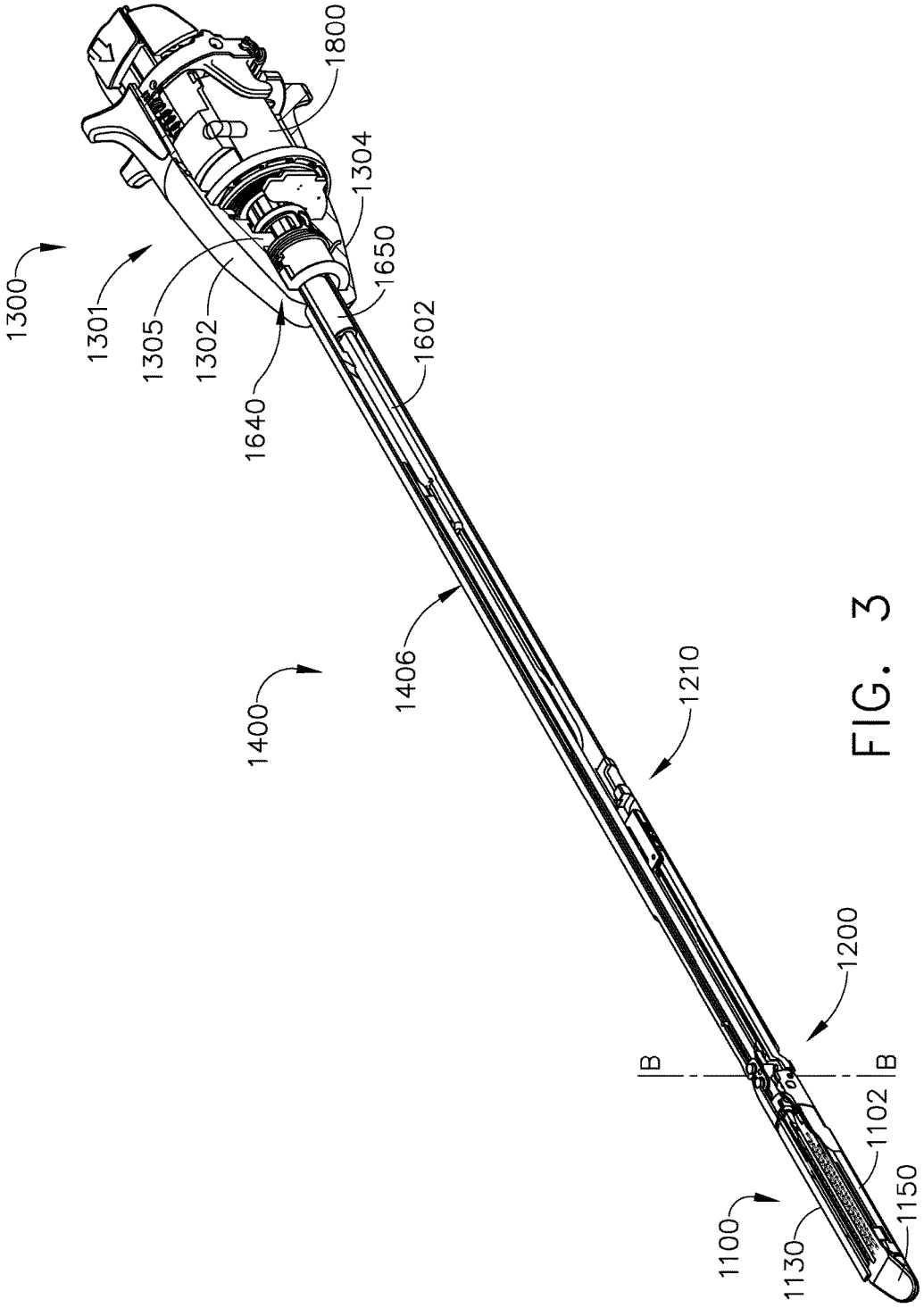
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FIG. 3

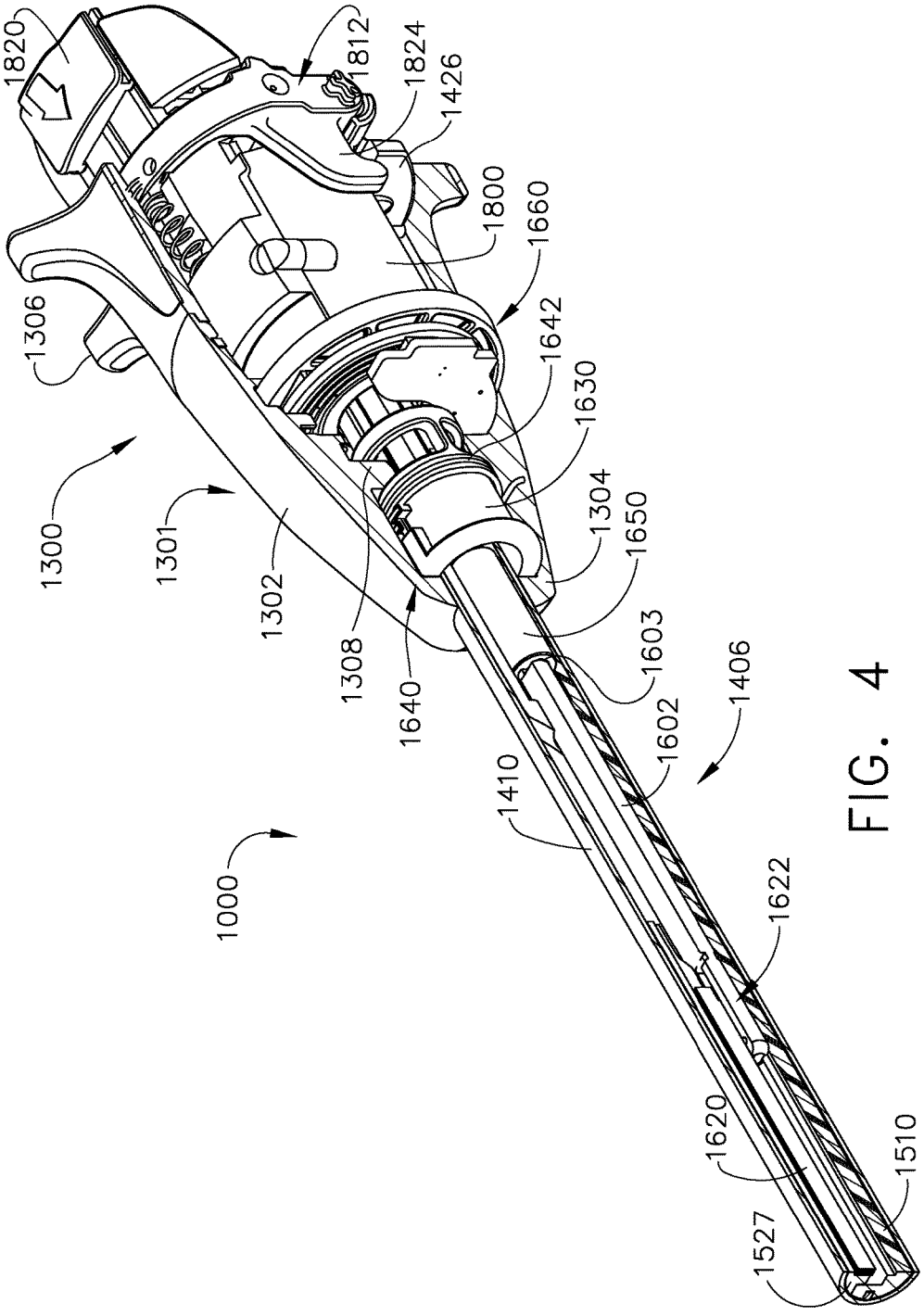
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FIG. 4

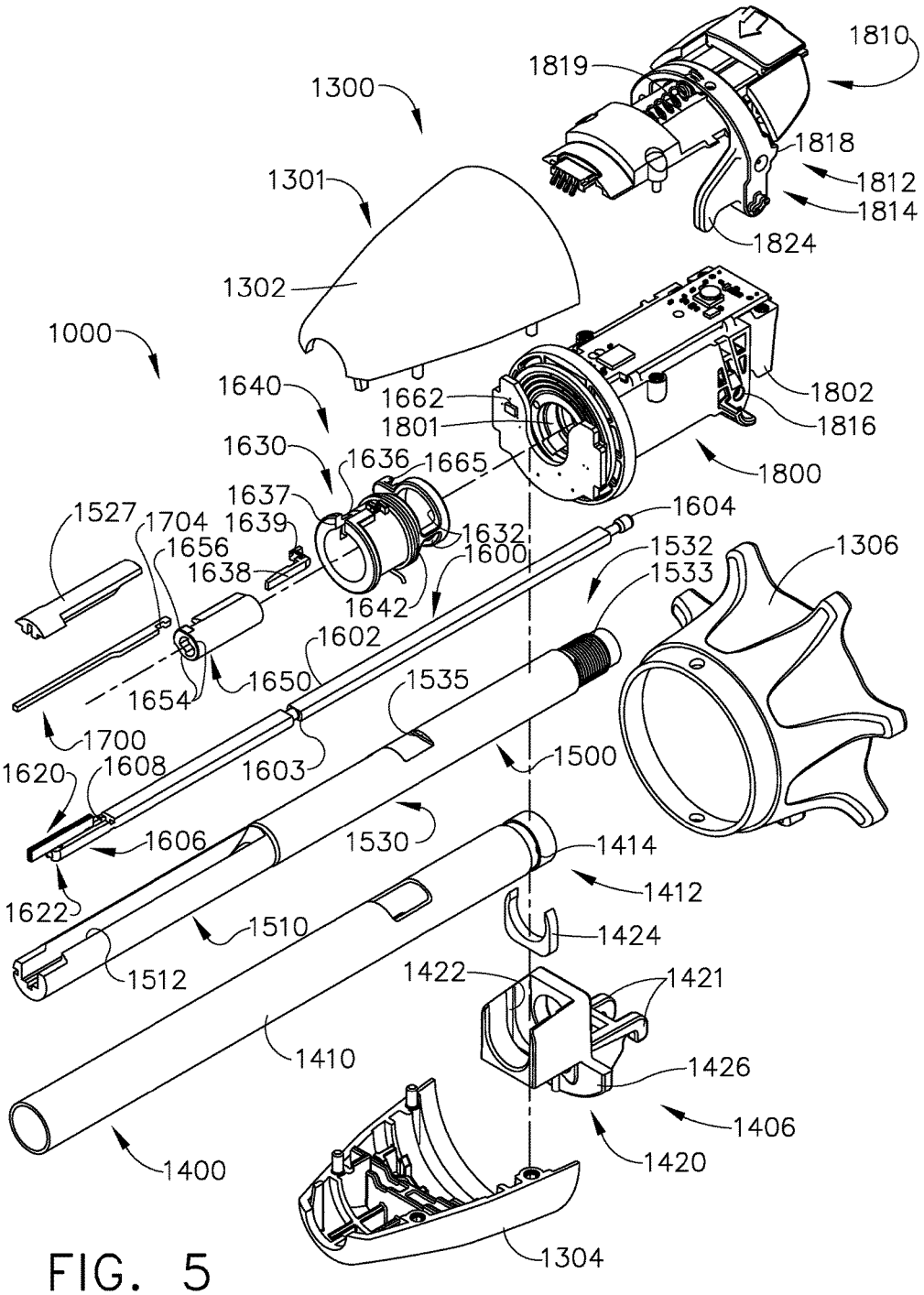
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FIG. 5

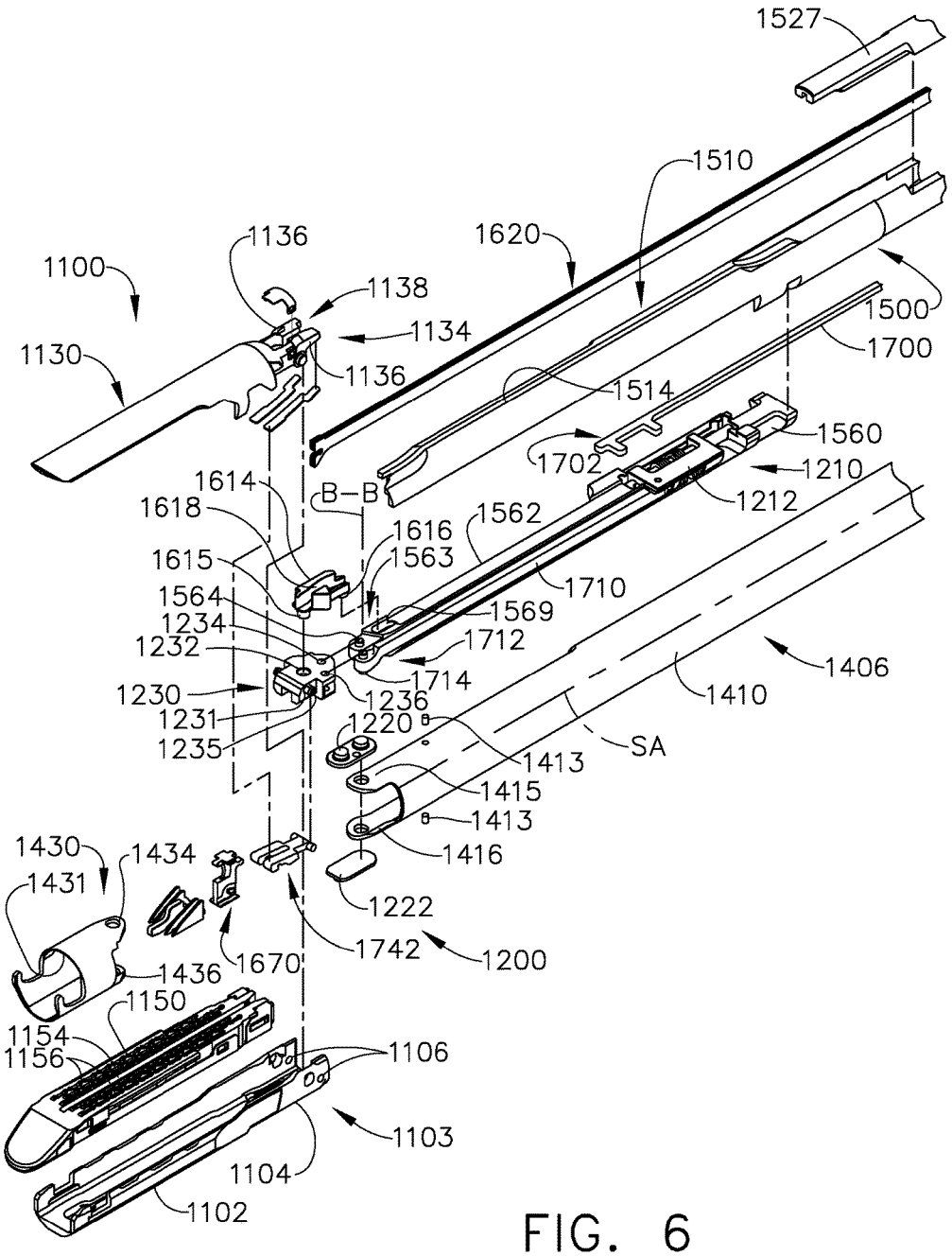
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FIG. 6

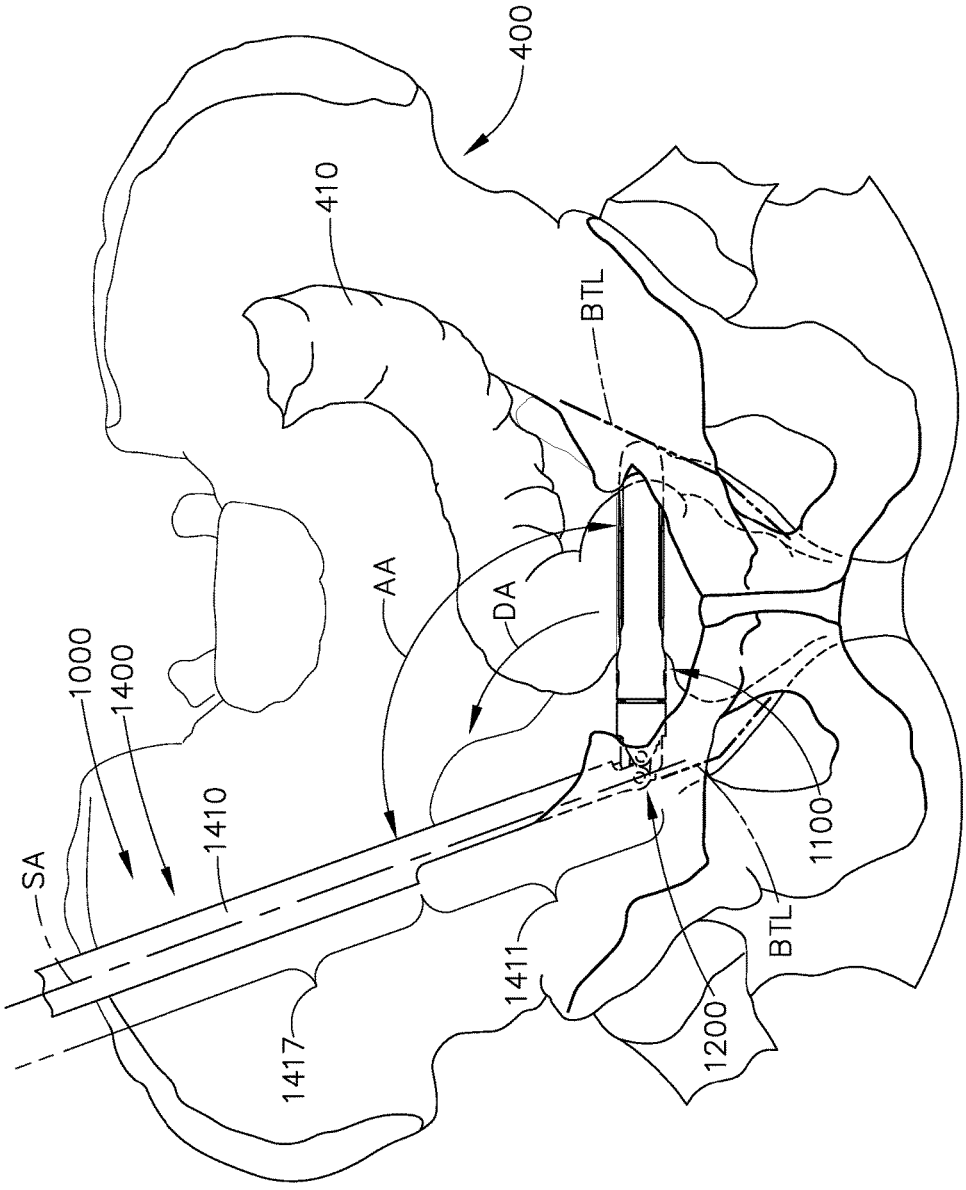

FIG. 7

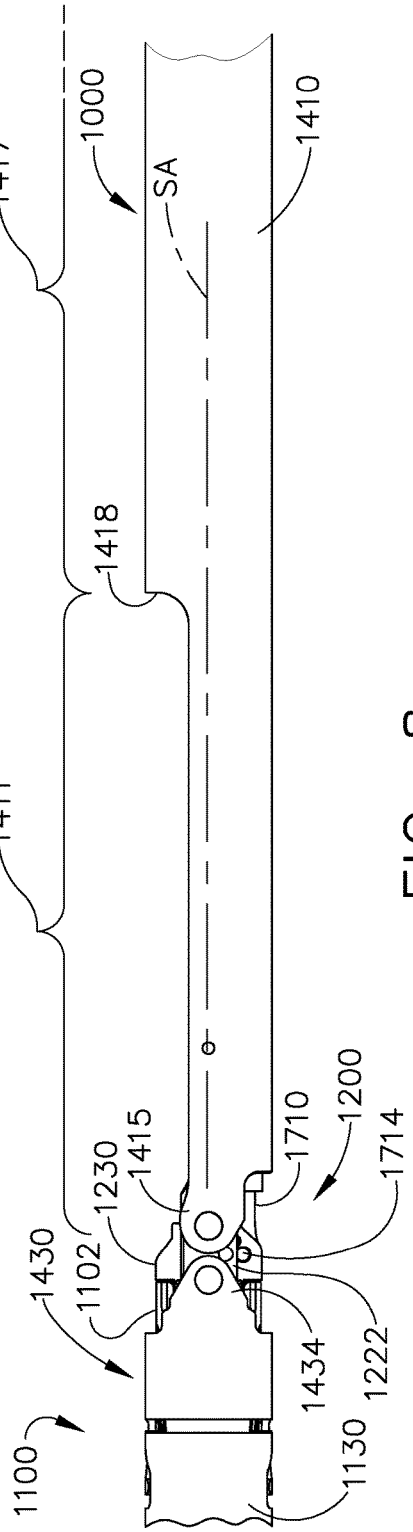
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FIG. 8

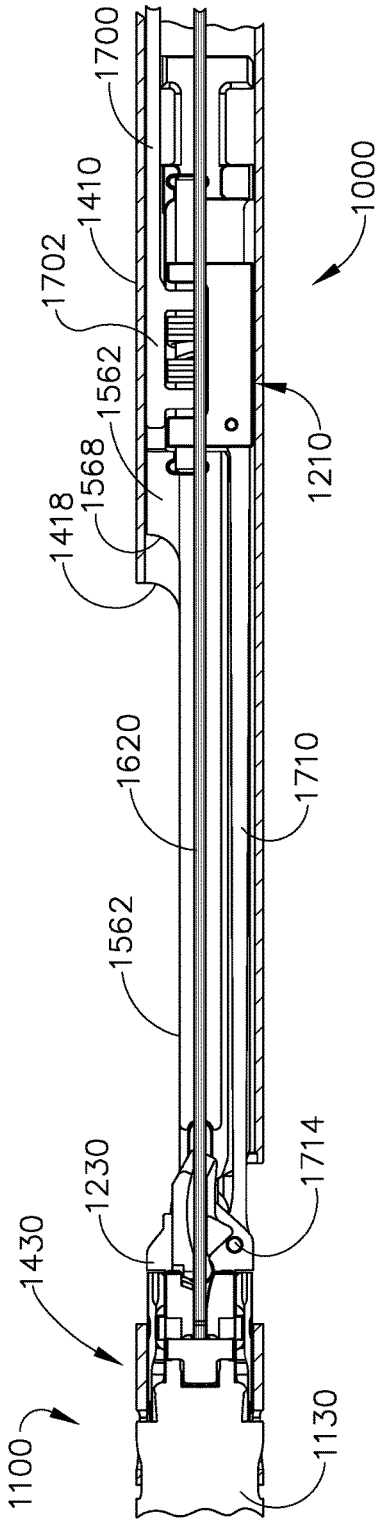
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FIG. 9

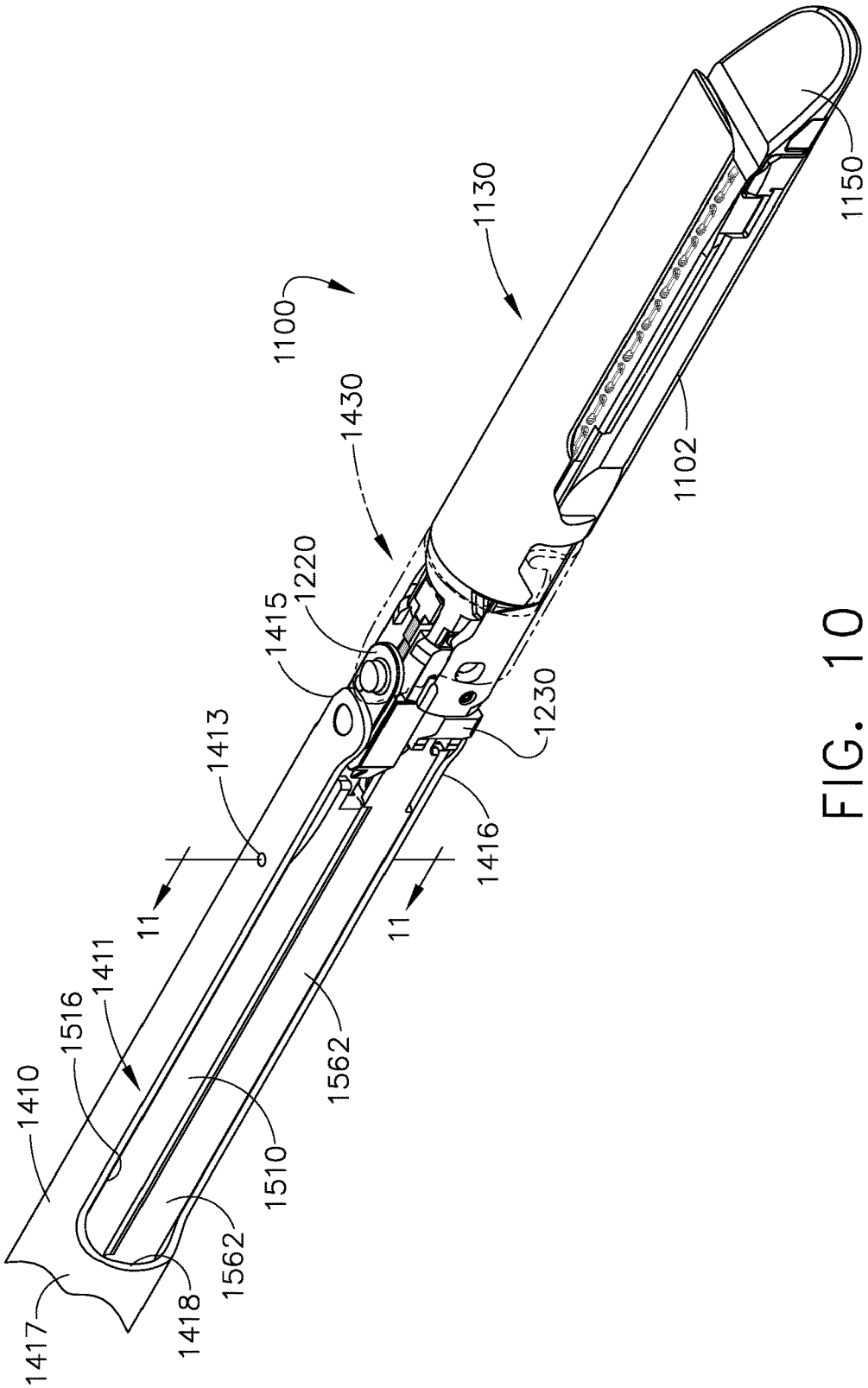
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FIG. 10

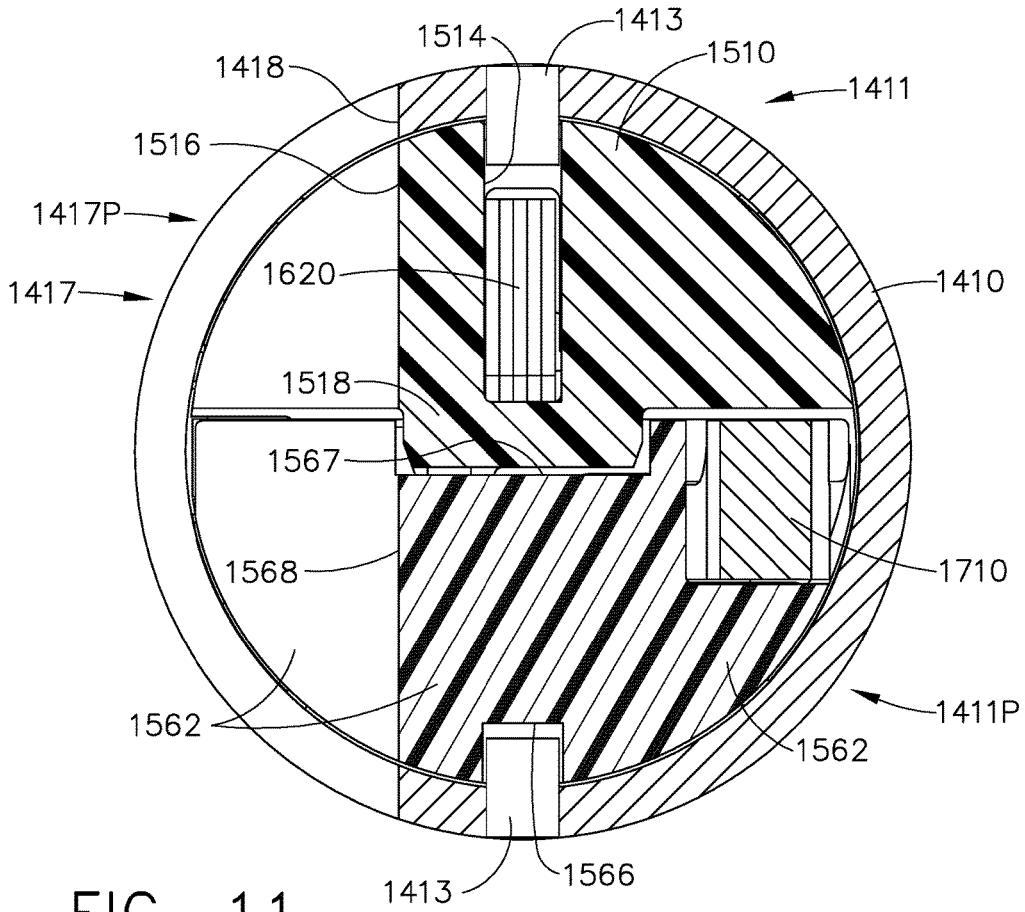
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FIG. 11

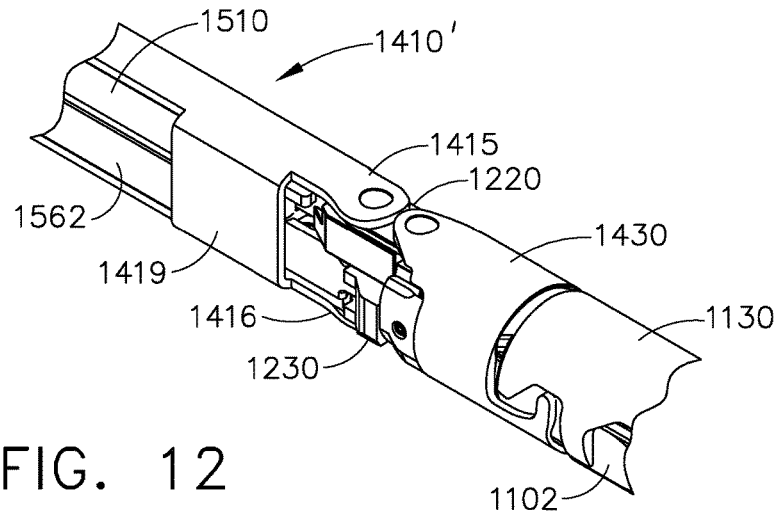
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FIG. 12

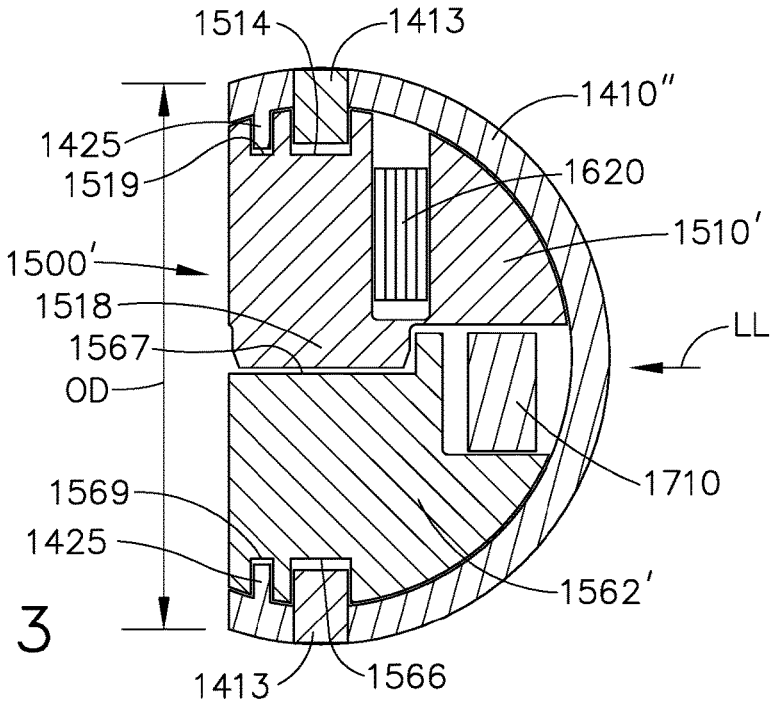
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FIG. 13

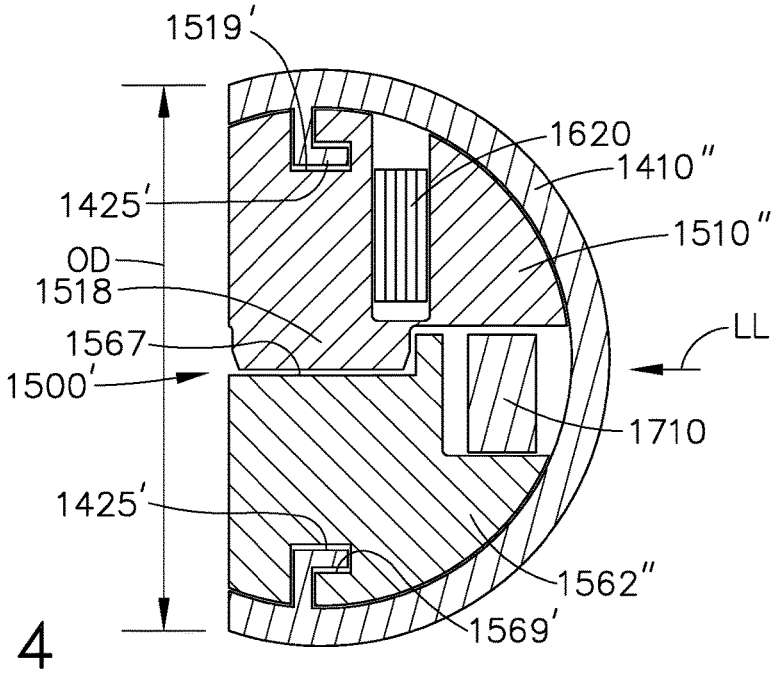
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FIG. 14

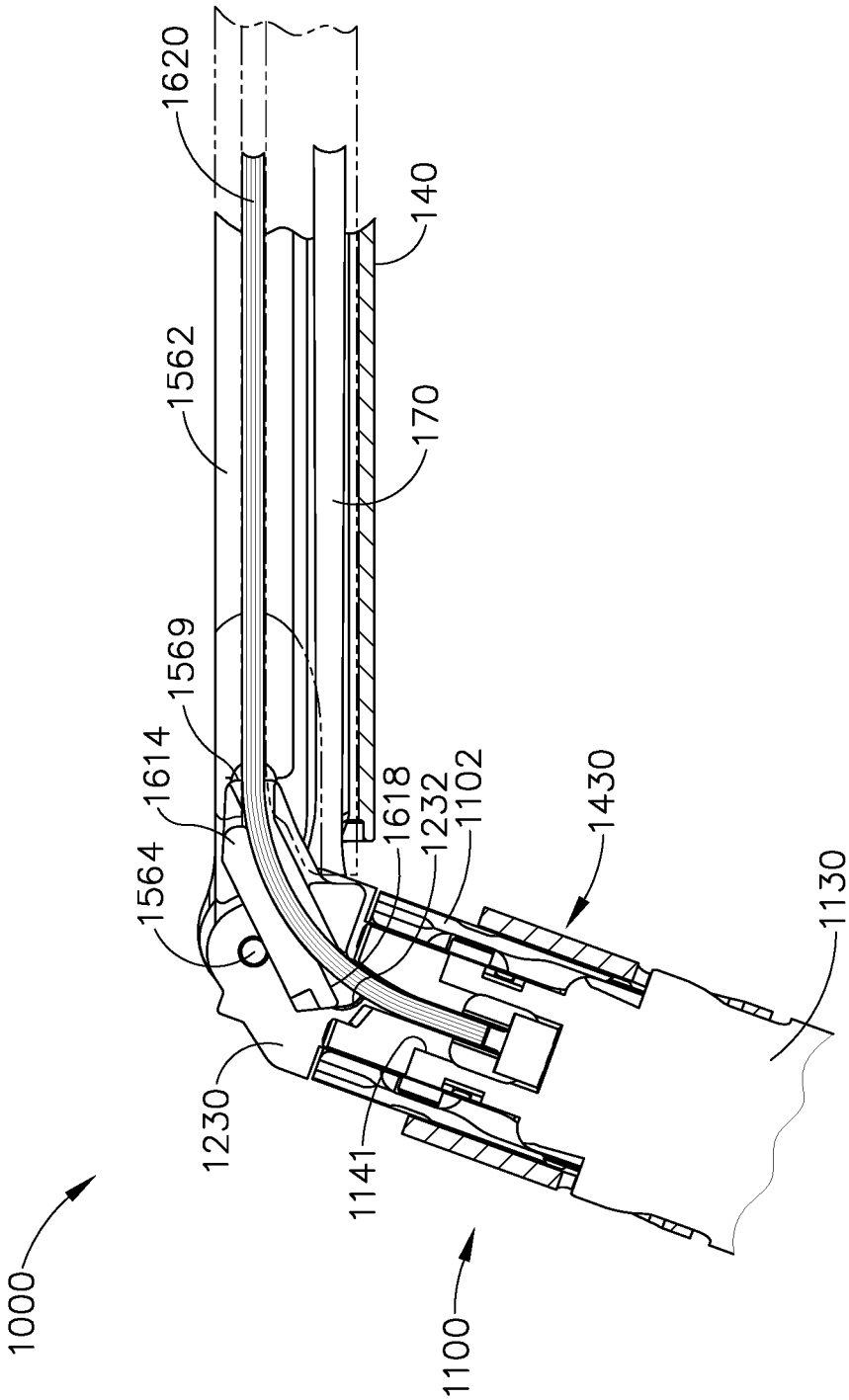
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FIG. 15

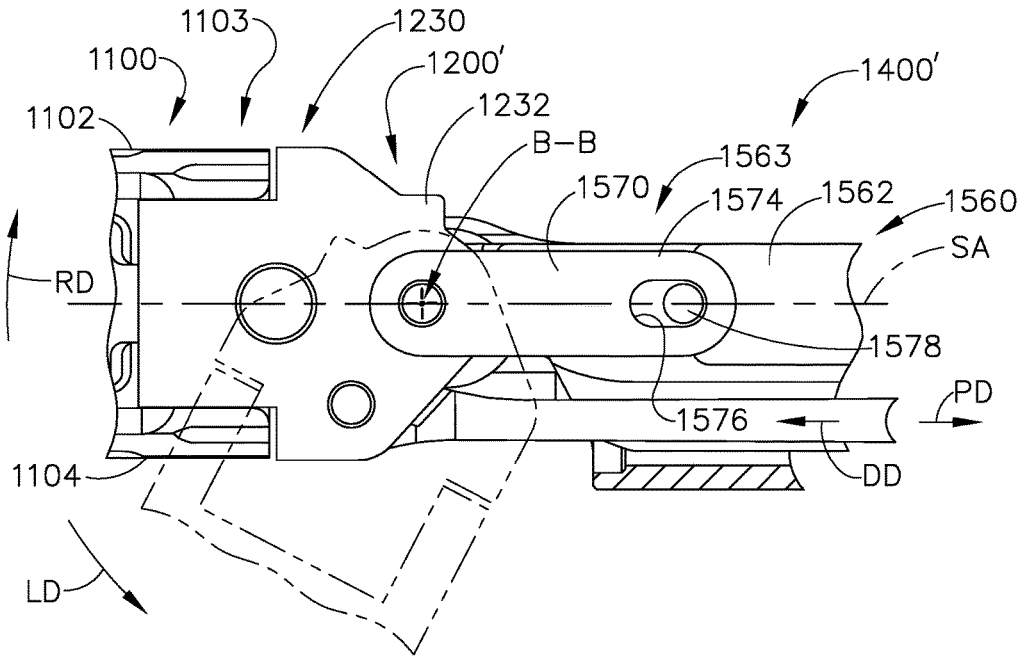
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FIG. 15A

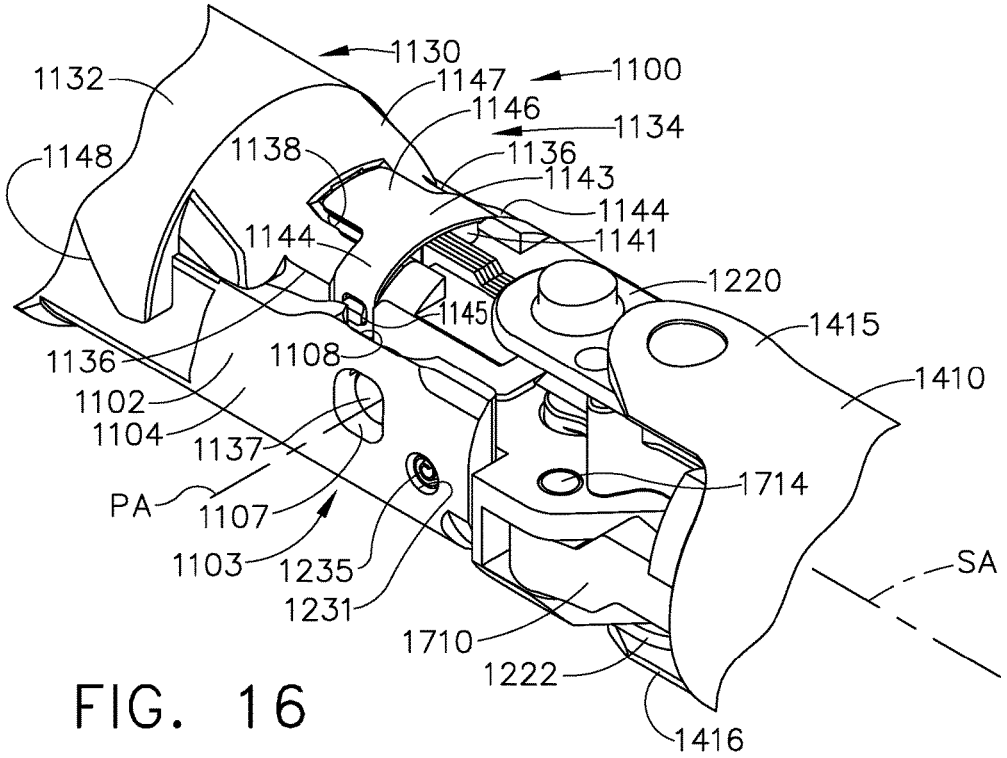
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FIG. 16

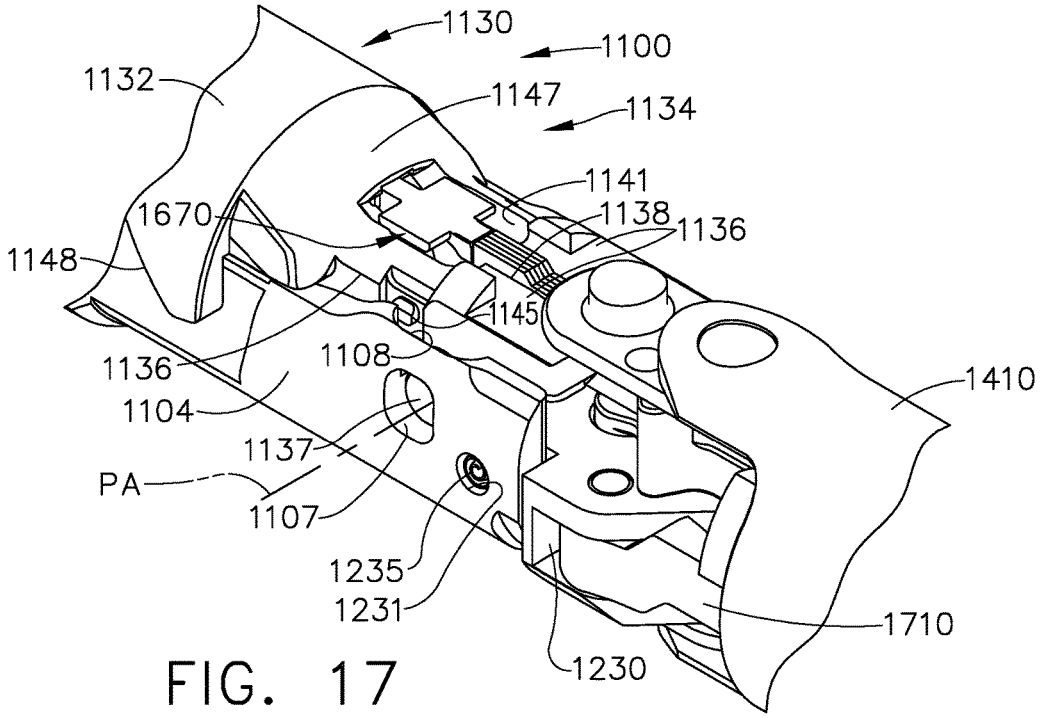
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FIG. 17

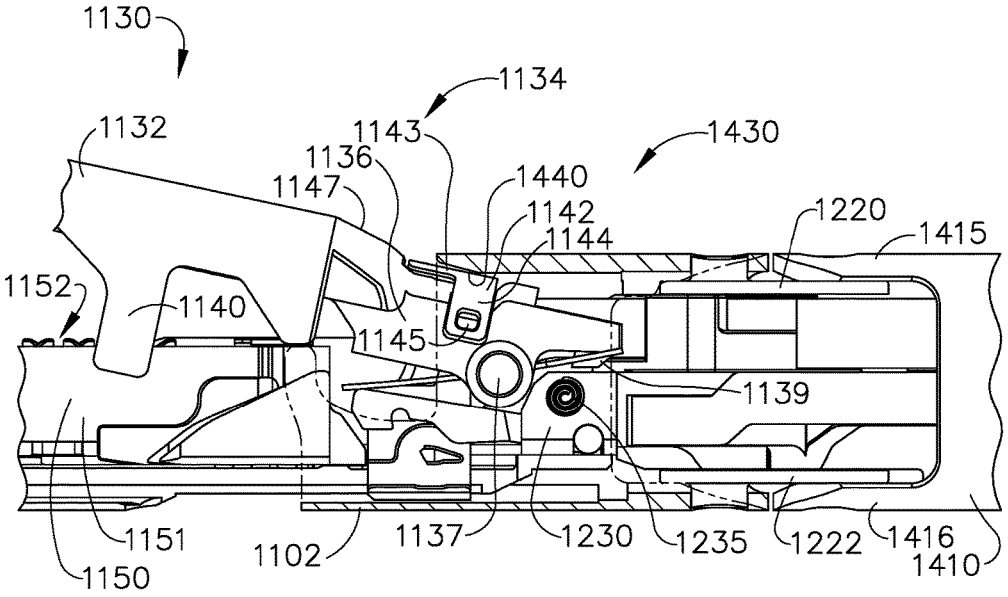

FIG. 18

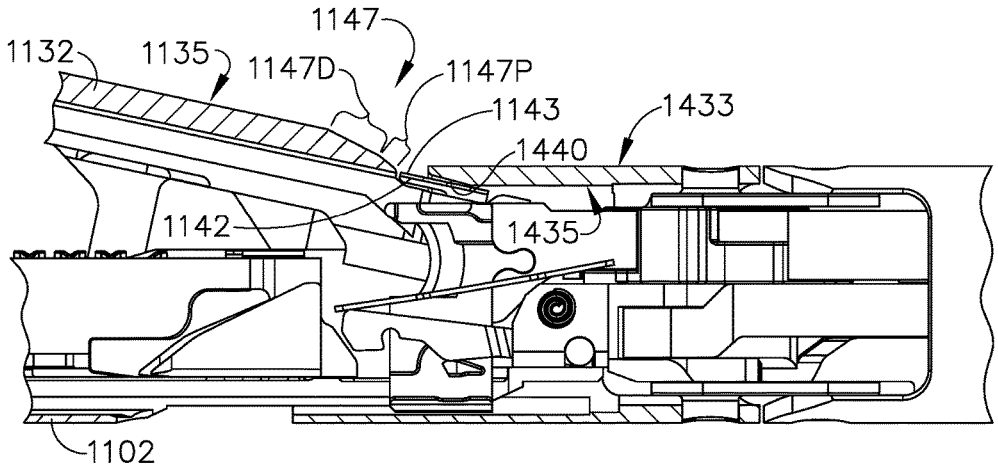

FIG. 18A

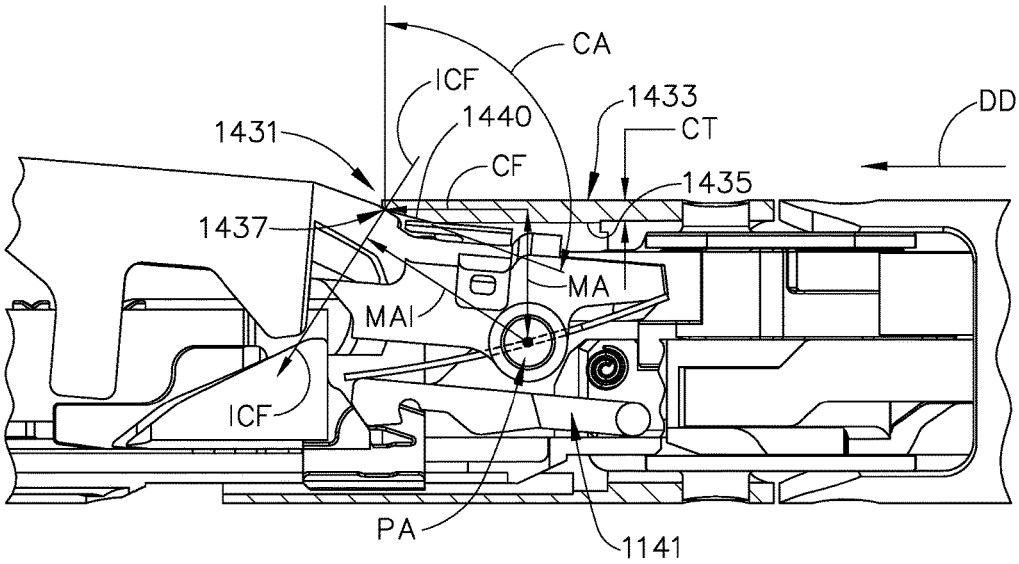
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FIG. 19

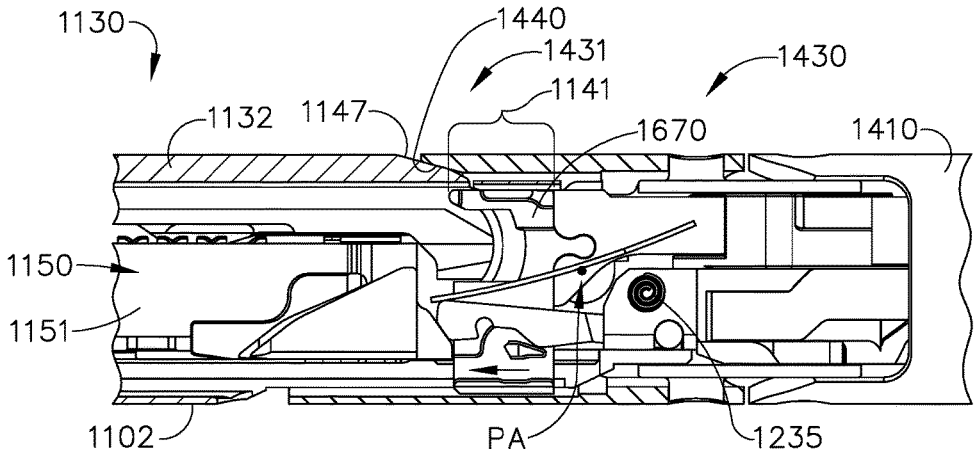
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FIG. 20

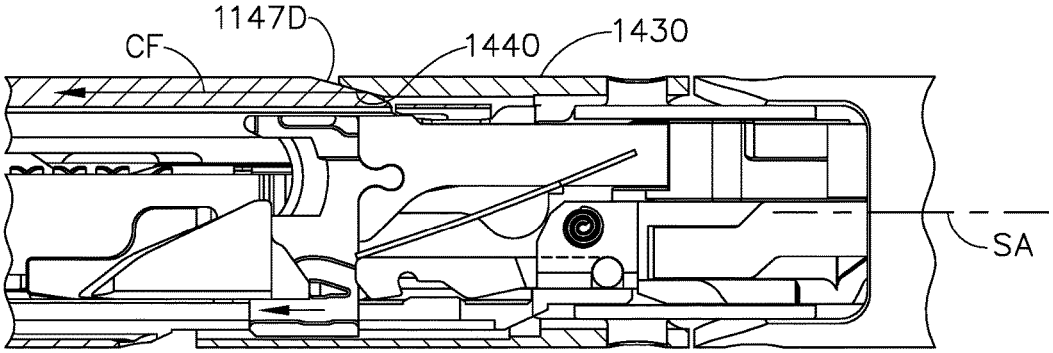

FIG. 20A

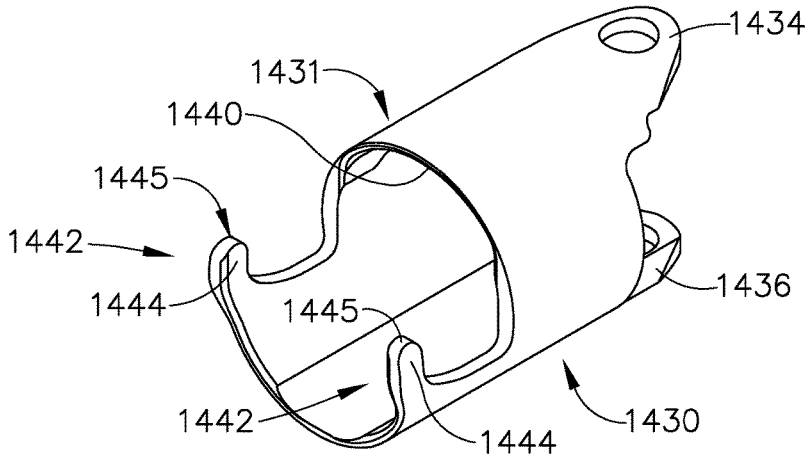

FIG. 21

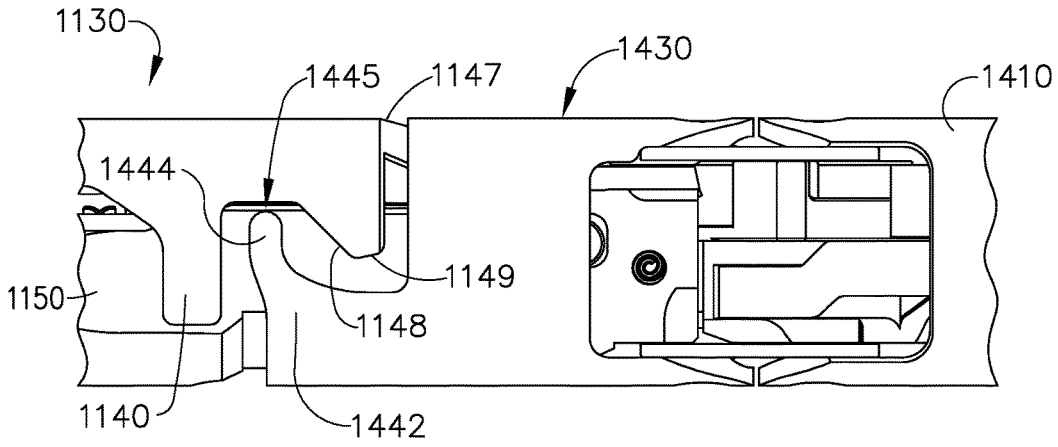
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FIG. 22

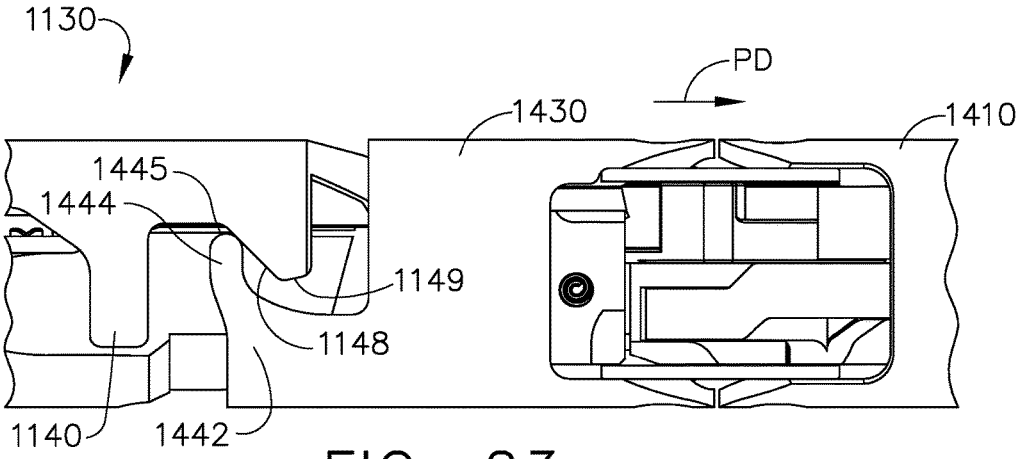
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FIG. 23

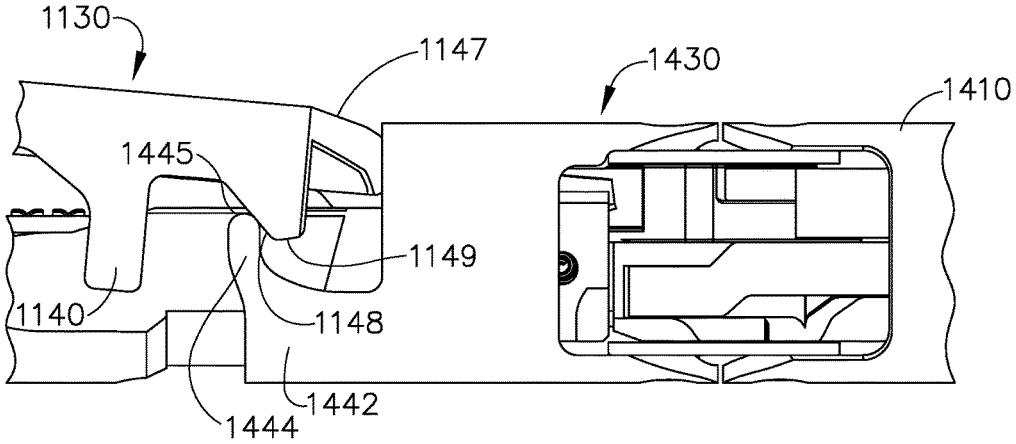
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FIG. 24

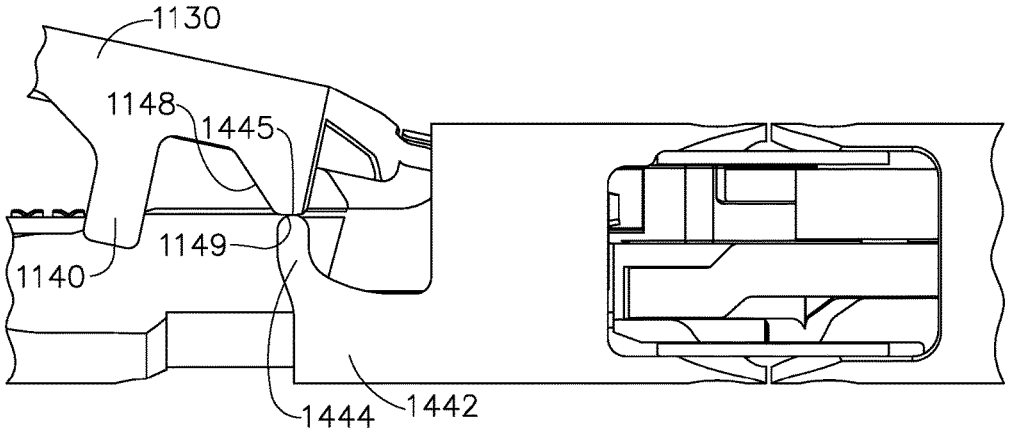
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FIG. 25

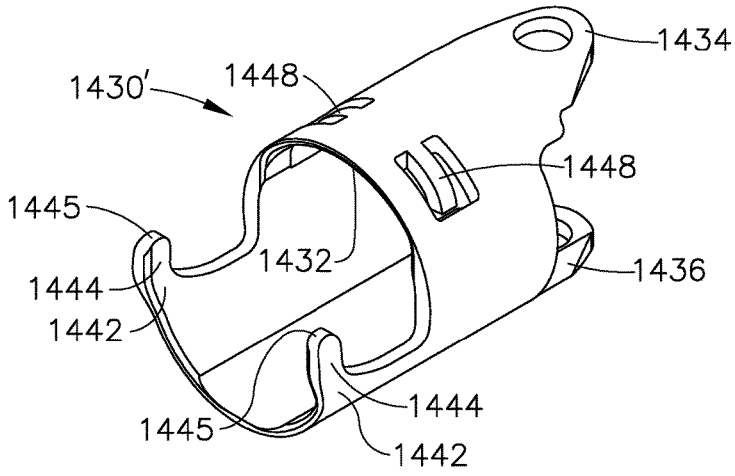

FIG. 26

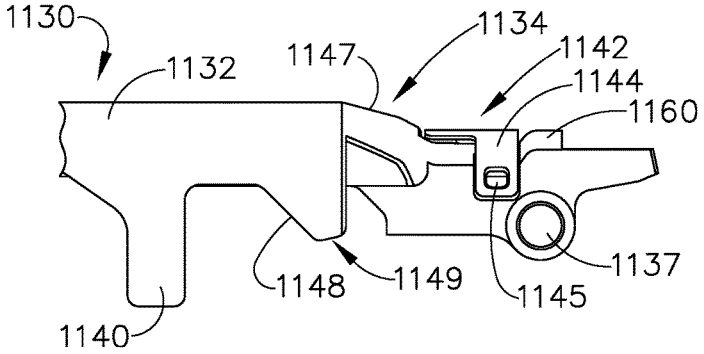

FIG. 27

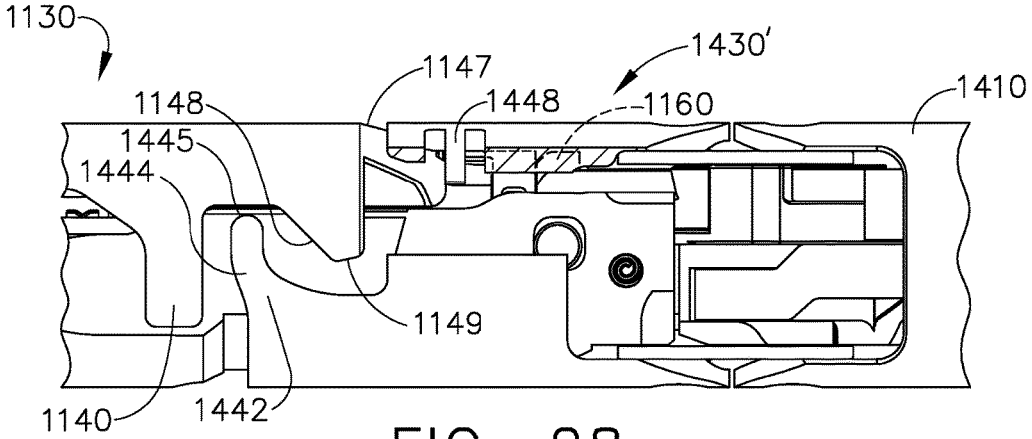

FIG. 28

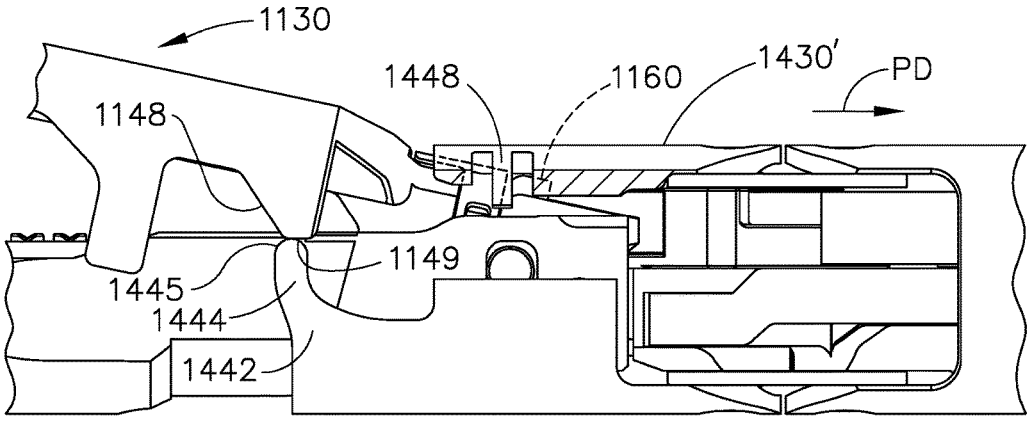

FIG. 29

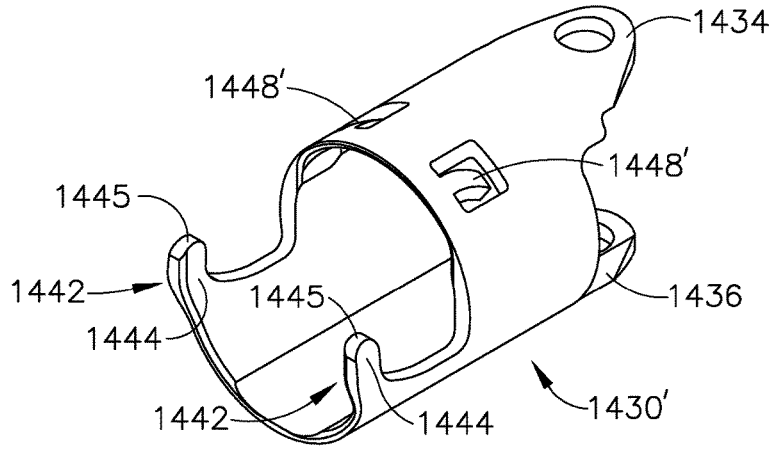

FIG. 30

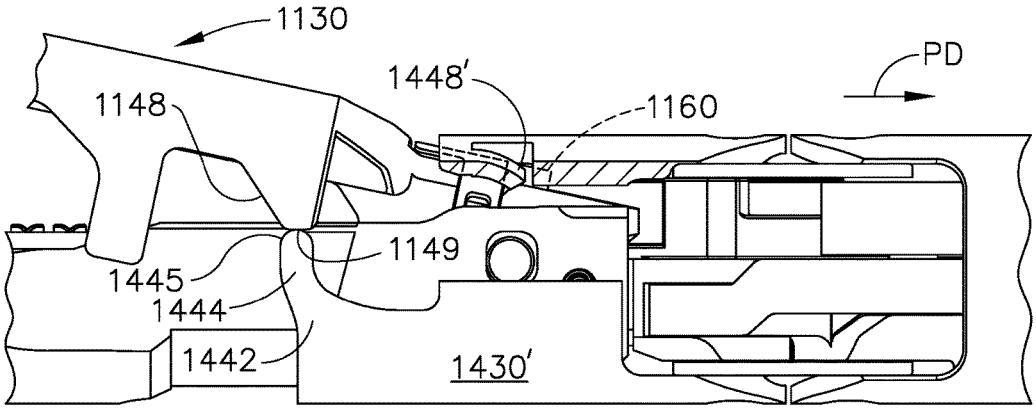

FIG. 31

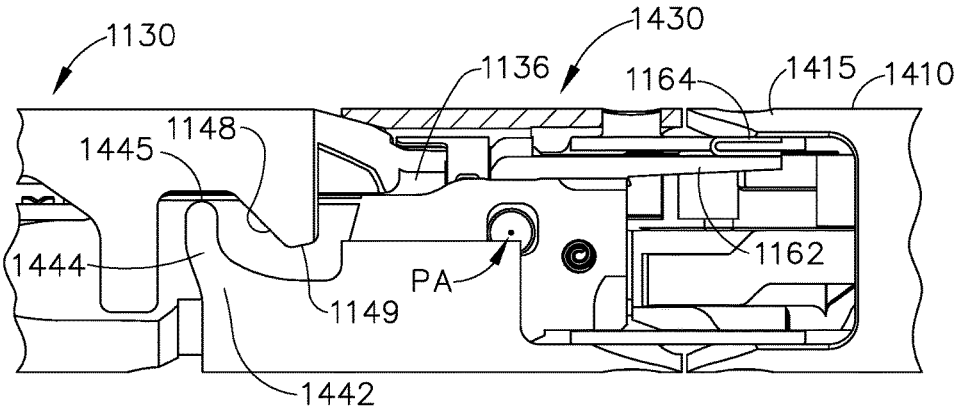
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FIG. 32

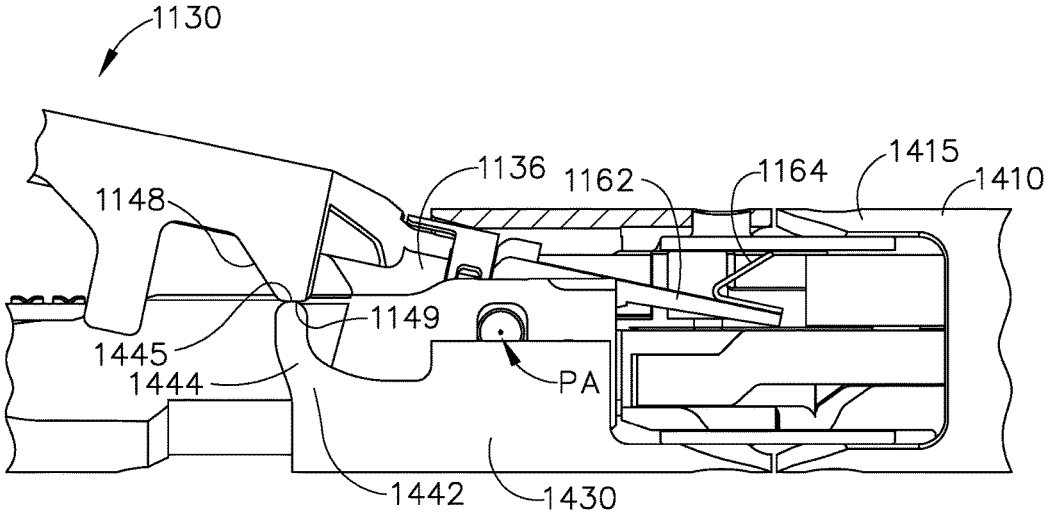
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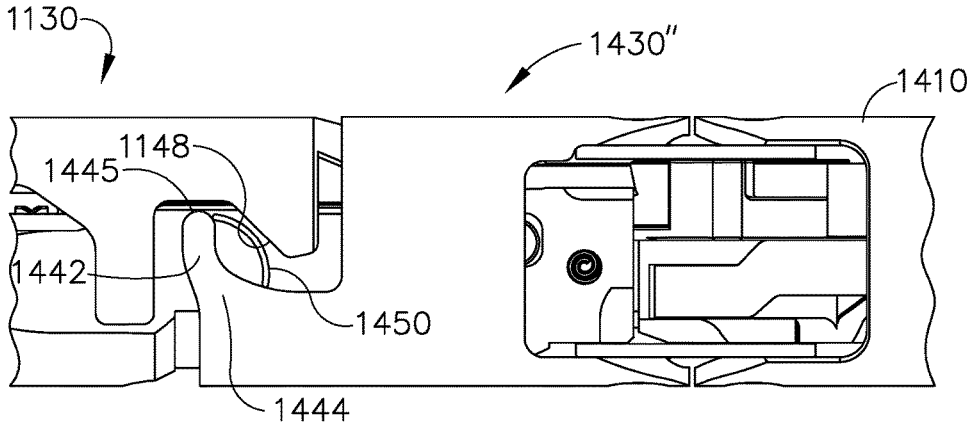
FIG. 33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1444

FIG. 34

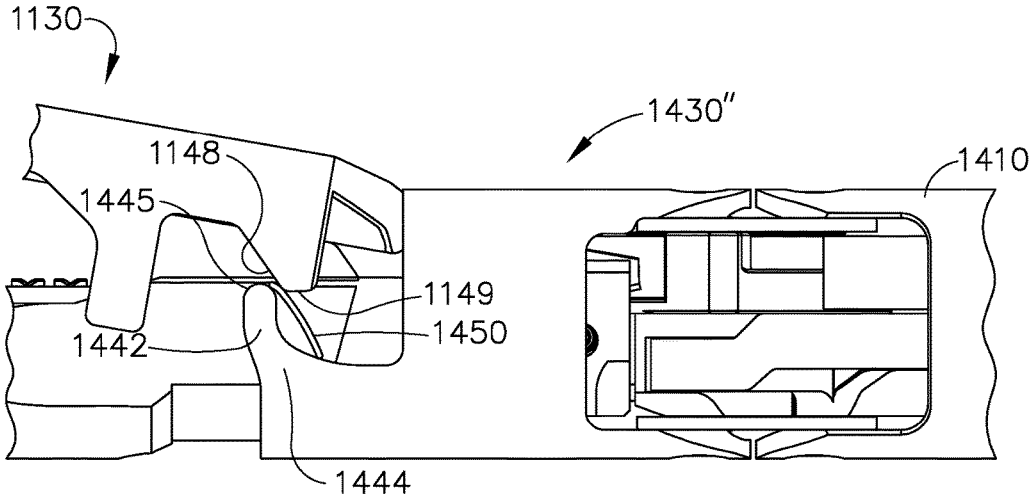
1130
1430"
1410
1148
1445
1149
1450
1442
1444

FIG. 35

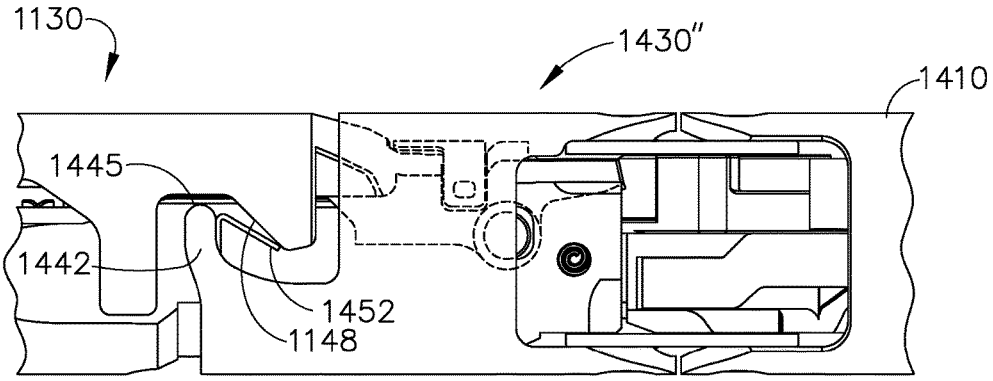
1130
1430"
1410
1445
1442
1452
1148

FIG. 36

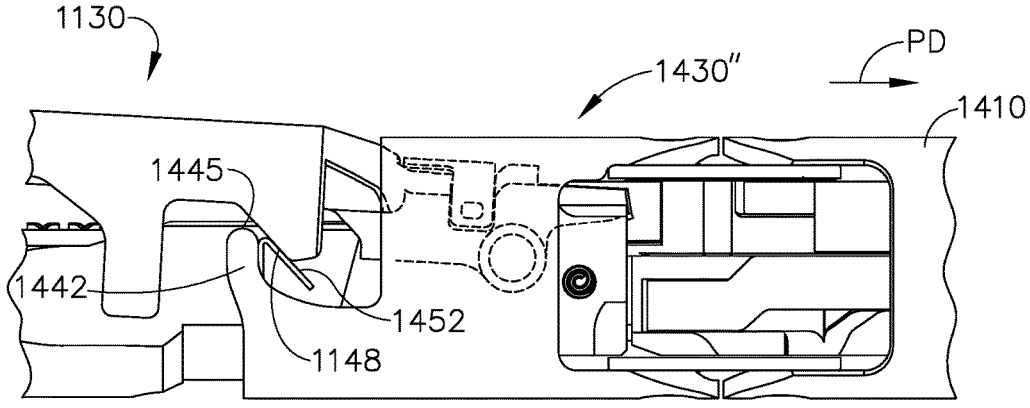
1130
1430"
PD
1410
1445
1442
1452
1148

FIG. 37

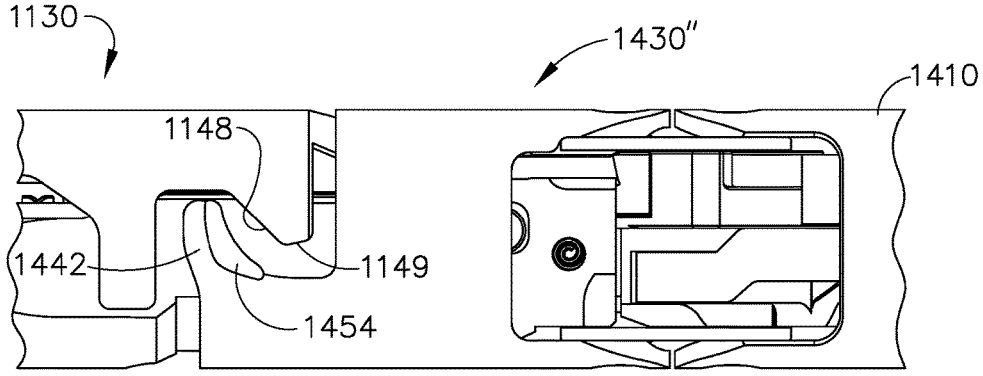
1130
1430"
1410
1148
1442
1149
1454

FIG. 38

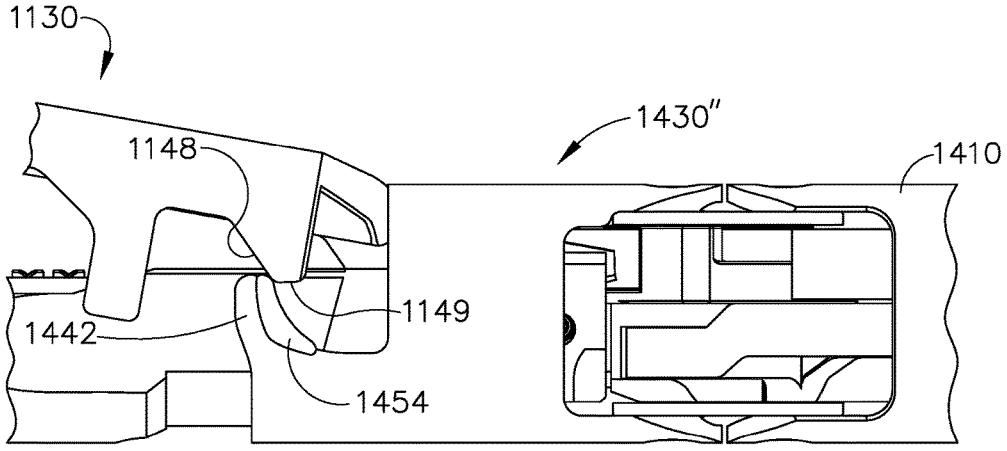
1130
1430"
1410
1148
1442
1149
1454

FIG. 39

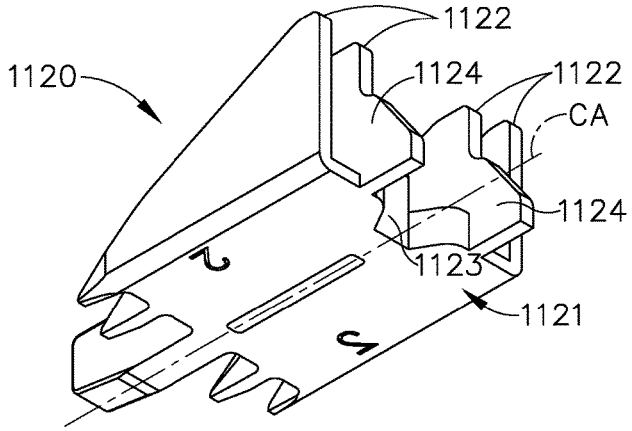

FIG. 40

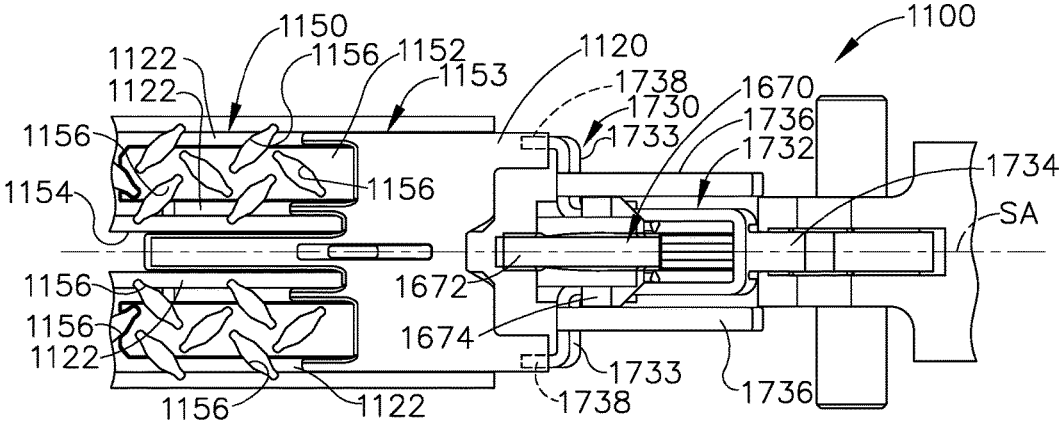

FIG. 41

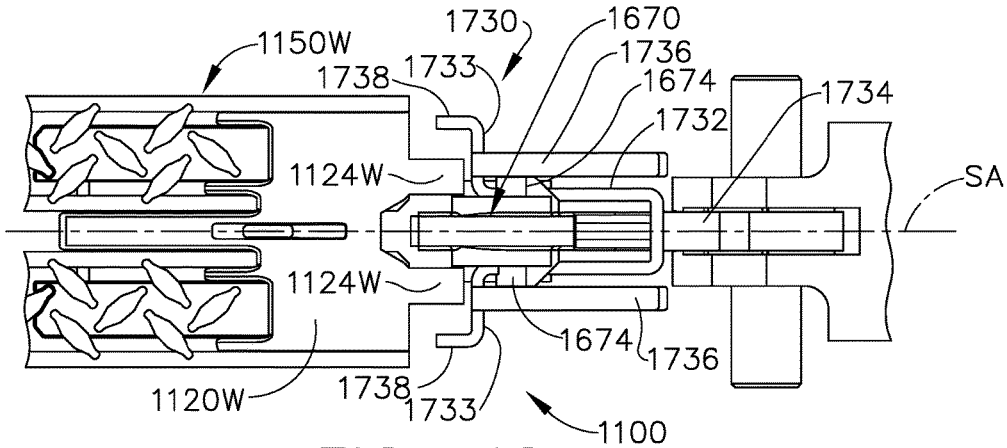

FIG. 42

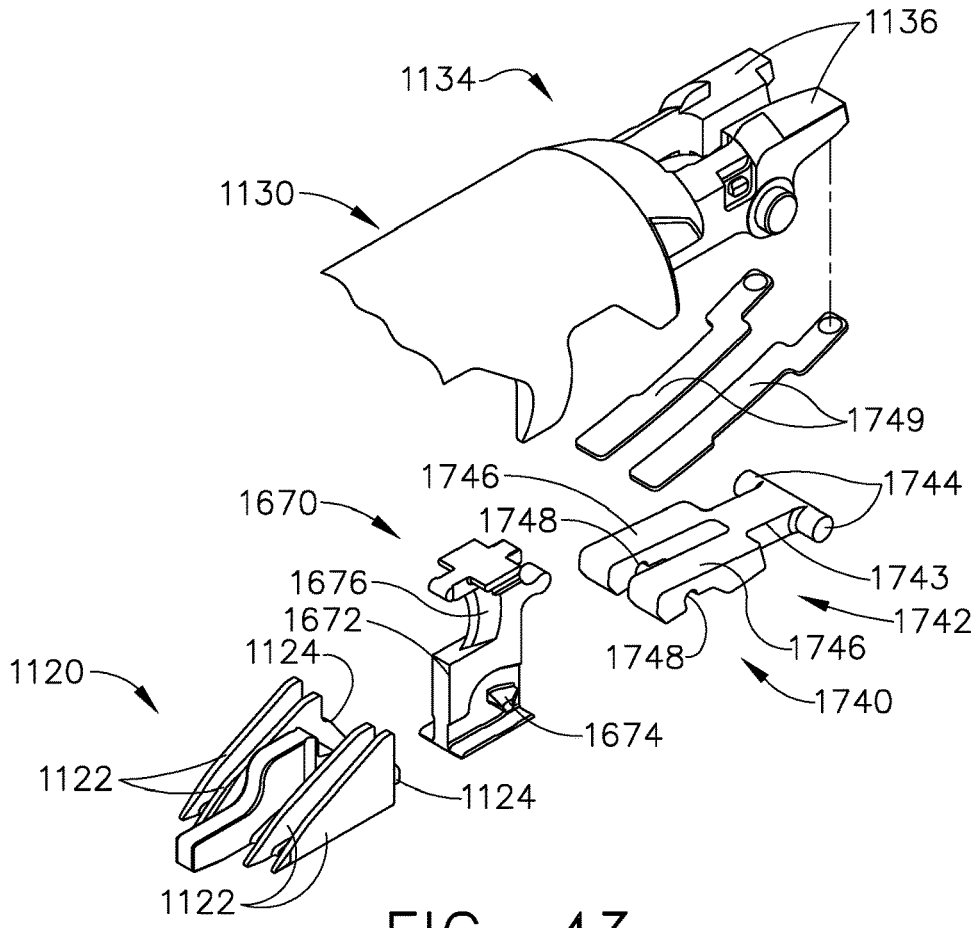
1136
1134
1130
1749
1746
1744
1670
1748
1743
1676
1742
1672
1748
1746
1124
1120
1740
1674
1122
1124
1122

FIG. 43

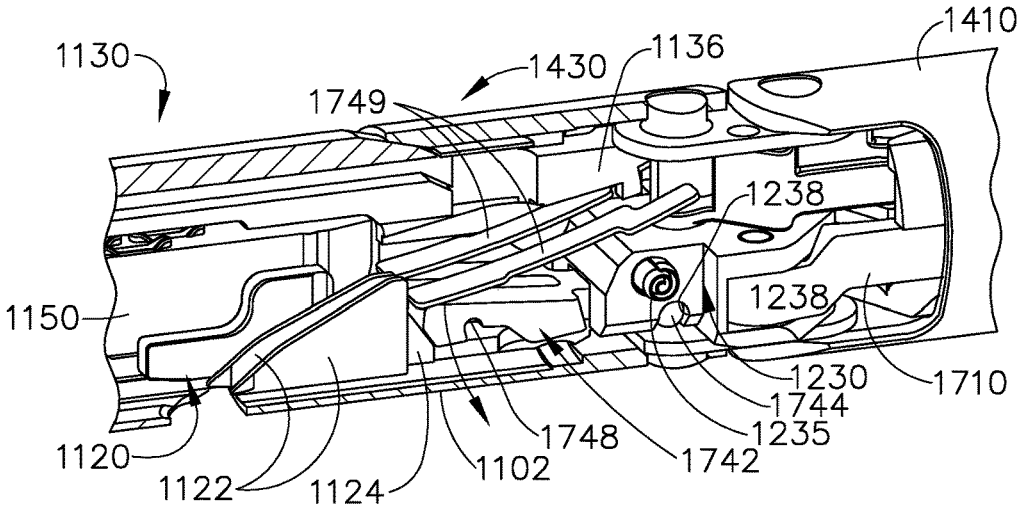
1410
1130
1430
1136
1749
1238
1150
1238
1230
1710
1744
1235
1748
1742
1120
1102
1122
1124

FIG. 44

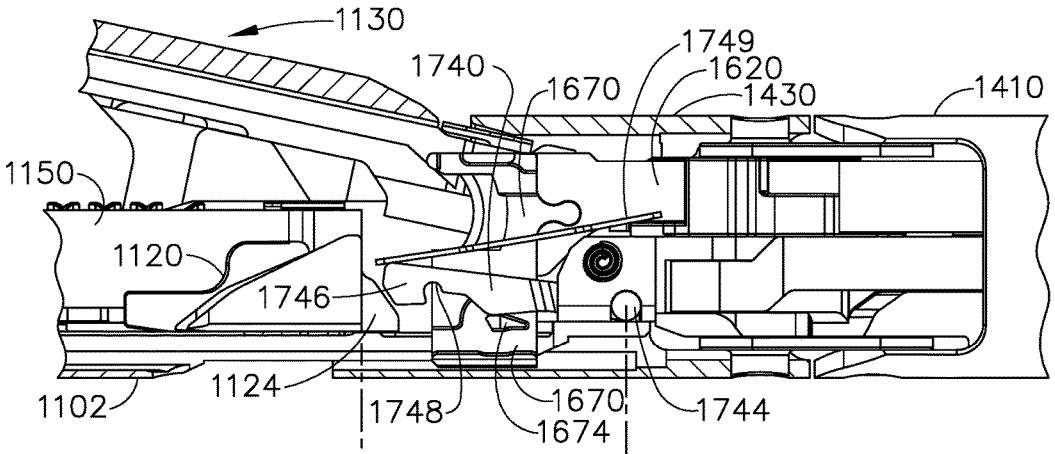

FIG. 45

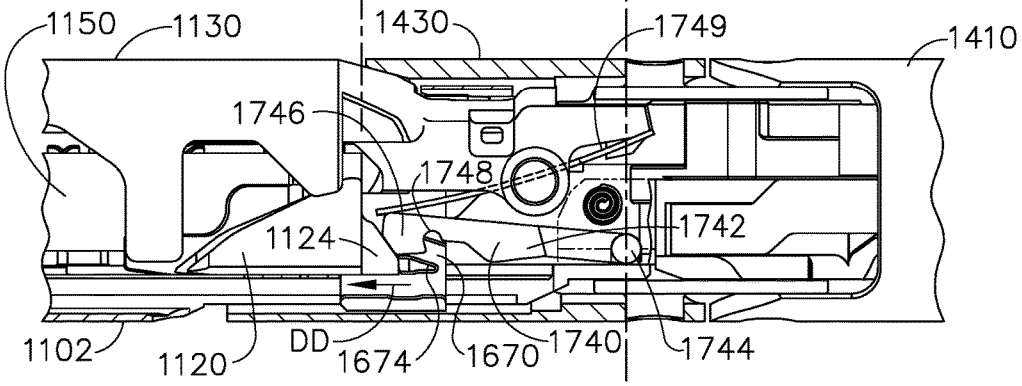

FIG. 46

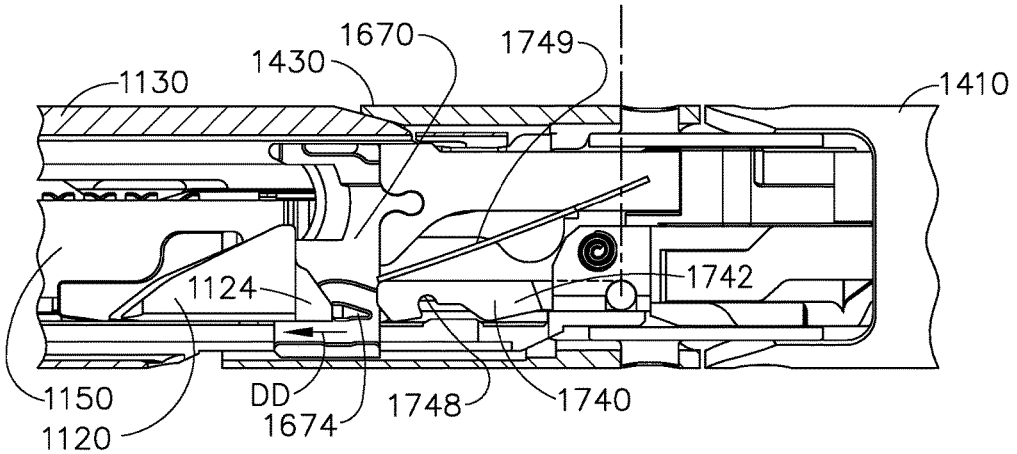

FIG. 47

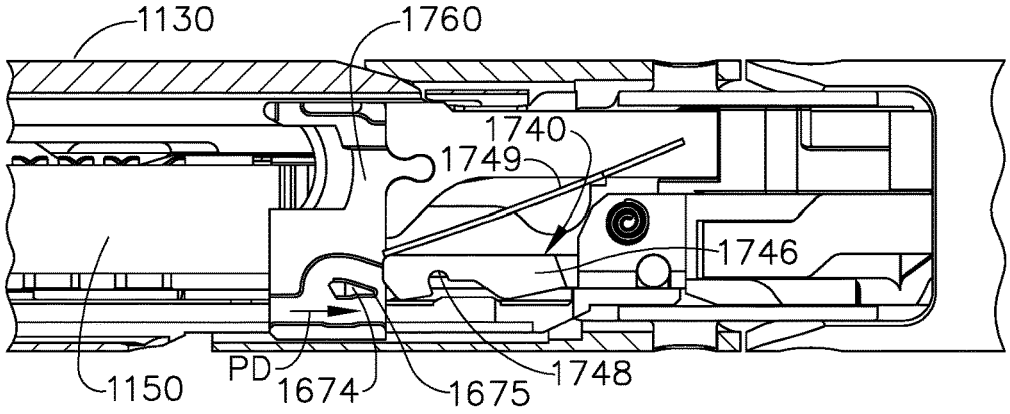

FIG. 48

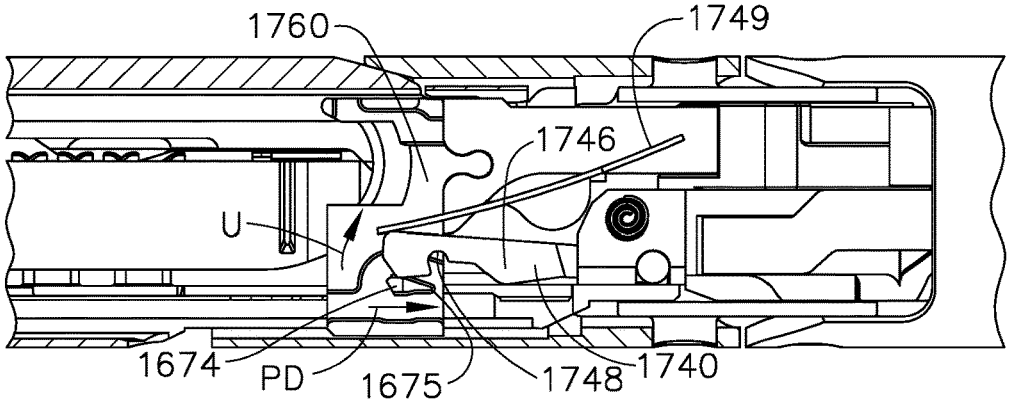

FIG. 49

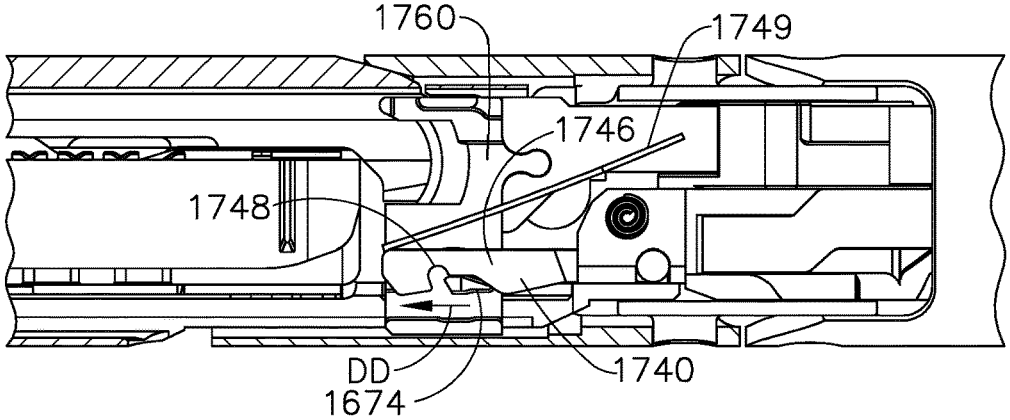

FIG. 50

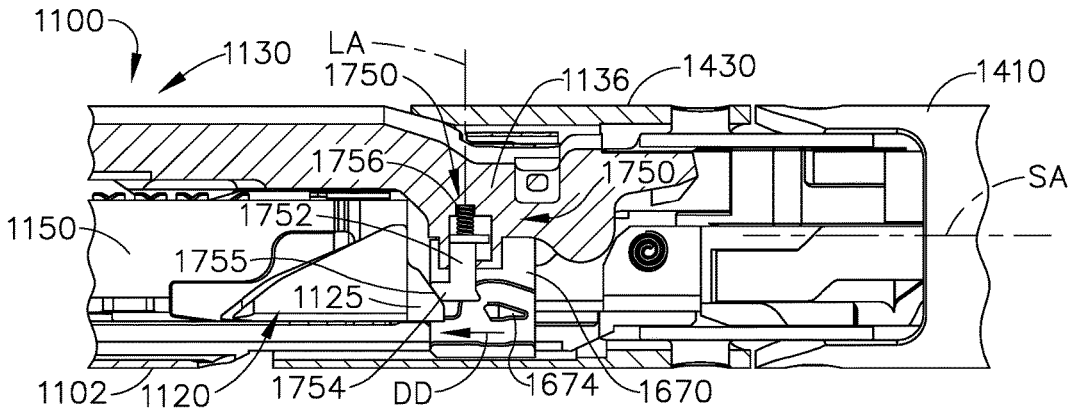

FIG. 51

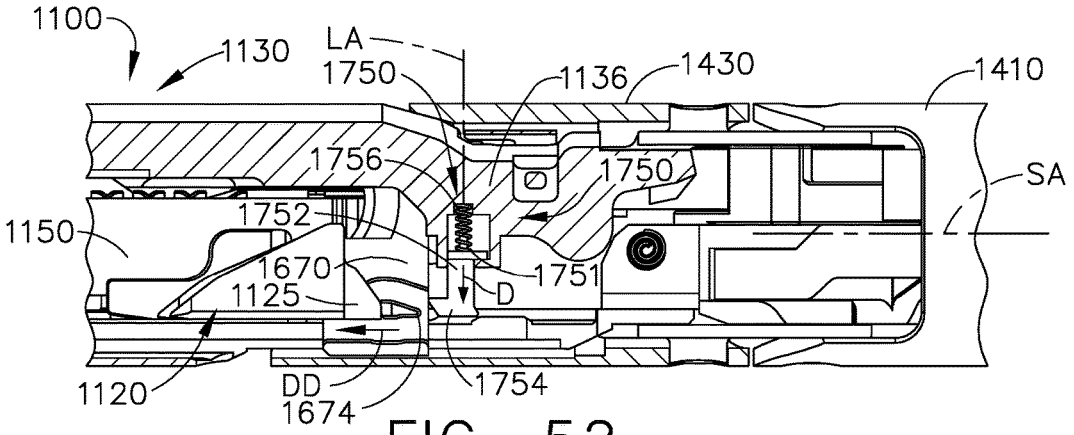

FIG. 52

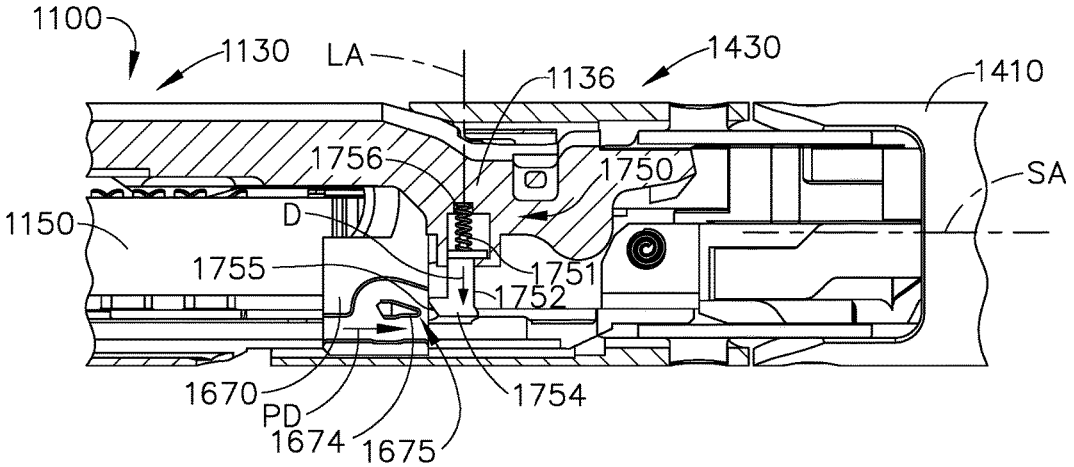

FIG. 53

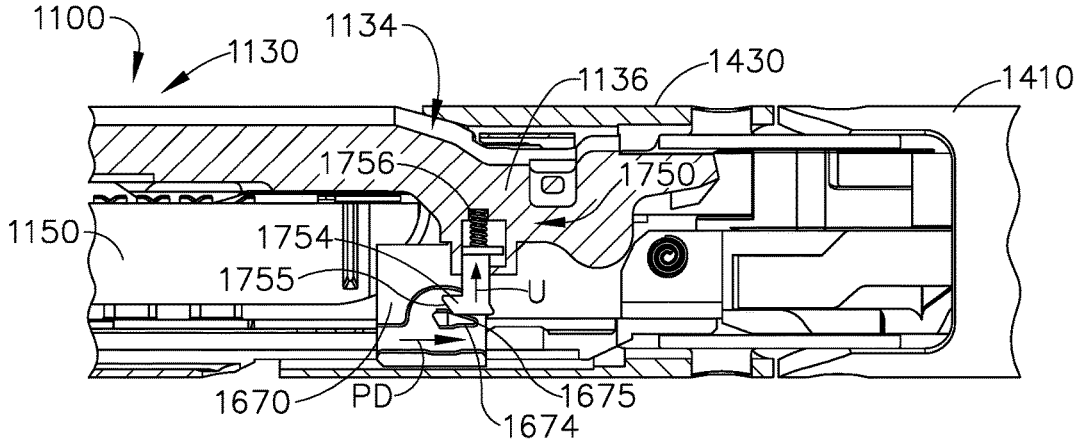
1100
1130
1134
1136
1430
1410
1756
1750
1150
1754
1755
U
1670
PD
1675
1674

FIG. 54

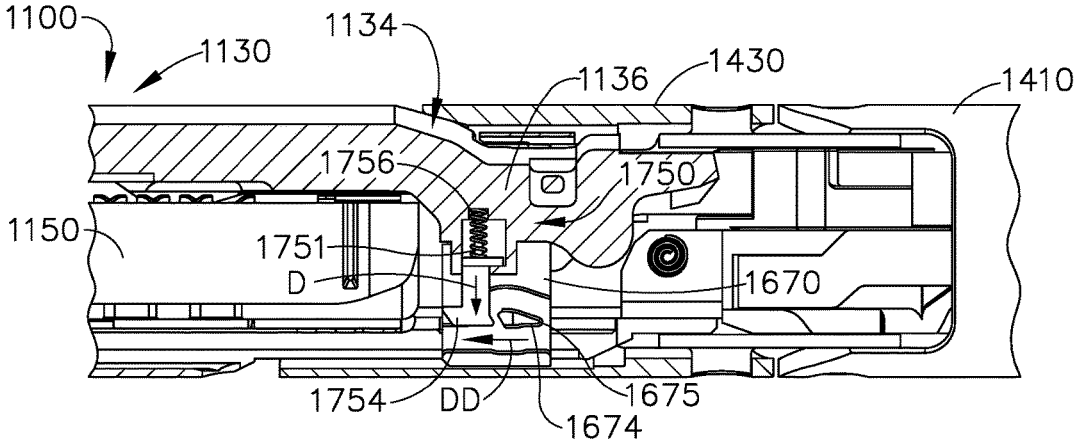
1100
1130
1134
1136
1430
1410
1756
1750
1150
1751
D
1670
1754
DD
1675
1674

FIG. 55

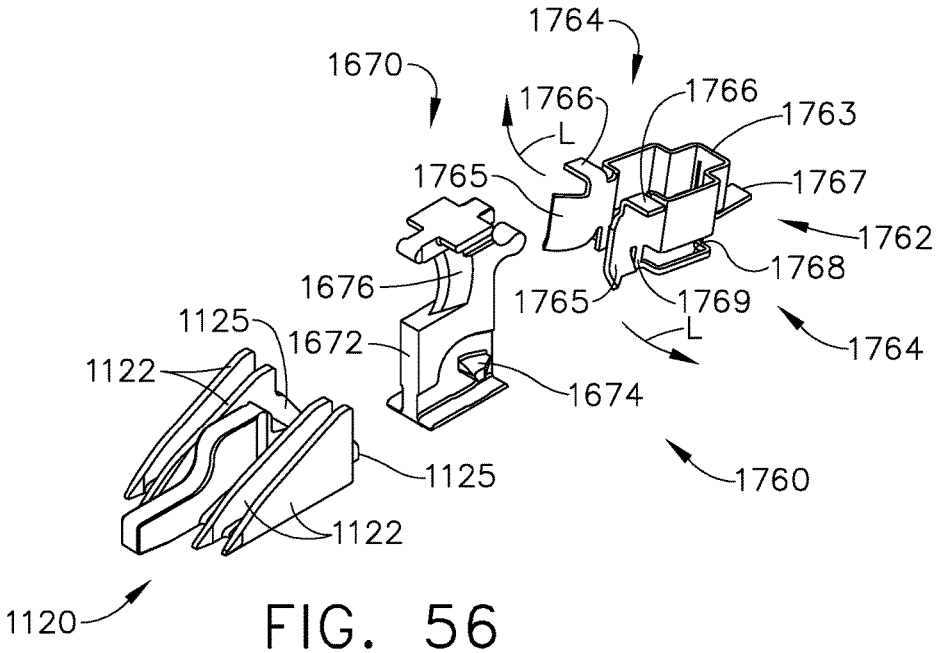
1764
1670
1766
1766
1763
L
1765
1767
1762
1768
1676
1765
1769
1125
1672
L
1764
1122
1674
1125
1760
1122
1120

FIG. 56

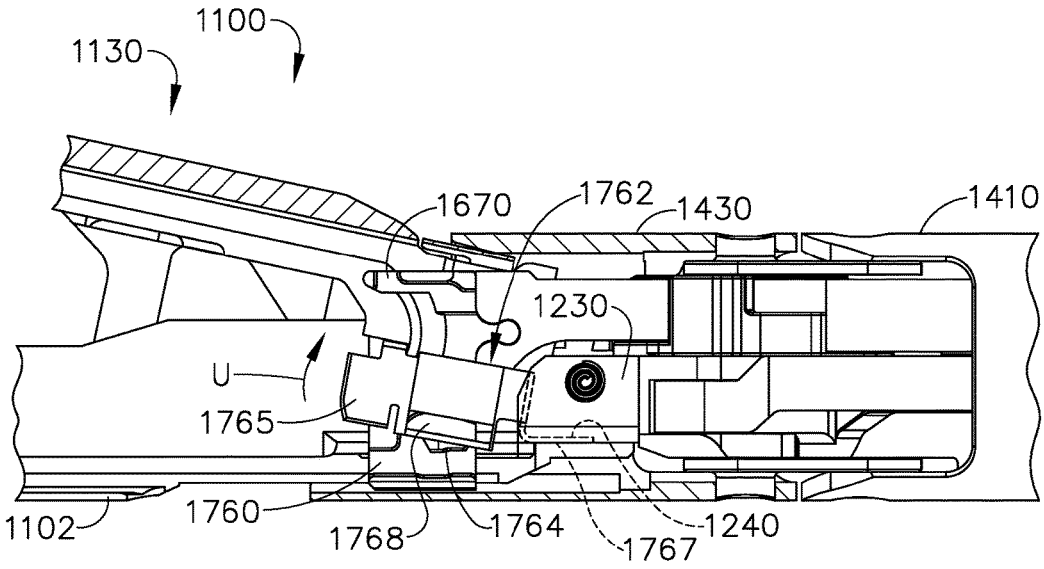
1100
1130
1670
1762
1430
1410
1230
U
1765
1102
1760
1768
1764
1240
1767

FIG. 57

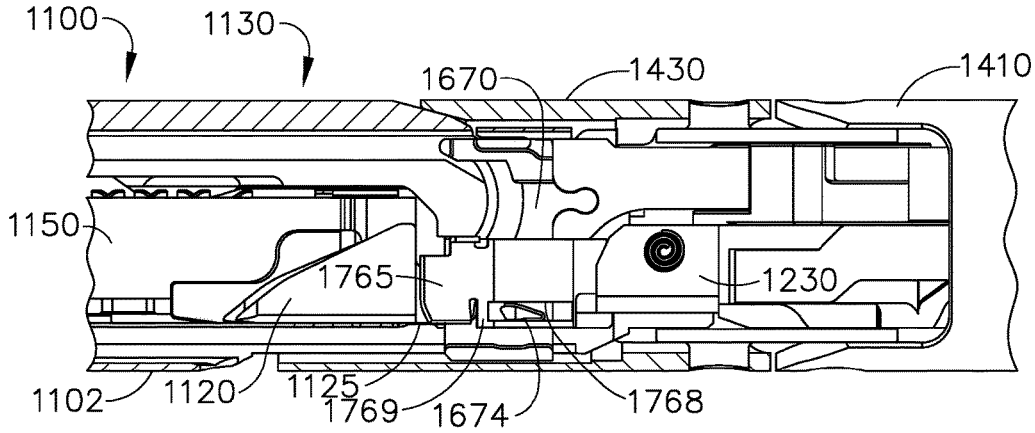

FIG. 58

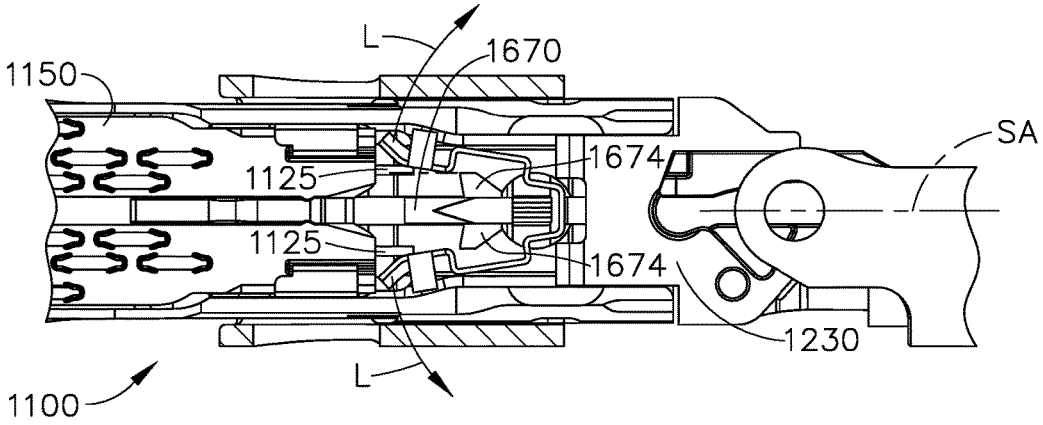

FIG. 59

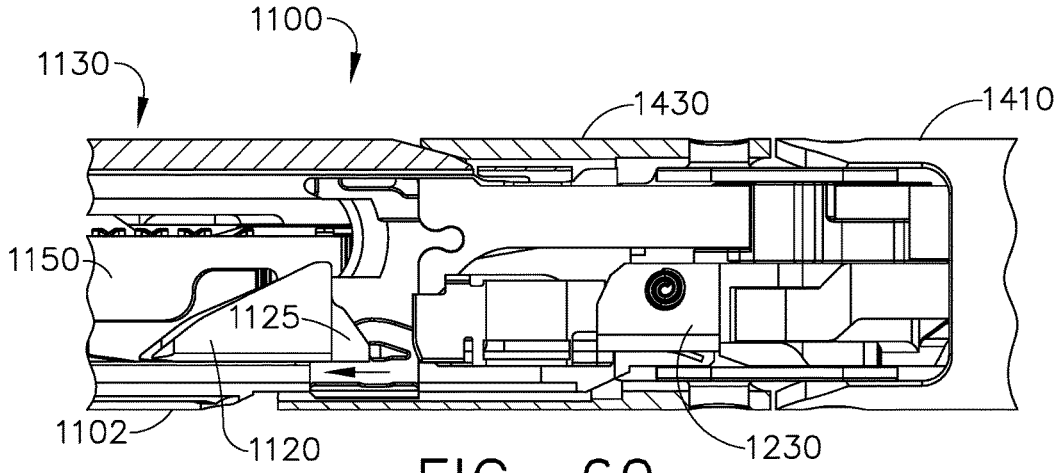

FIG. 60

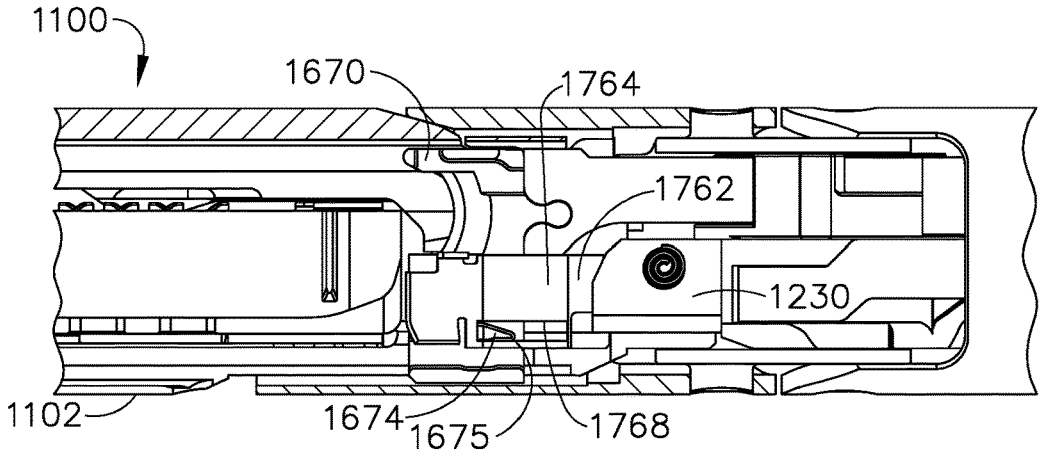

FIG. 61

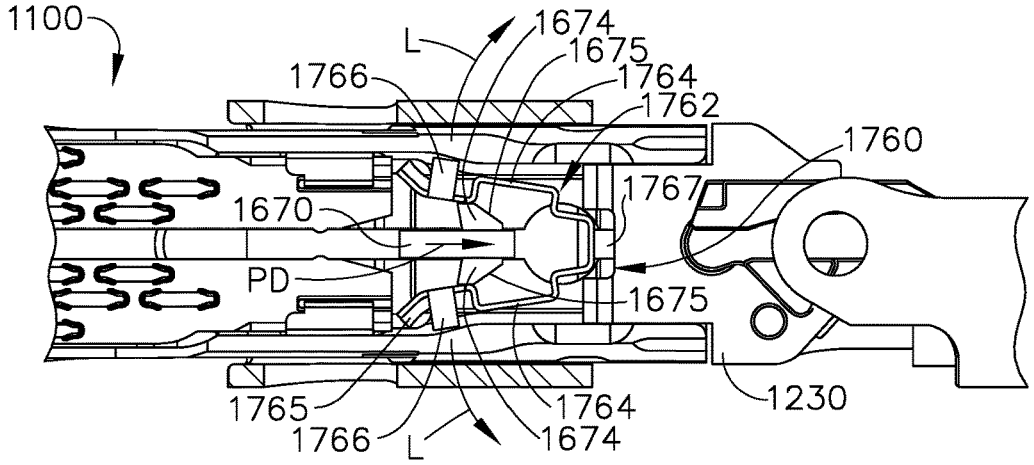

FIG. 62

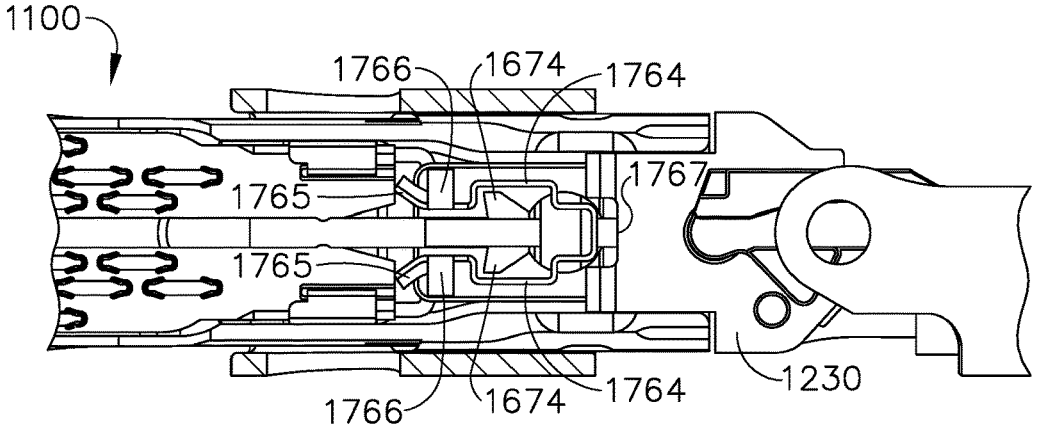

FIG. 63

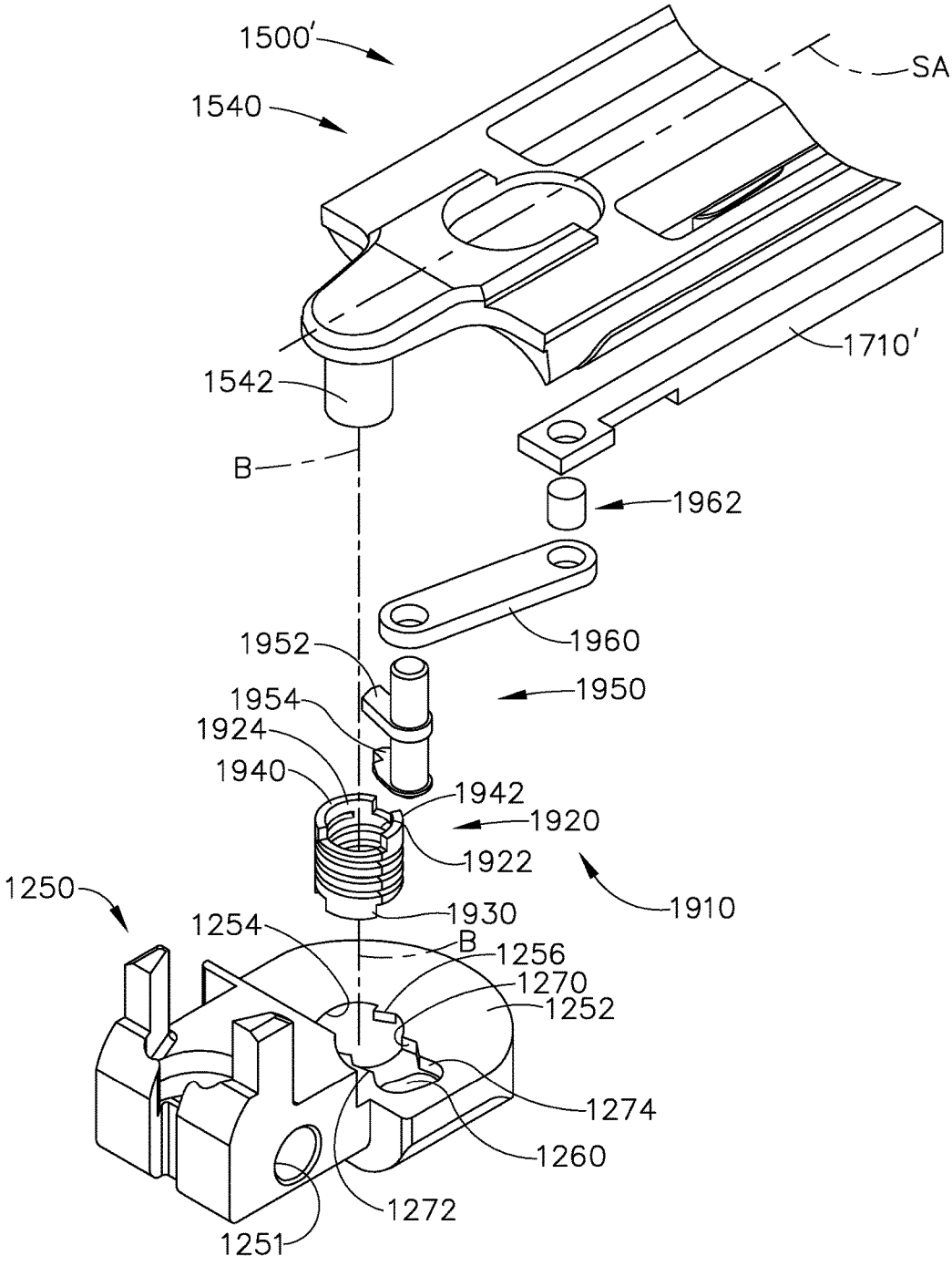
1500'
SA
1540
1710'
1542
B
1962
1960
1952
1950
1954
1924
1940
1942
1920
1922
1910
1250
1930
1254
B
1256
1270
1252
1274
1260
1272
1251

FIG. 64

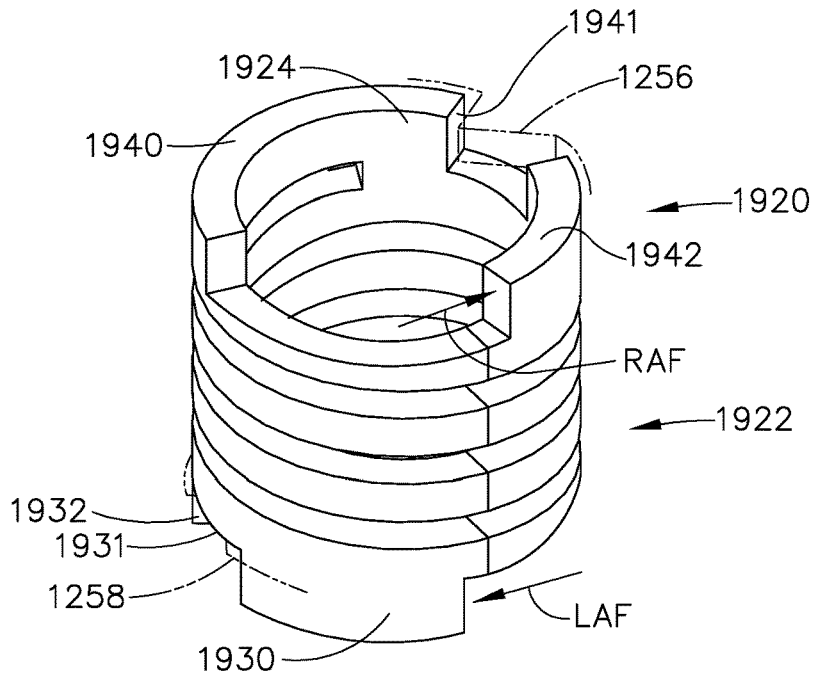
1941
1924
1256
1940
1920
1942
RAF
1922
1932
1931
1258
LAF
1930

FIG. 65

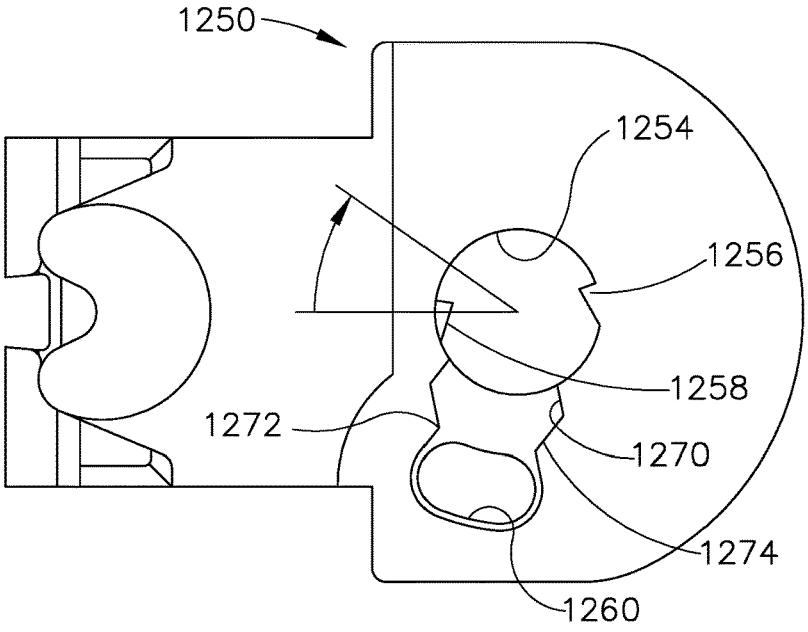
1250
1254
1256
1258
1272
1270
1274
1260

FIG. 66

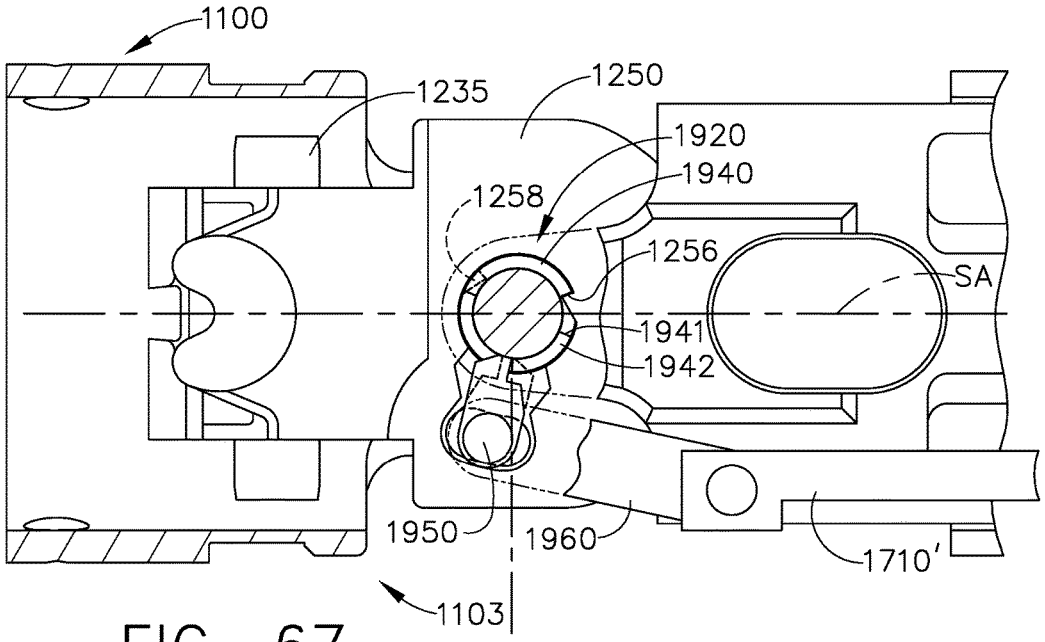
1100
1235
1250
1920
1940
1258
1256
SA
1941
1942
1950
1960
1710'
1103

FIG. 67

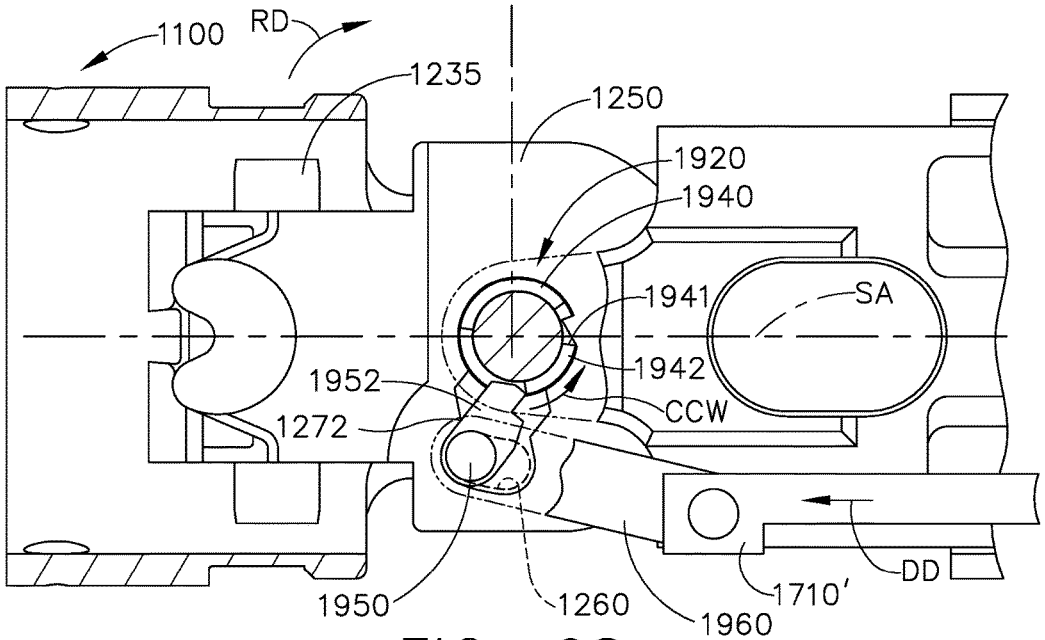
1100
RD
1235
1250
1920
1940
1941
SA
1942
1952
CCW
1272
1950
1260
1960
1710'
DD

FIG. 68

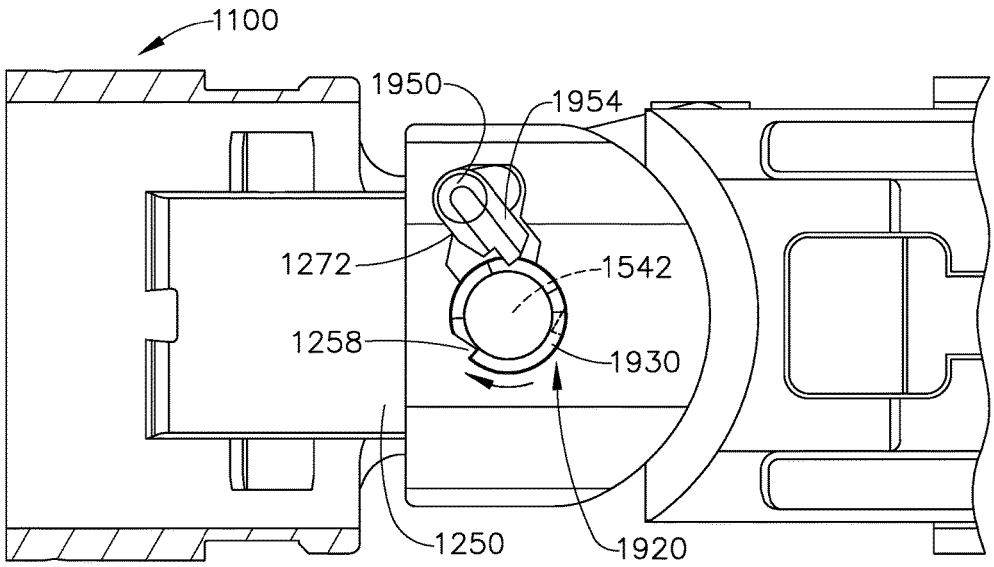
1100
1950
1954
1272
1542
1258
1930
1250
1920

FIG. 69

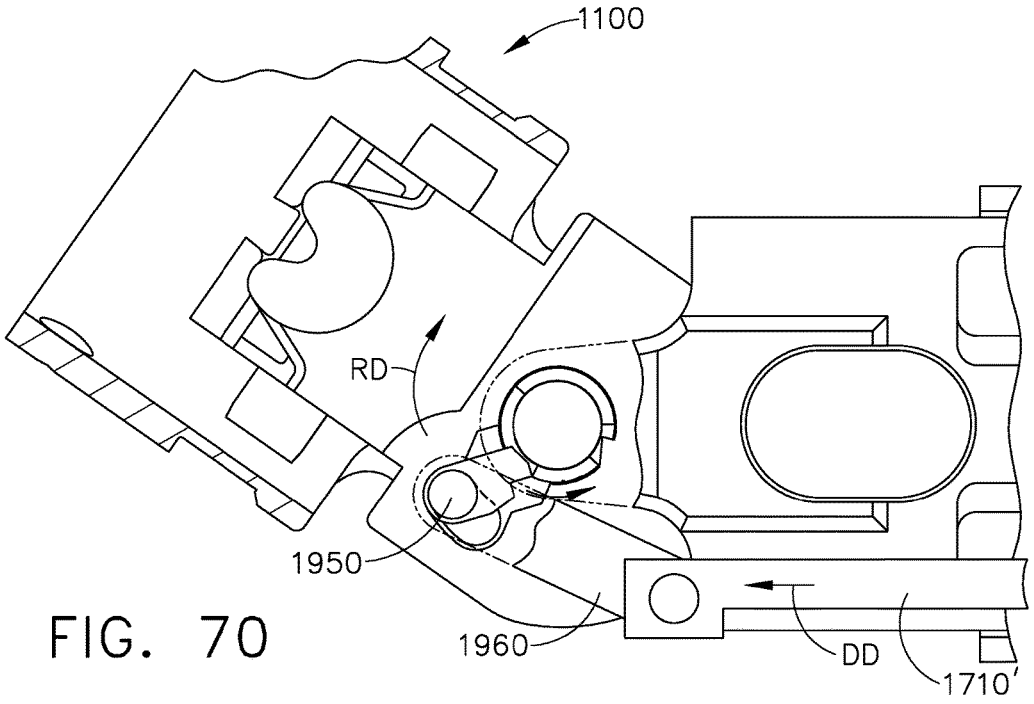
1100
RD
1950
1960
DD
1710'

FIG. 70

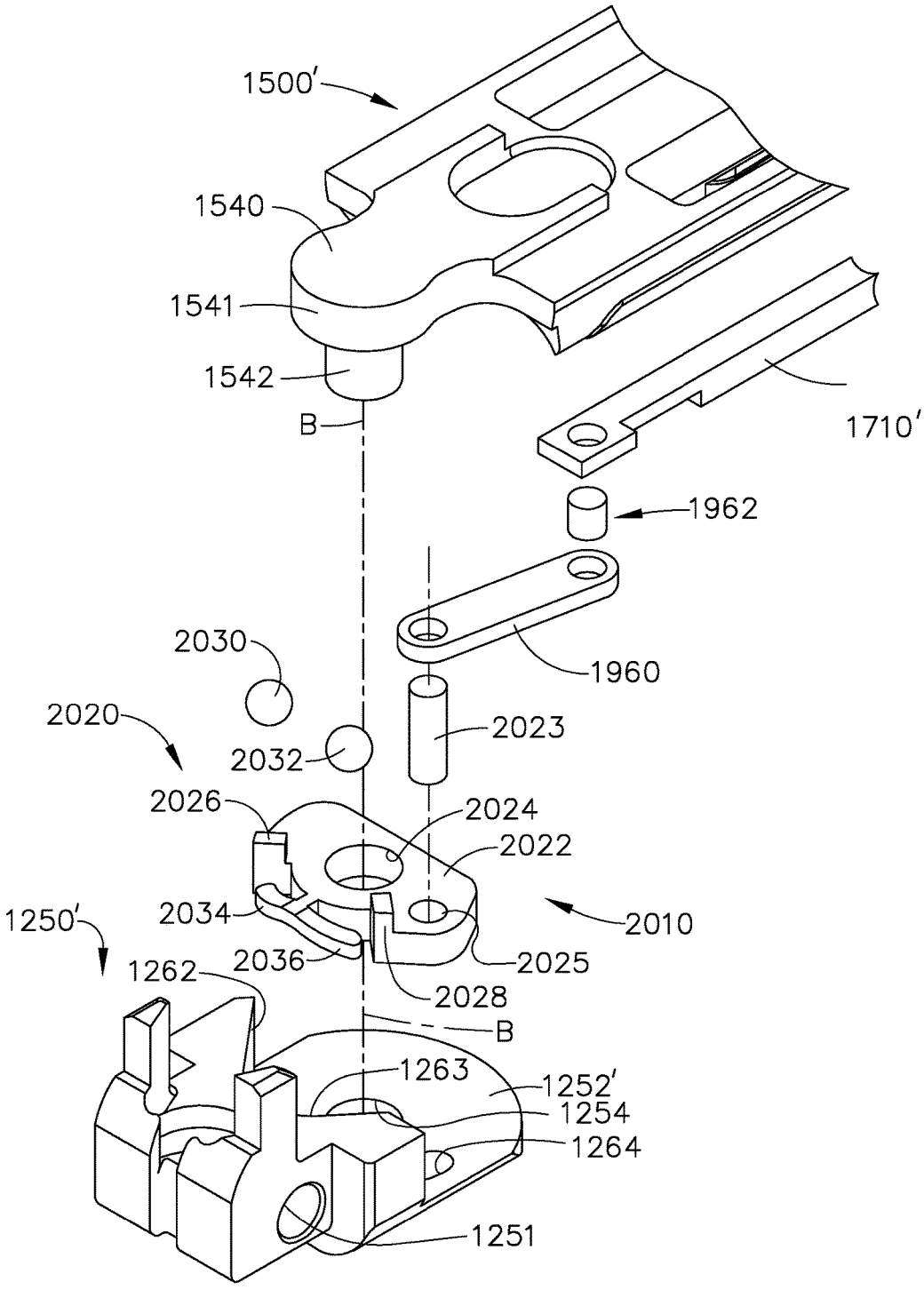
1500′
1540
1541
1542
B
1710′
1962
1960
2030
2020
2032
2023
2026
2024
2022
2034
2010
1250′
2036
2025
1262
2028
B
1263
1252′
1254
1264
1251

FIG. 71

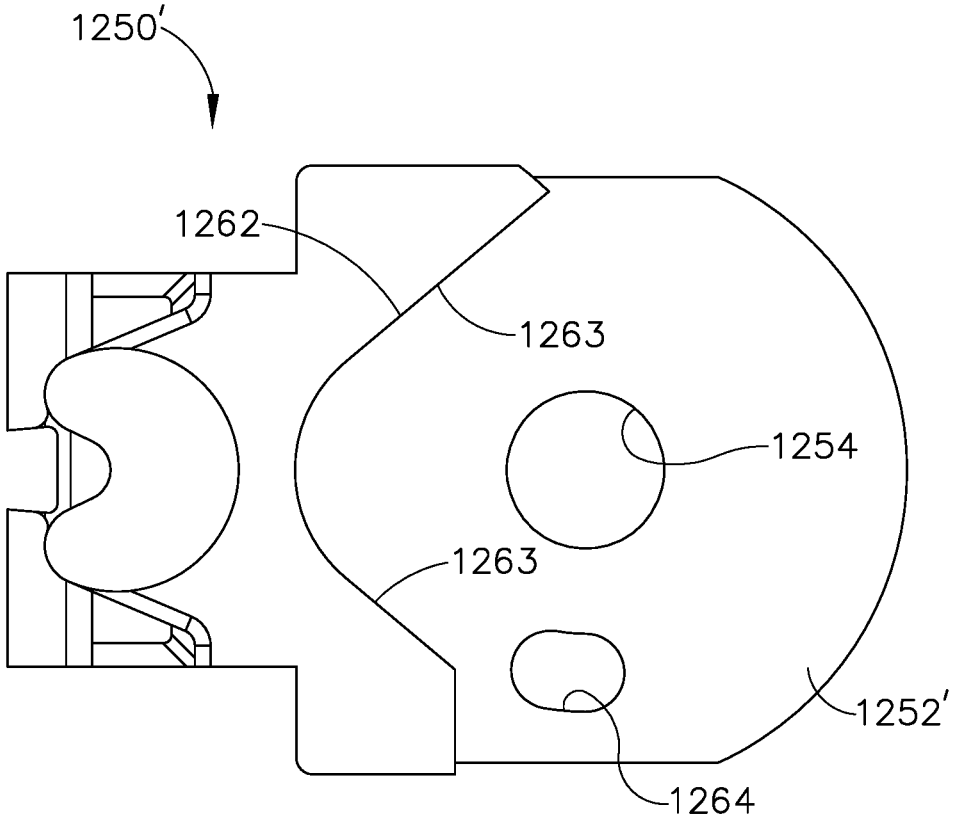

FIG. 72

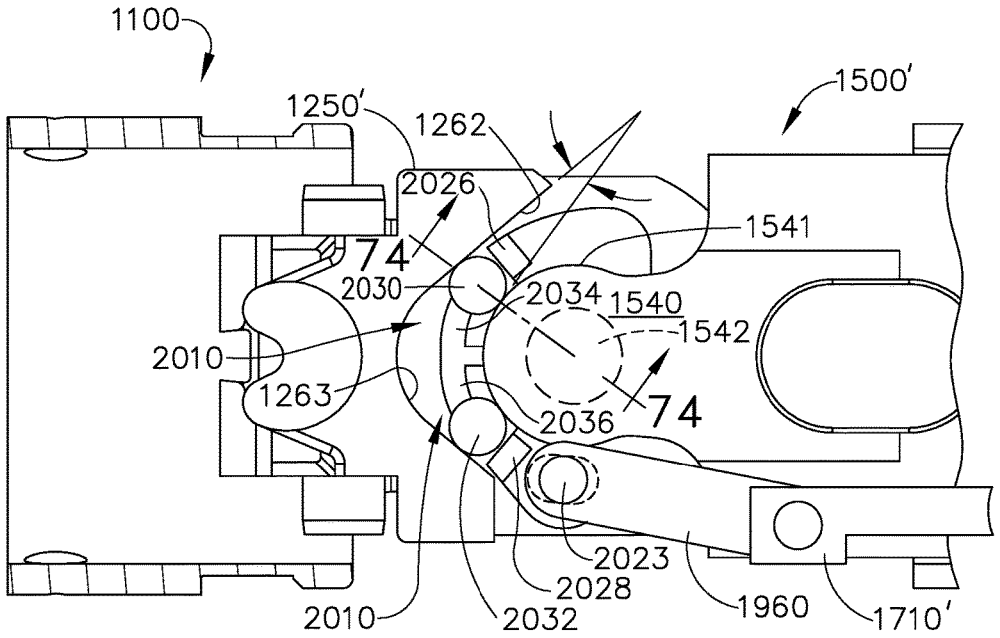
1100
1250'
1262
1500'
2026
1541
74
2030
2034
1540
1542
2010
1263
2036
74
2023
2028
2010
2032
1960
1710'

FIG. 73

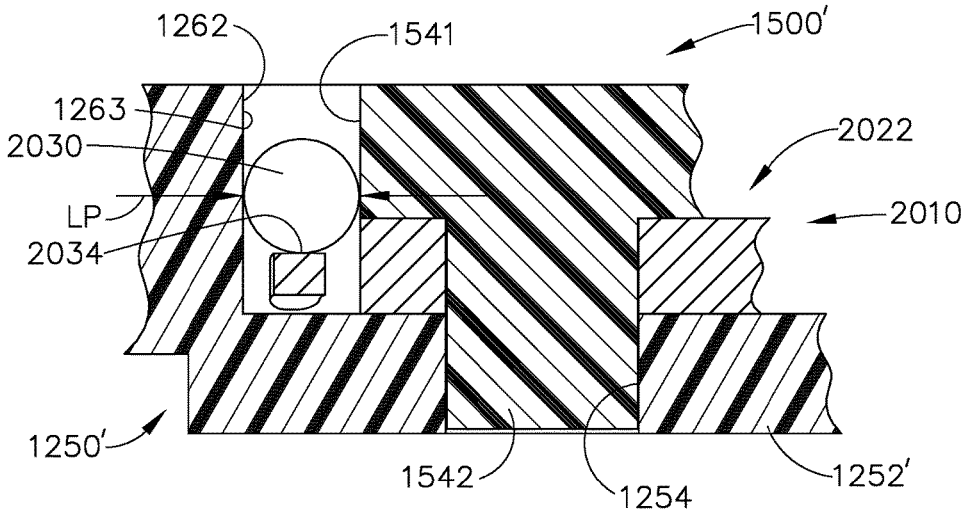
1262
1541
1500'
1263
2030
2022
LP
2010
2034
1250'
1542
1254
1252'

FIG. 74

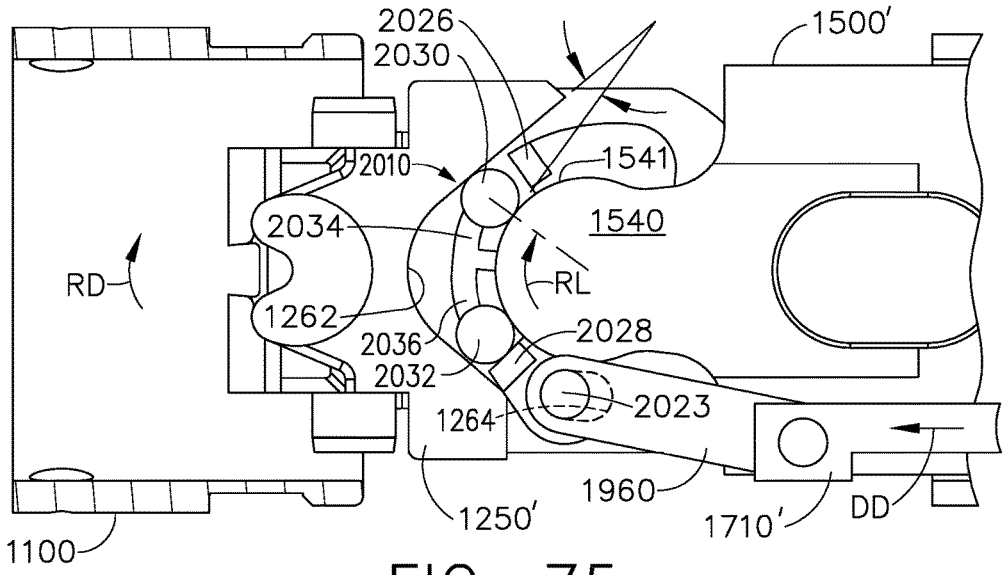
2026
2030
1500'
2010
1541
1540
2034
RD
RL
1262
2036
2028
2032
2023
1264
1960
1250'
1710'
DD
1100

FIG. 75

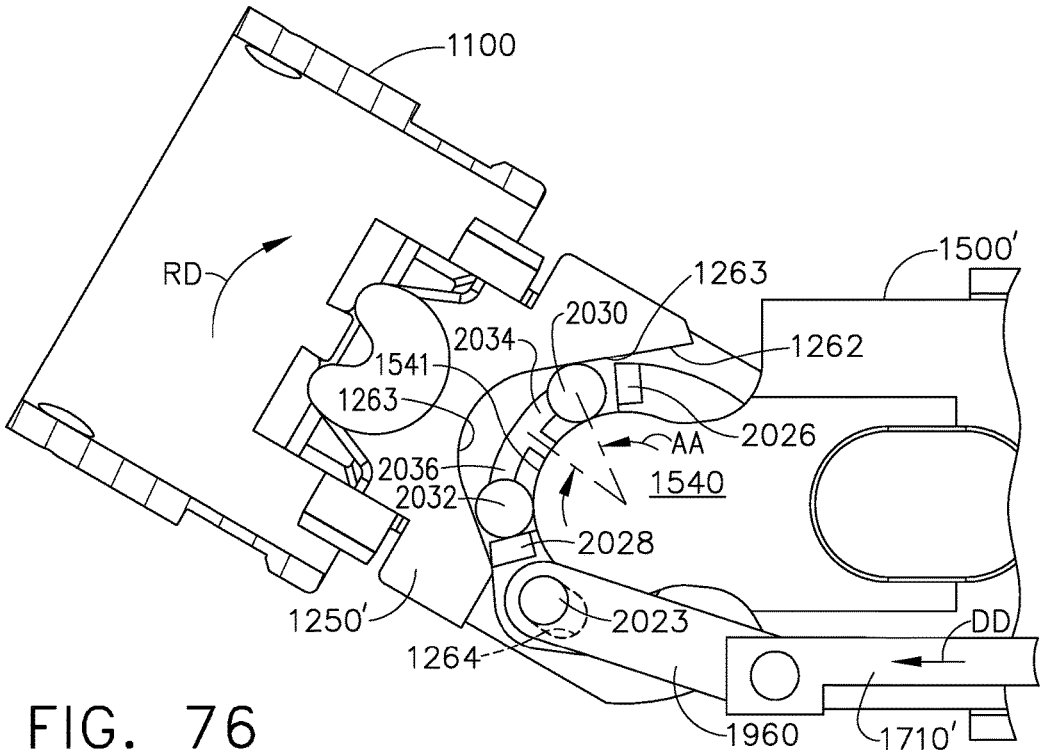
1100
RD
1263
1500'
2030
2034
1262
1541
1263
AA
2026
2036
1540
2032
2028
1250'
2023
DD
1264
1960
1710'

FIG. 76

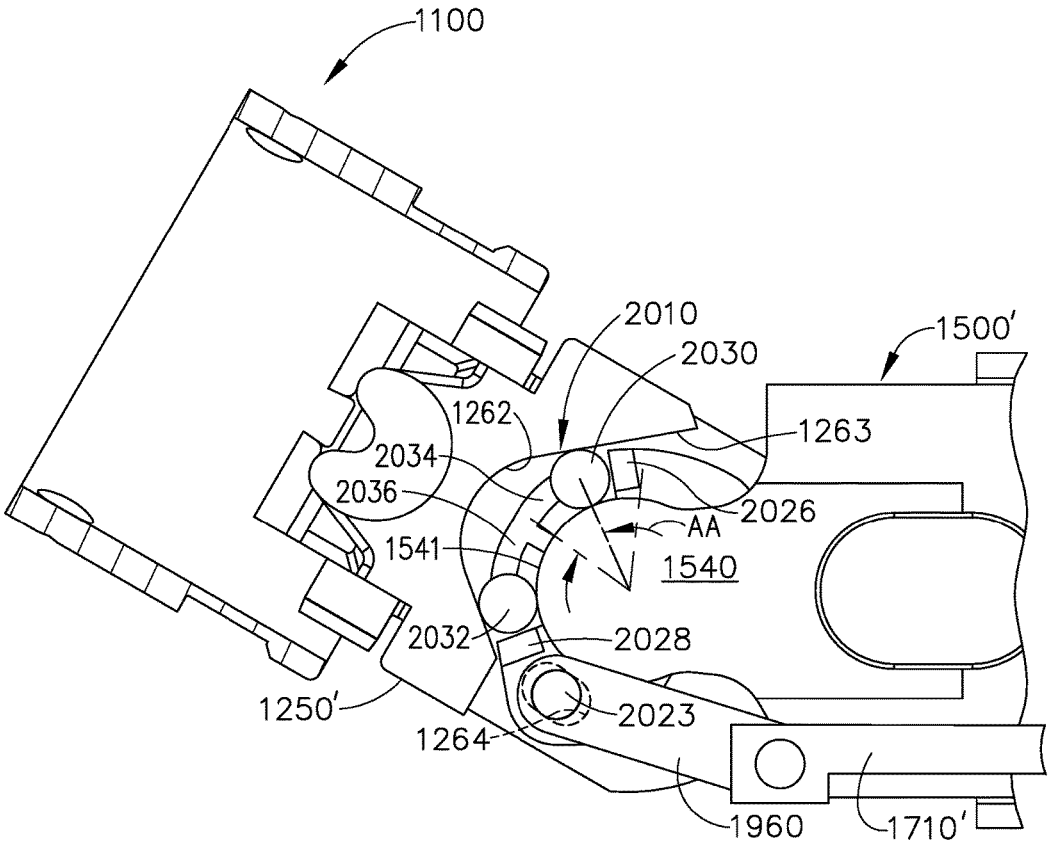
1100
2010
2030
1500'
1262
1263
2034
2036
2026
AA
1541
1540
2032
2028
1250'
2023
1264
1960
1710'

FIG. 77

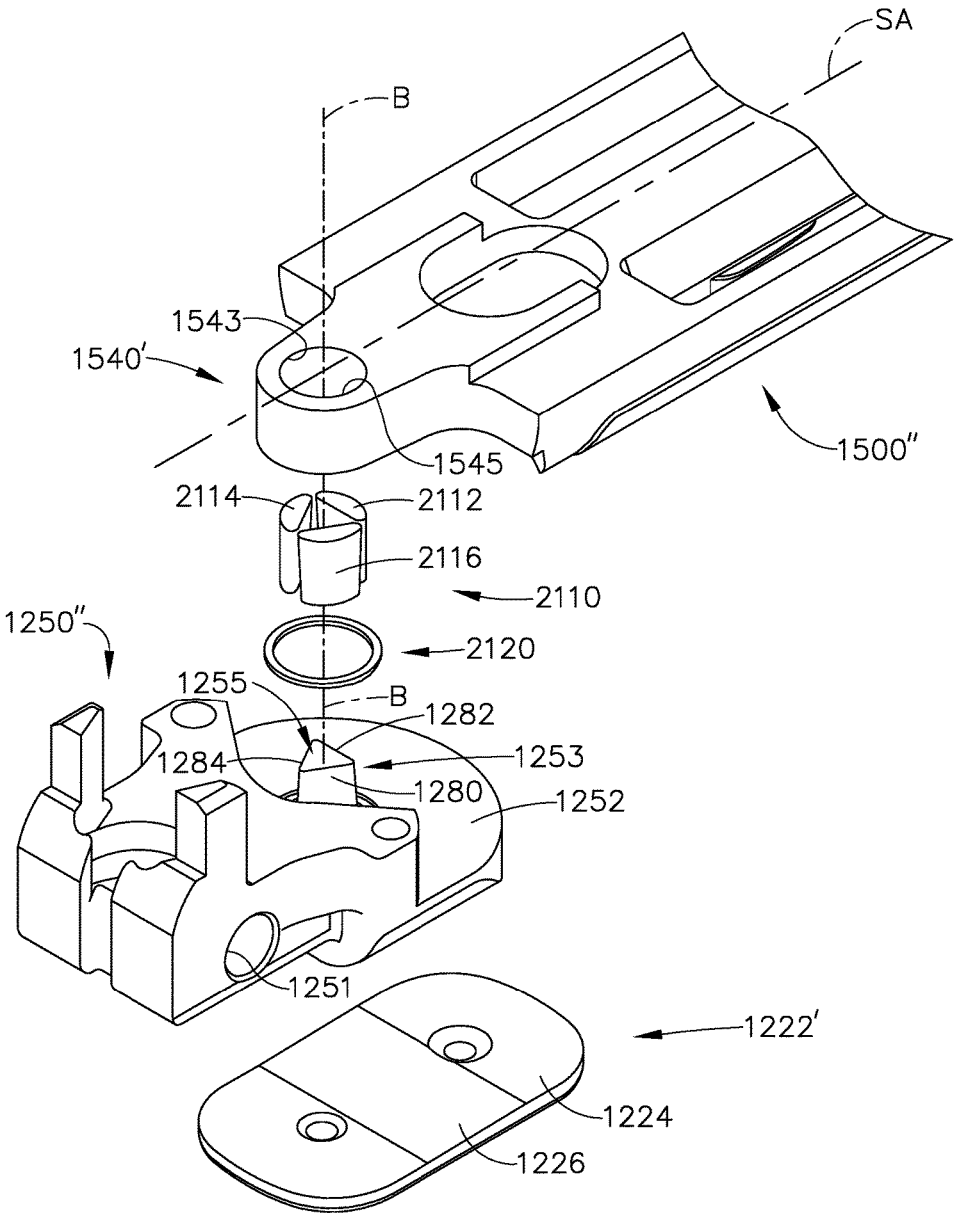
SA
B
1543
1540'
1545
1500"
2114
2112
2116
2110
1250"
2120
1255
B
1282
1284
1253
1280
1252
1251
1222'
1224
1226

FIG. 78

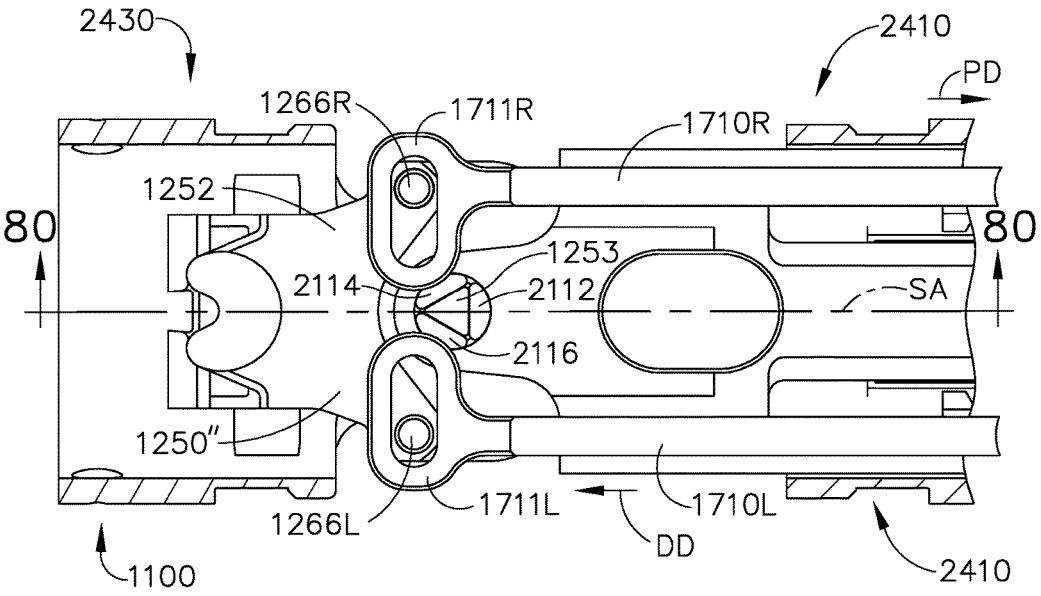
2430
2410
PD
1266R
1711R
1710R
1252
80
80
1253
2114
2112
SA
2116
1250″
1711L
1710L
1266L
DD
1100
2410

FIG. 79

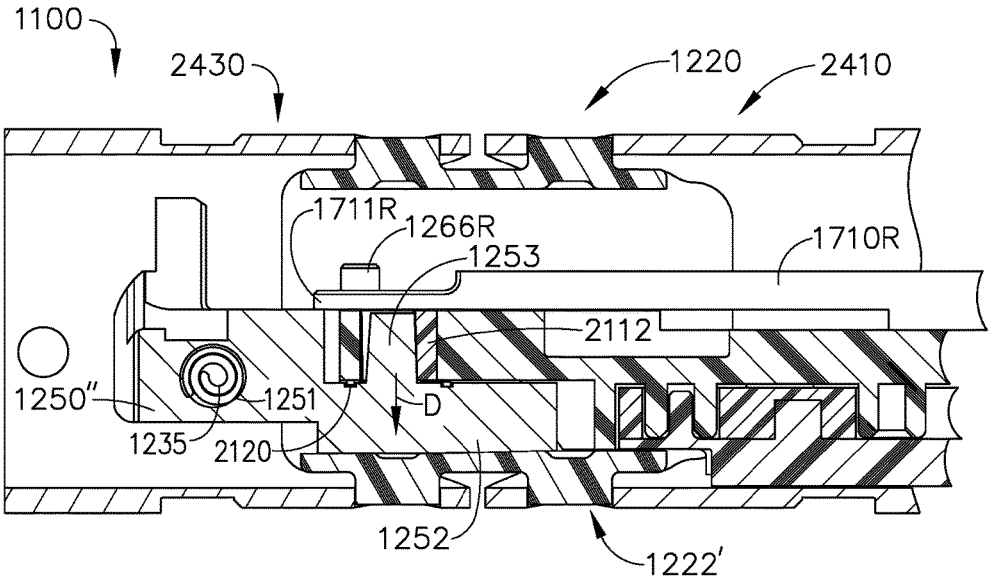
1100
2430
1220
2410
1711R
1266R
1253
1710R
2112
1250″
1251
D
1235
2120
1252
1222′

FIG. 80

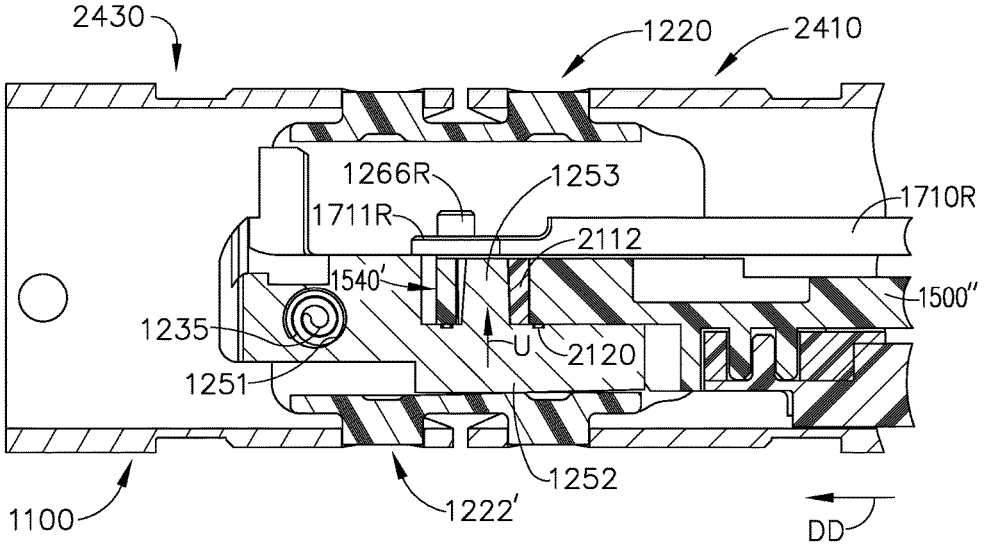
2430
1220
2410
1266R
1253
1711R
1710R
2112
1540'
1500"
1235
U
2120
1251
1252
1100
1222'
DD

FIG. 81

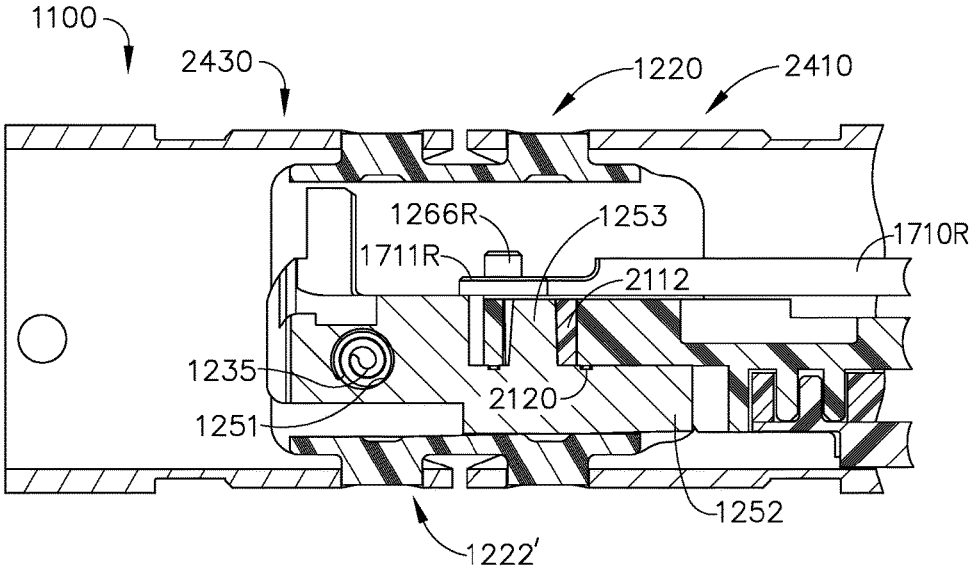
1100
2430
1220
2410
1266R
1253
1711R
1710R
2112
1235
2120
1251
1252
1222'

FIG. 82

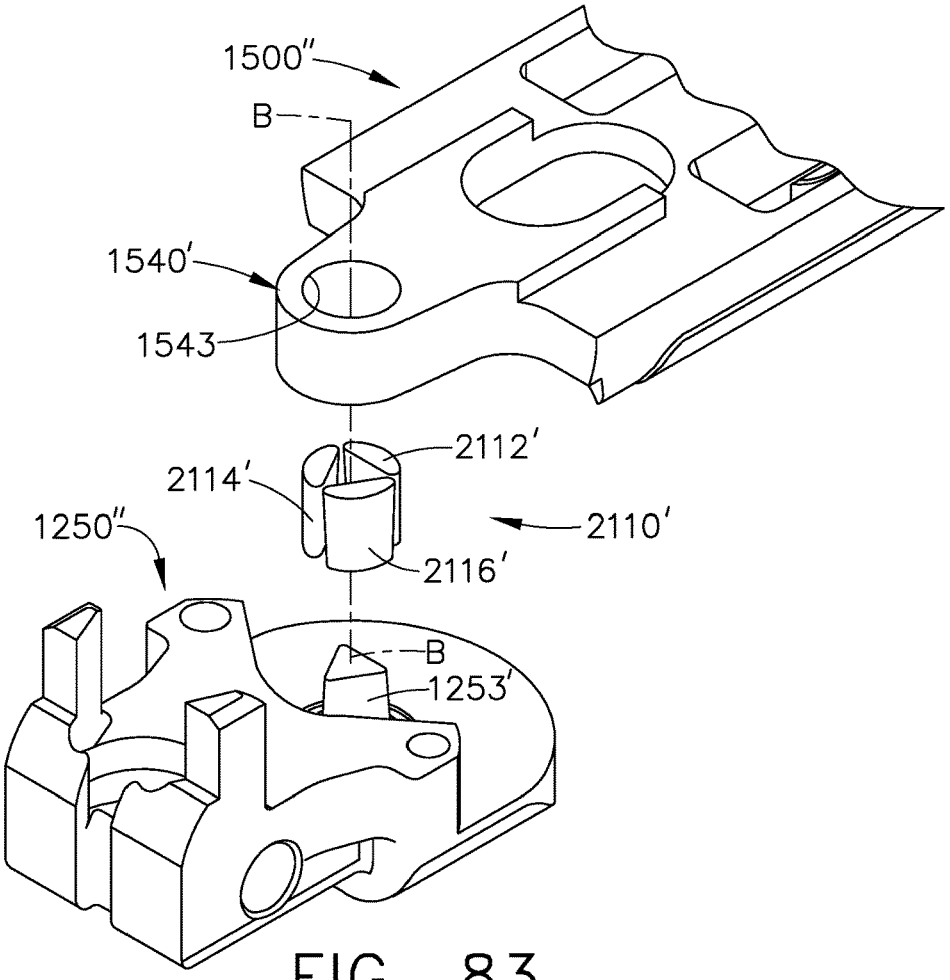
1500″
B
1540′
1543
2112′
2114′
2110′
1250″
2116′
B
1253′

FIG. 83

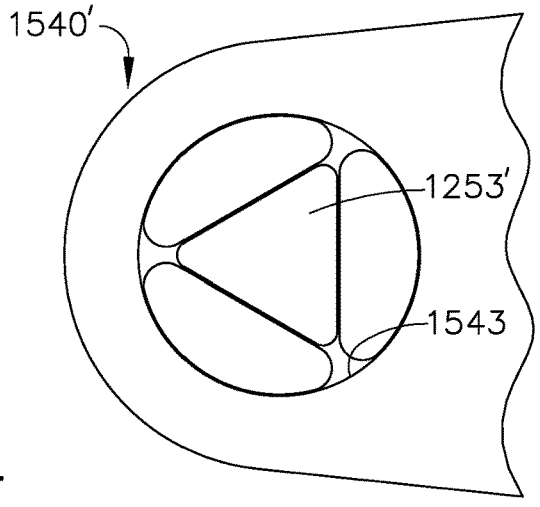
1540′
1253′
1543

FIG. 84

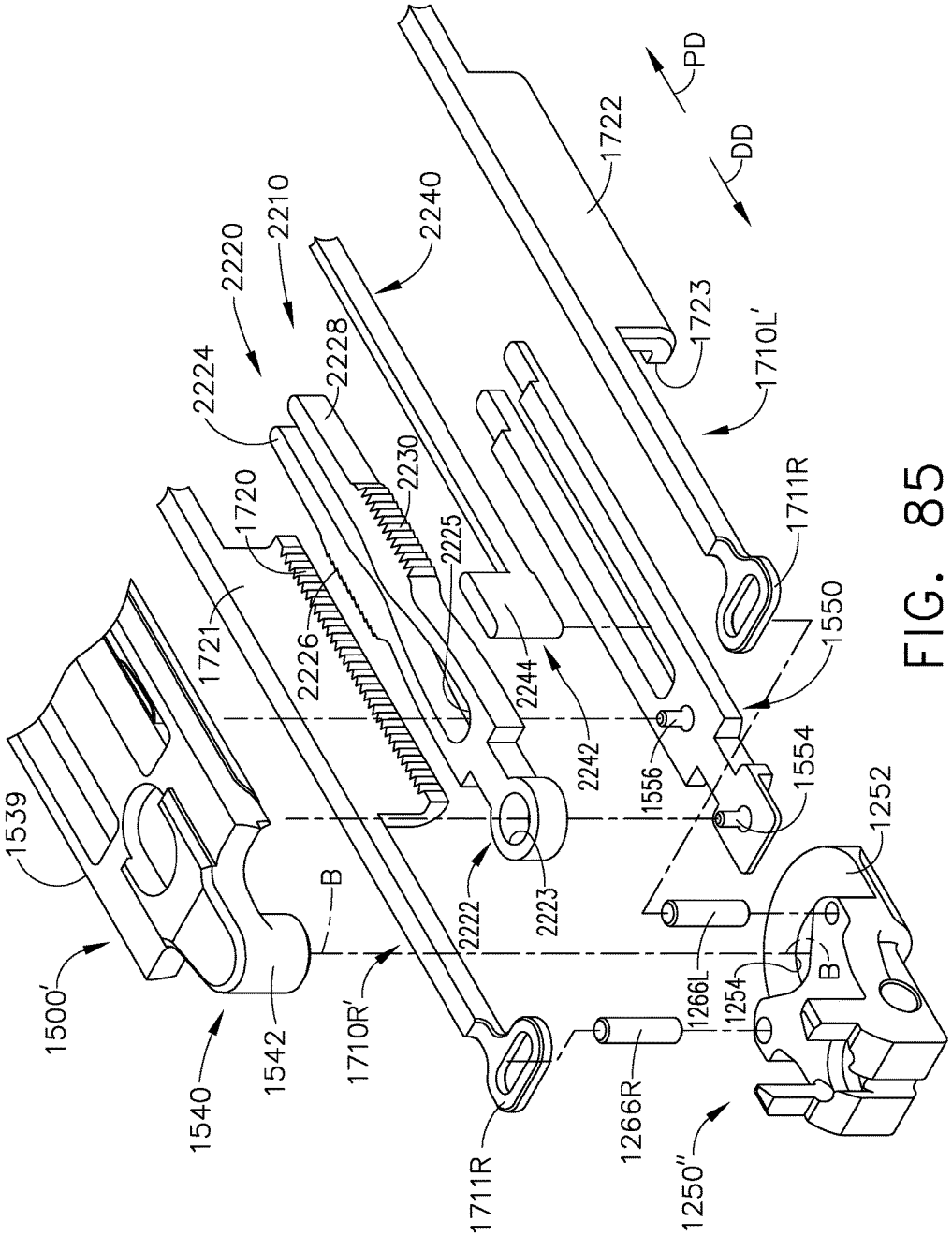
1539
1500'
1540
1542
B
1710R'
1711R
1720
1721
2220
2210
2224
2228
2240
2230
2225
2226
2222
2223
2244
2242
1722
PD
DD
1723
1710L'
1711R
1550
1556
1554
1252
1266L
1254
1266R
1250''

FIG. 85

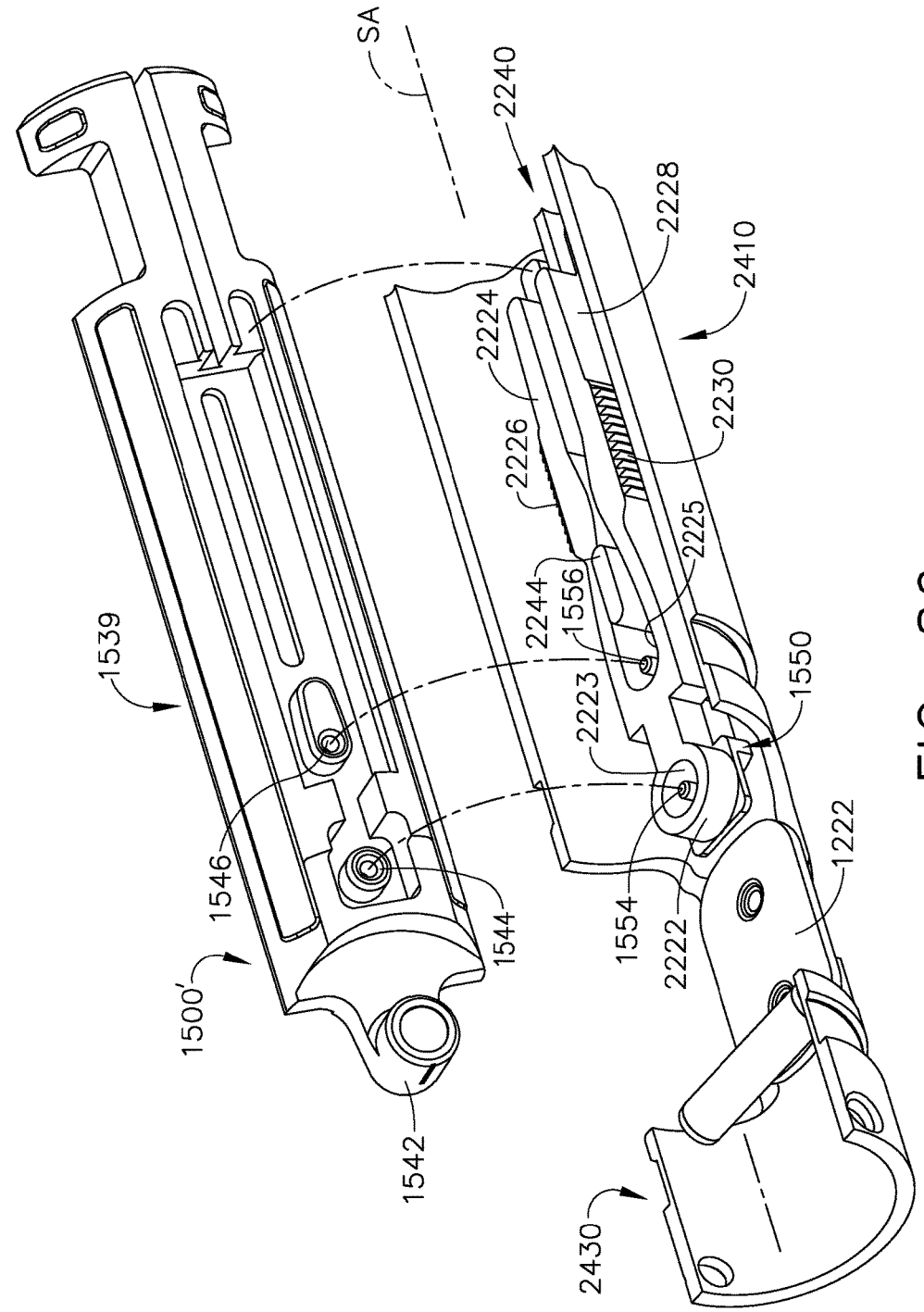
SA
2240
2228
2410
2224
2230
2226
2225
2244
1556
1539
2223
1550
1546
1554
1222
1544
2222
1500'
1542
2430

FIG. 86

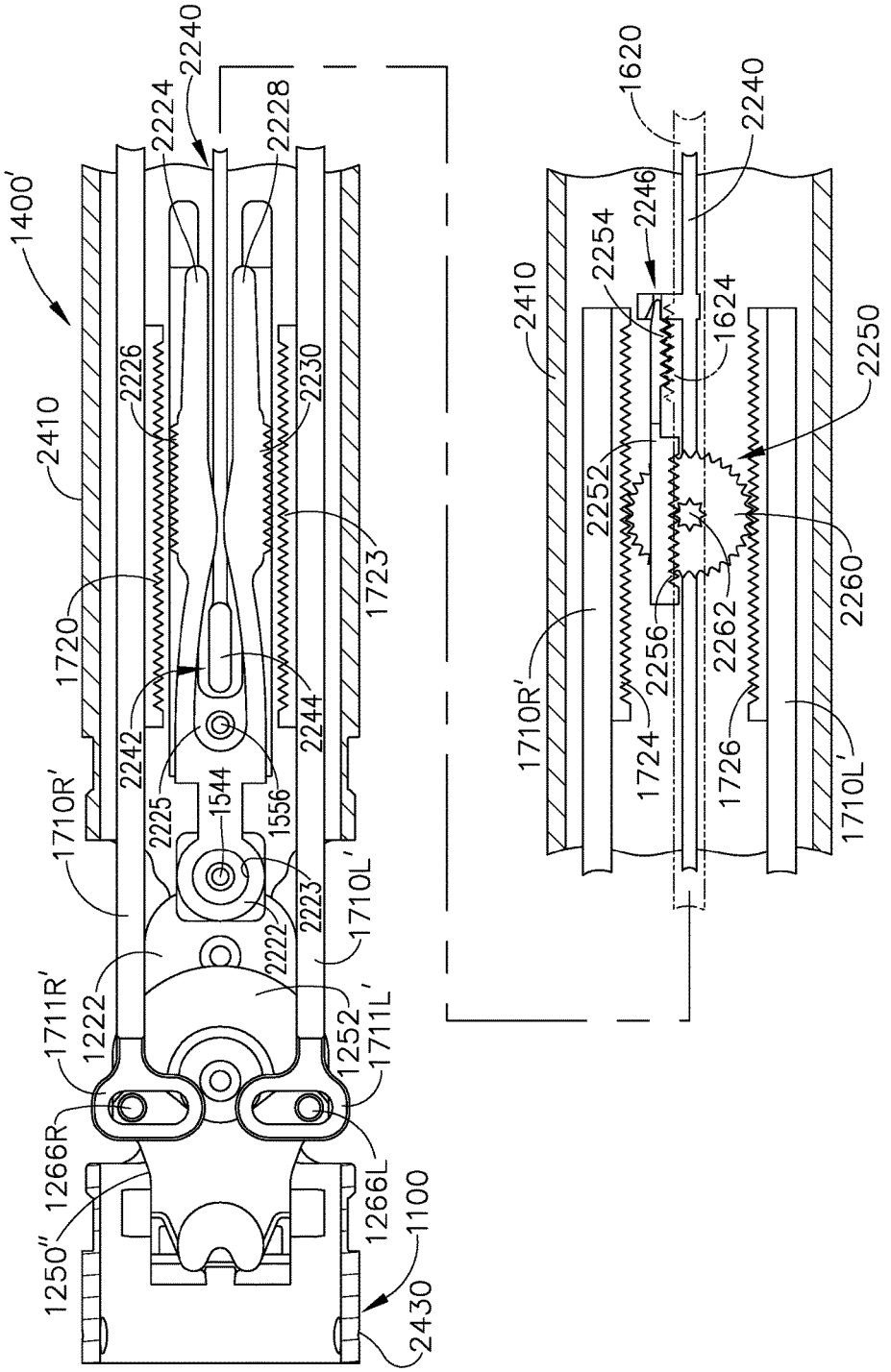
1400'
2410
2240
2224
2228
2226
2230
1720
1723
2242
2244
2225
1544
1556
1710R'
1710L'
2223
2222
1711R'
1222
1252
1711L'
1266R
1266L
1250''
1100
2430
1620
2246
2254
1624
2252
2250
2256
2262
2260
1724
1726

FIG. 87

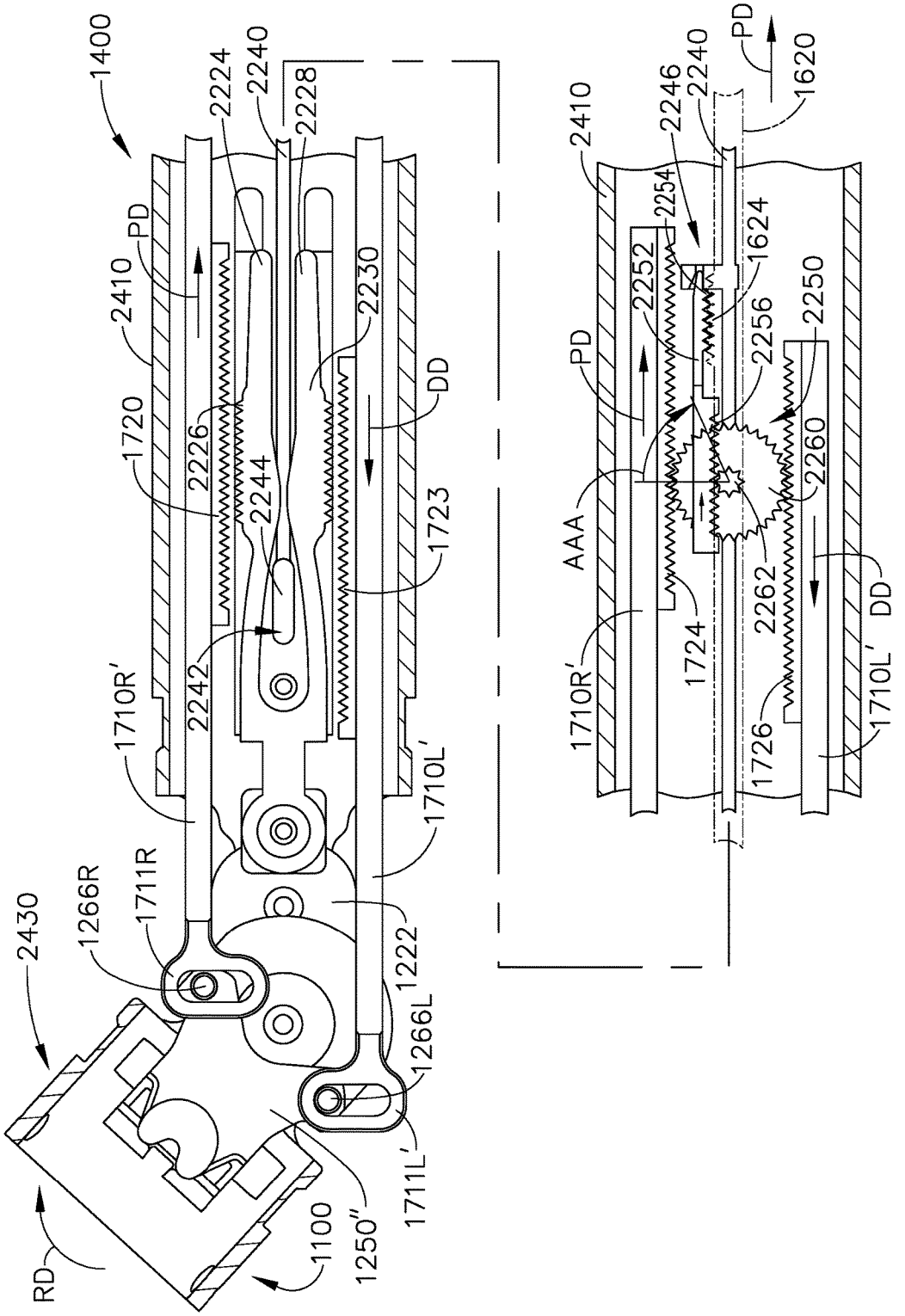
1400
2224
2240
2228
PD
2410
2230
1720
2226
DD
2244
1723
2242
1710R'
1710L'
2430
1266R
1711R
1222
1266L
1711L'
1100
1250"
RD
2410
2246
2240
PD
1620
2254
2252
1624
2250
PD
2256
AAA
2260
1724
2262
1710R'
DD
1726
1710L'

FIG. 88

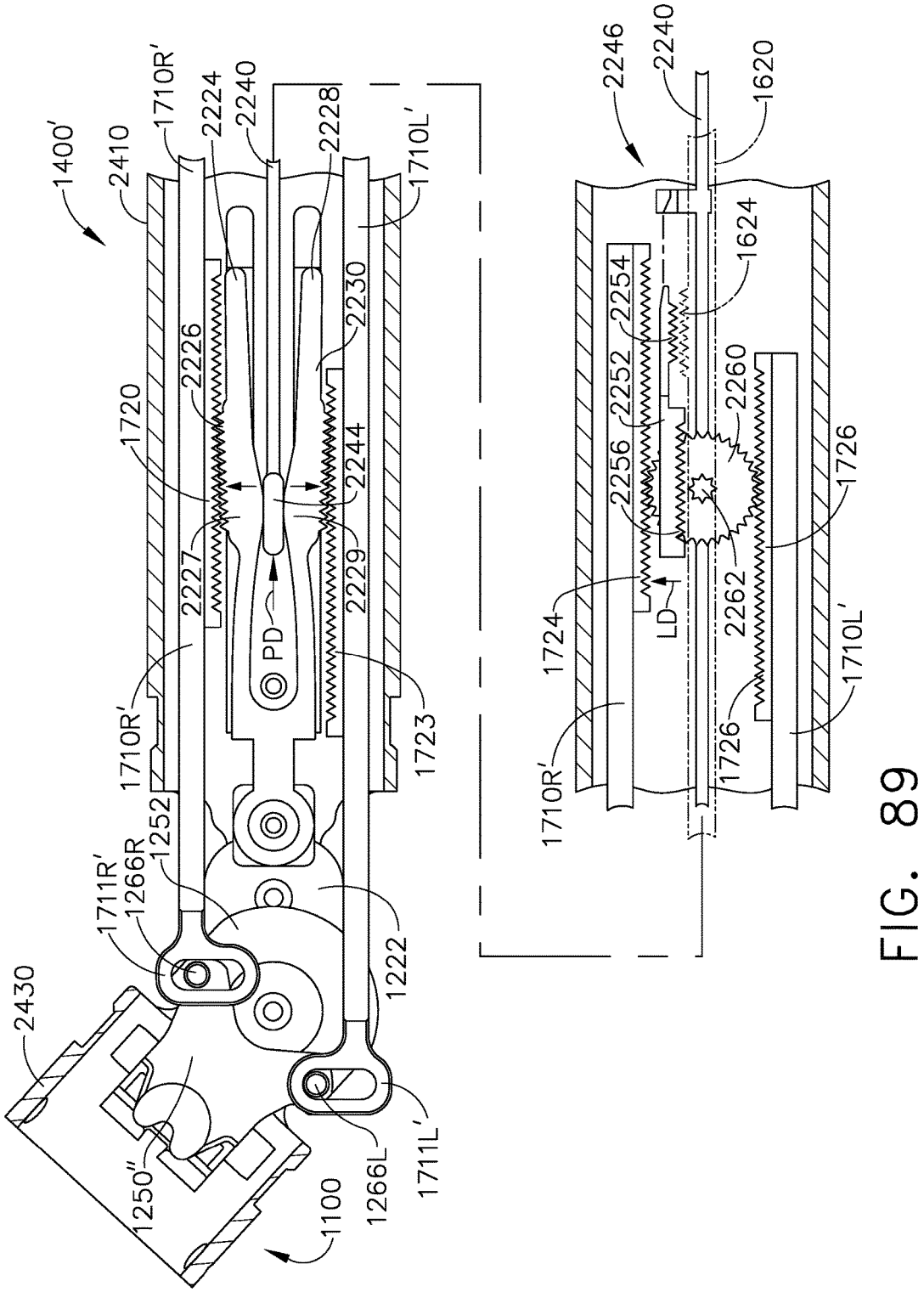
1400'
2410
1710R'
2224
2240
2228
1710L'
2226
2230
1720
2244
2227
2229
PD
1723
1710R'
1252
1711R'
1266R
1222
2430
1250"
1100
1266L
1711L'
2246
2240
1620
1624
2254
2252
2260
2256
1726
1724
LD
2262
1726
1710R'
1710L'

FIG. 89

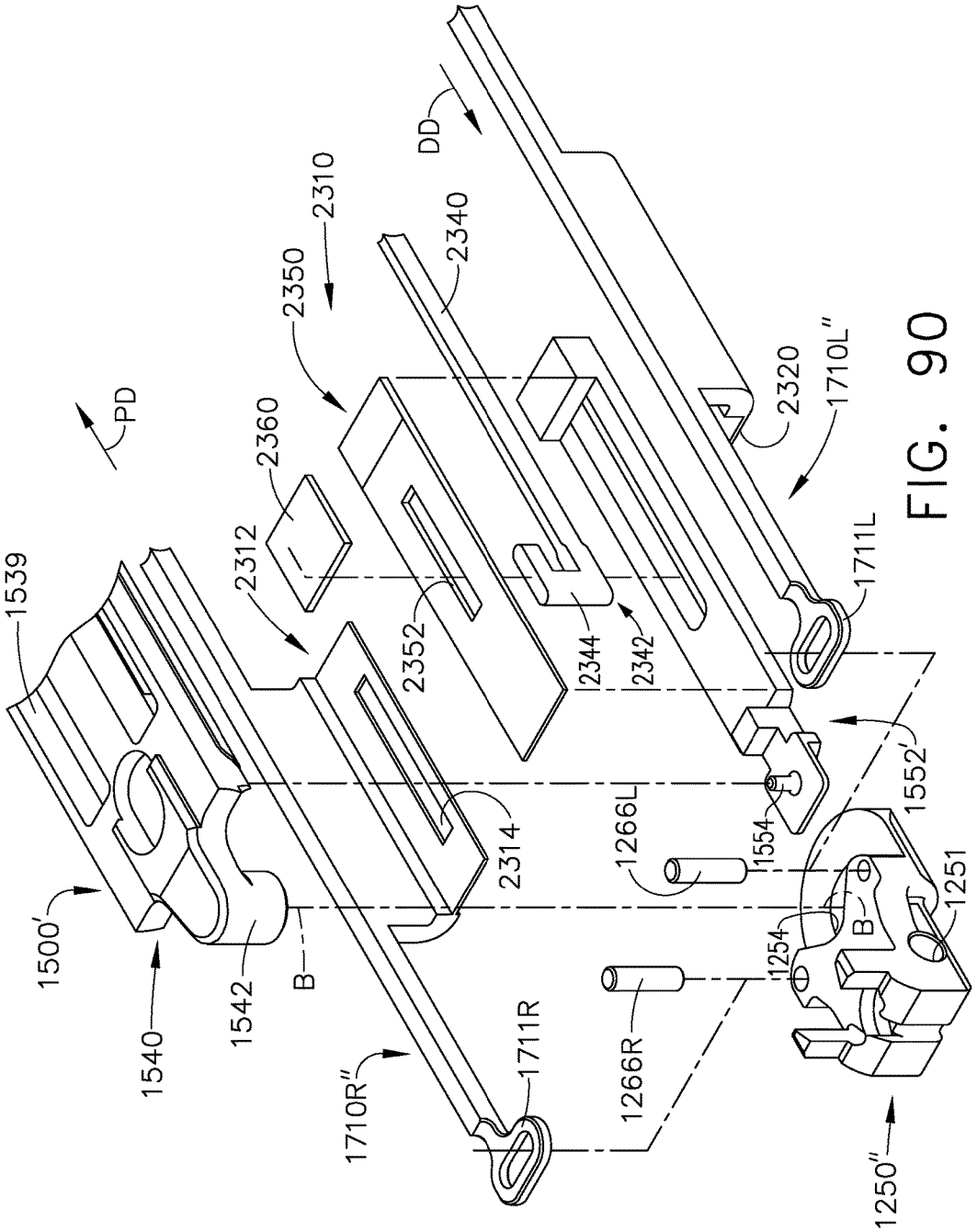
DD
2310
2350
2340
2360
2312
PD
2320
1710L"
1711L
1539
2352
2344
2342
1552'
1554
1266L
2314
1251
1254
B
1500'
1542
1540
1711R
1710R"
1266R
1250"

FIG. 90

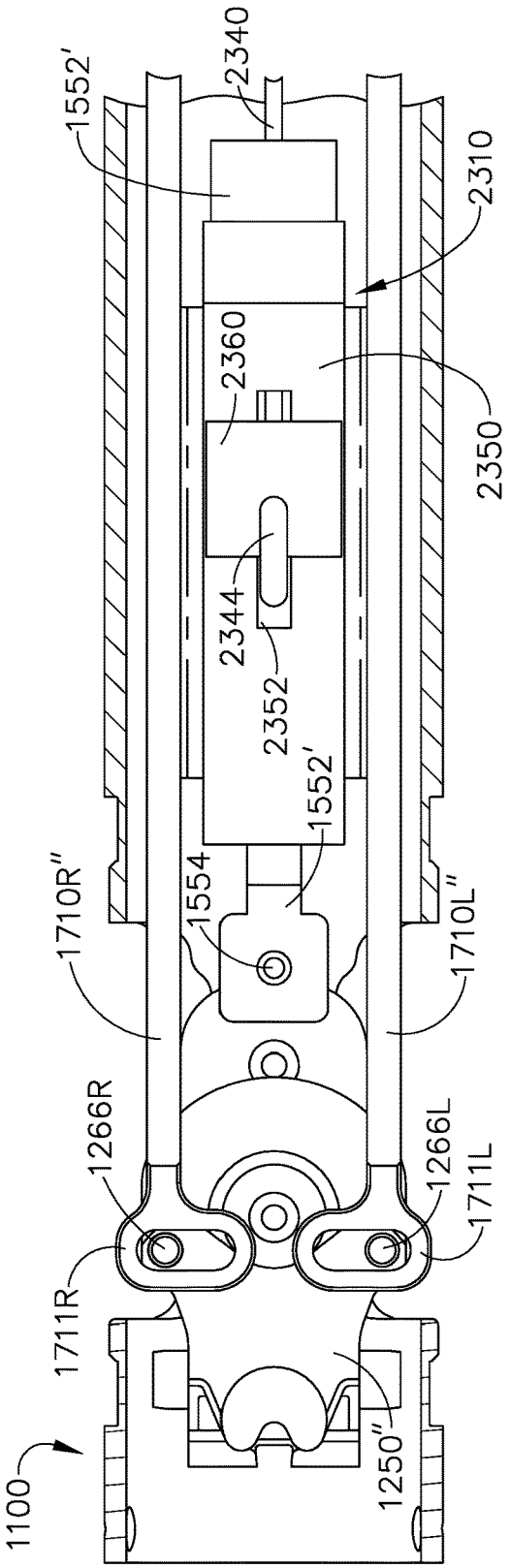
1552'
2340
2310
2360
2350
2344
2352
1552'
1554
1710R"
1710L"
1266R
1266L
1711L
1711R
1250"
1100

FIG. 91

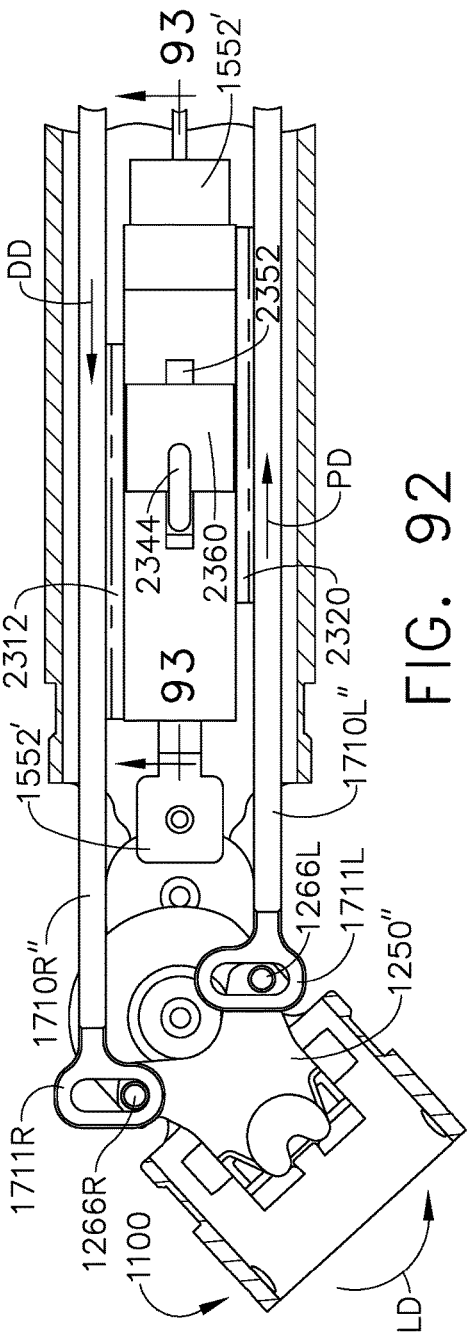
93
1552'
DD
2352
PD
2344
2360
2320
2312
93
1552'
1710L"
1266L
1711L
1250"
1710R"
1711R
1266R
1100
LD

FIG. 92

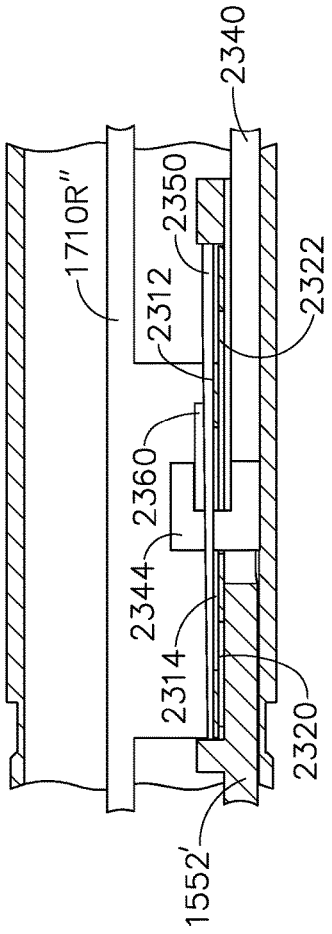
2340
1710R"
2350
2312
2322
2360
2344
2314
2320
1552'

FIG. 93

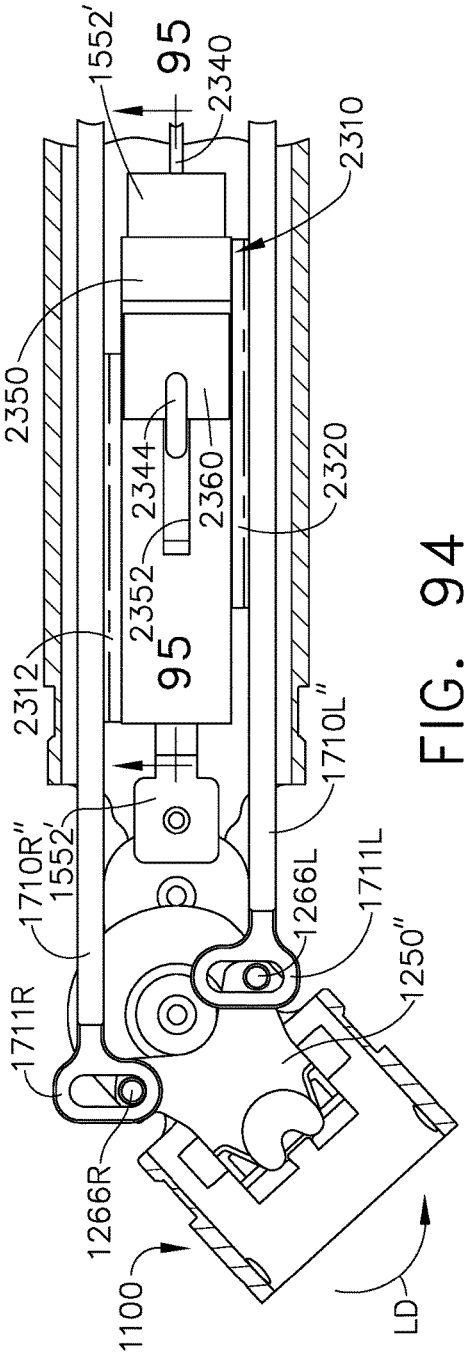
1552'
95
2340
2310
2350
2344
2360
2320
2352
95
2312
1710L"
1710R"
1552'
1266L
1711L
1711R
1250"
1266R
1100
LD

FIG. 94

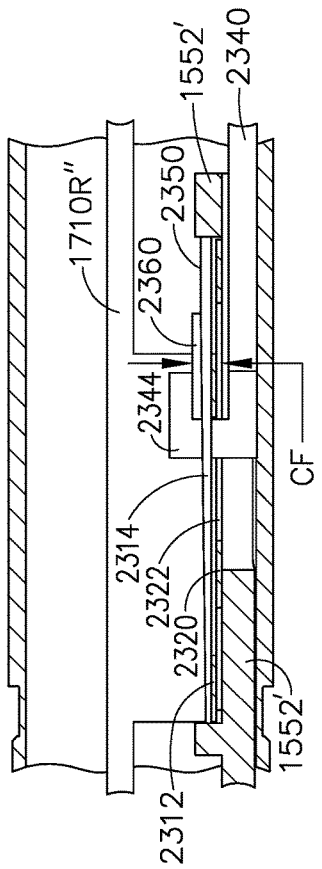
1552'
2340
1710R"
2350
2360
2344
CF
2314
2322
2320
1552'
2312

FIG. 95

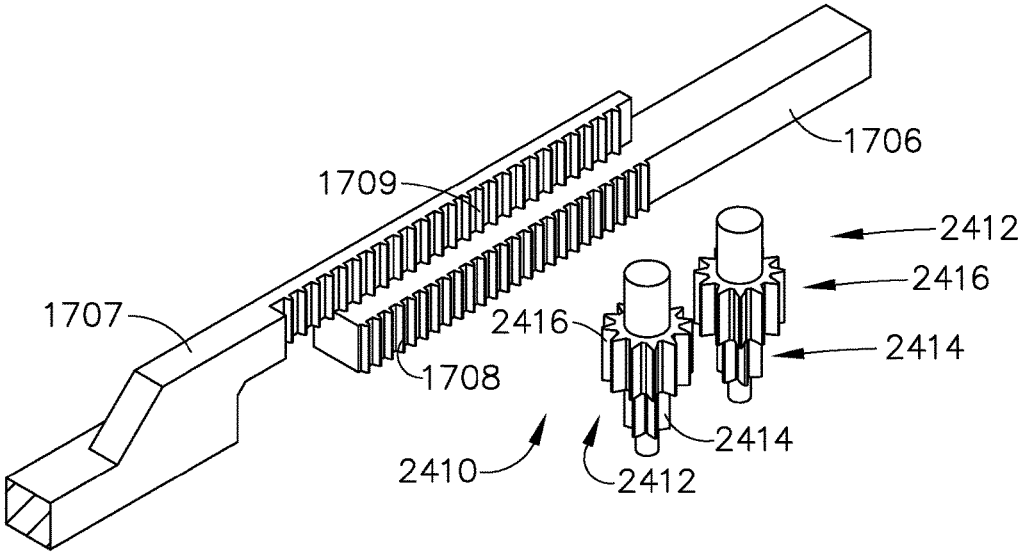
1706
1709
2412
2416
1707
2416
2414
1708
2414
2410
2412

FIG. 96

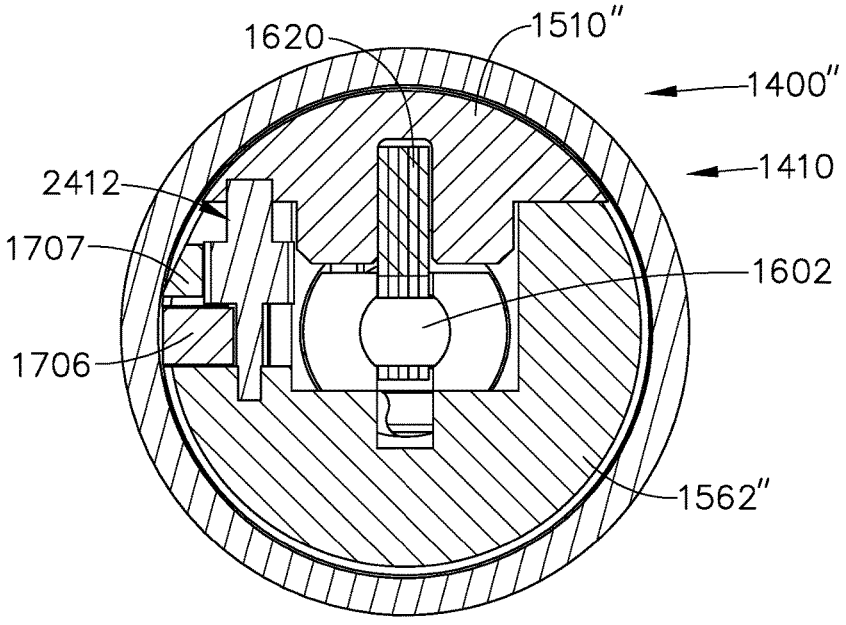
1620
1510″
1400″
1410
2412
1707
1602
1706
1562″

FIG. 97

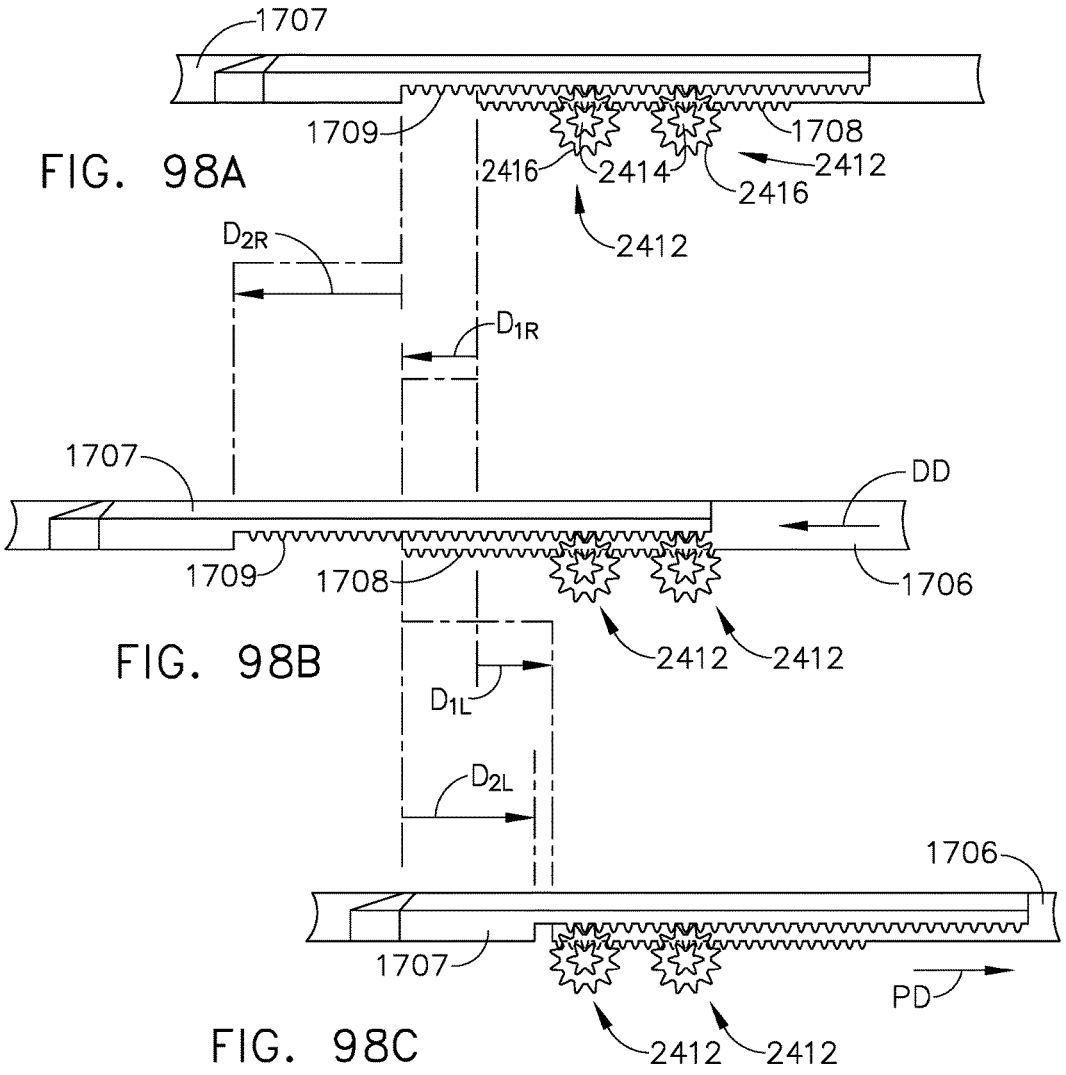

FIG. 98A

FIG. 98B

FIG. 98C

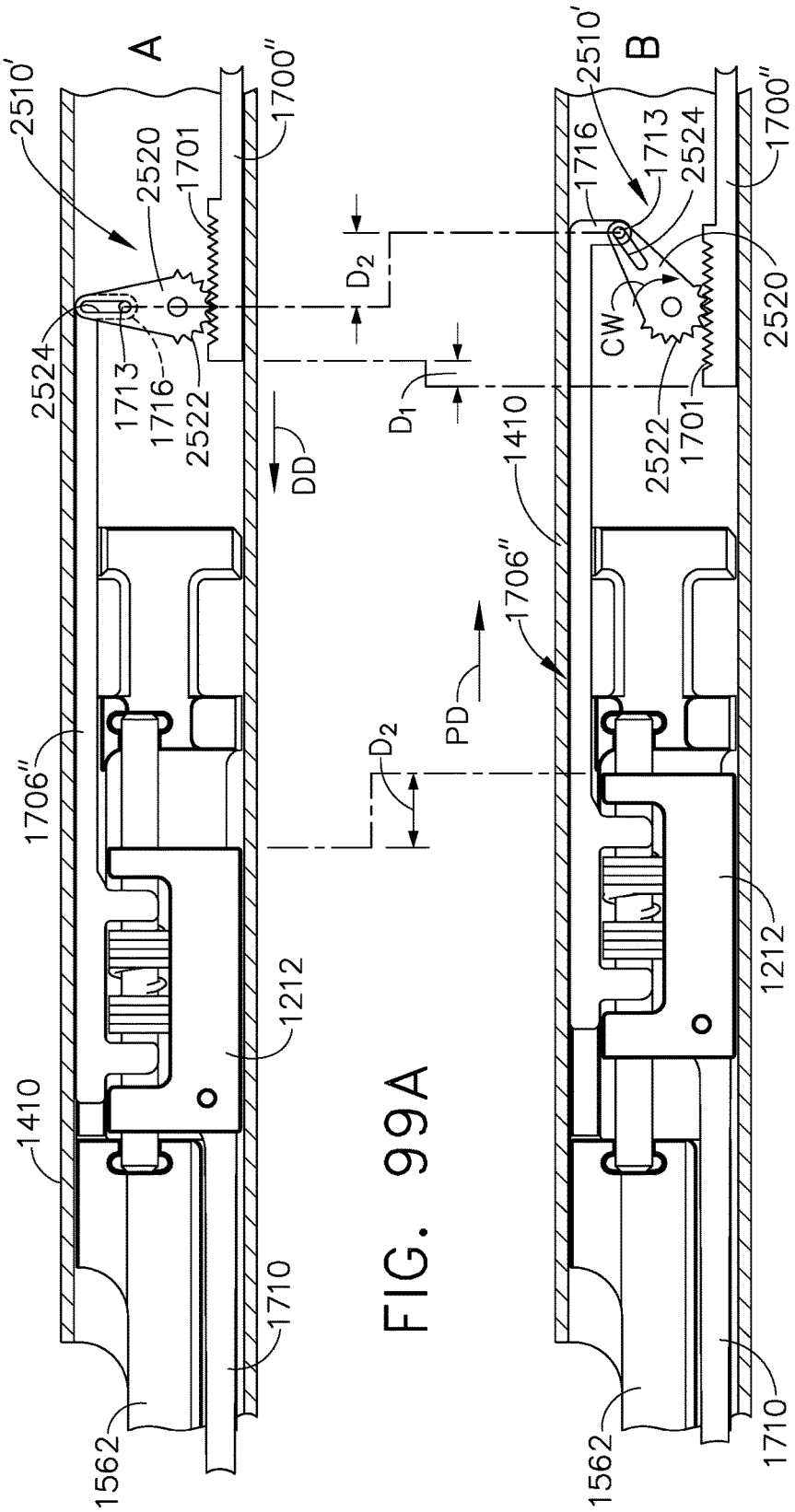

FIG. 99A

FIG. 99B

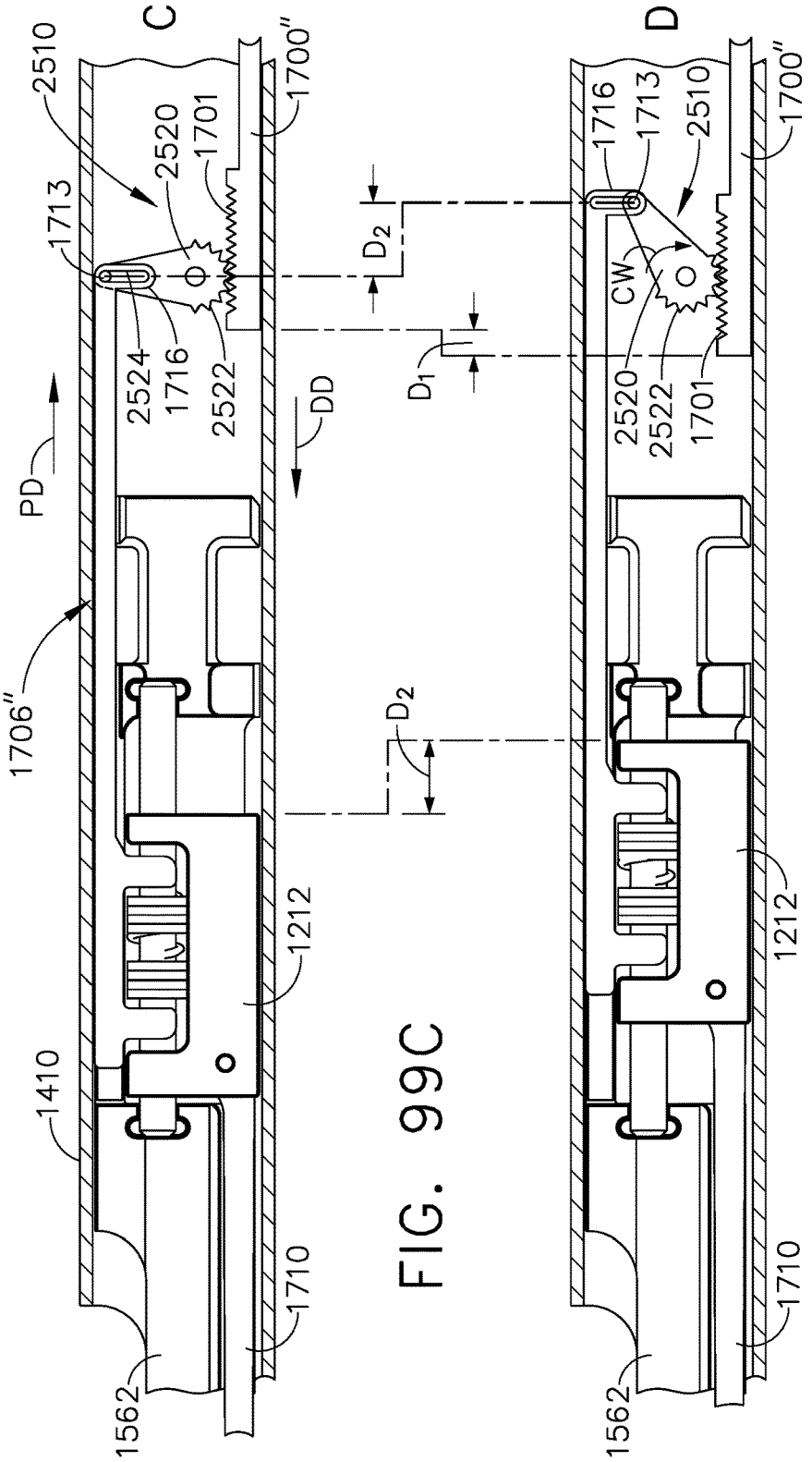

FIG. 99C

FIG. 99D

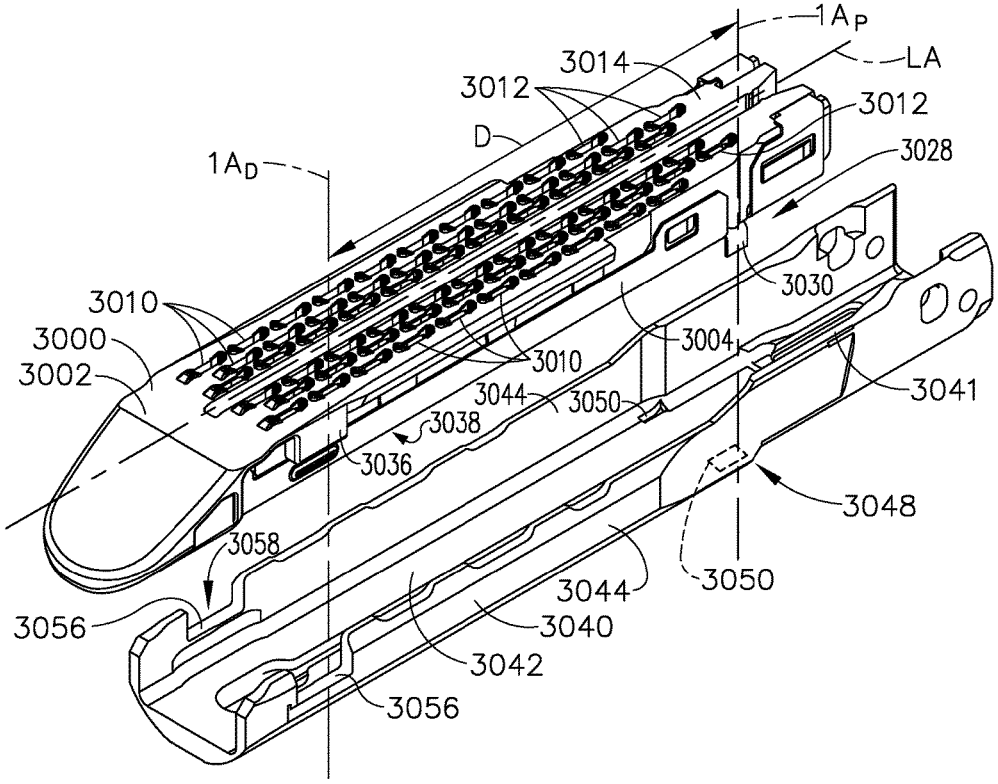

FIG. 100

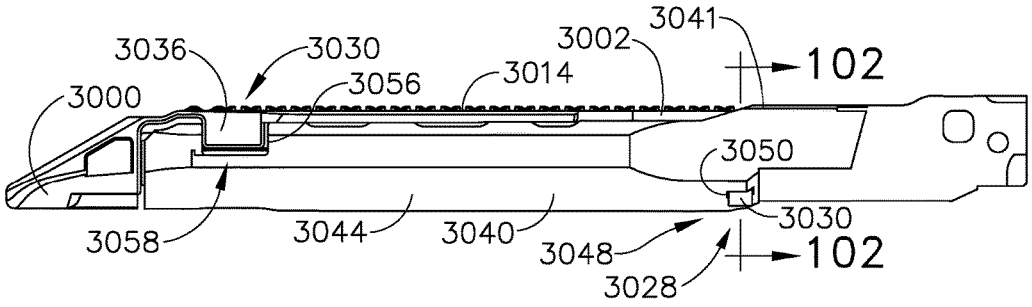

FIG. 101

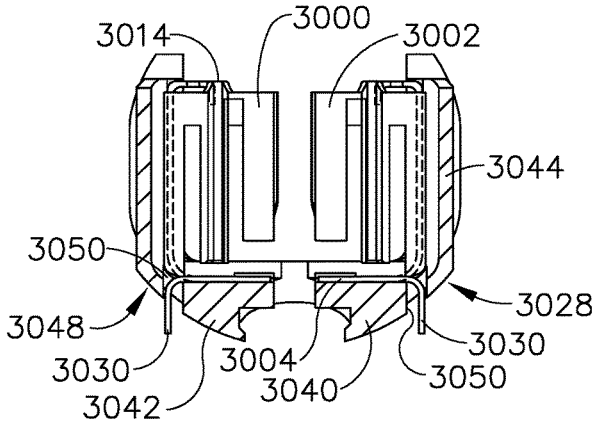

FIG. 102

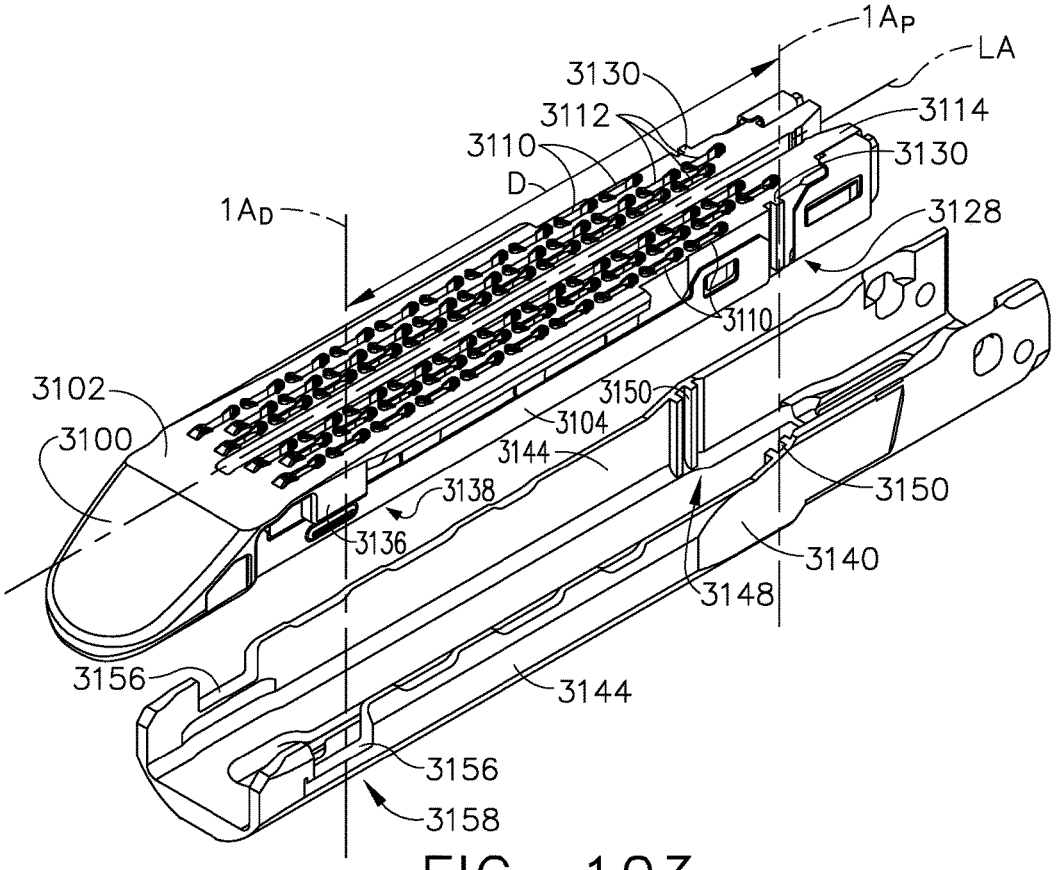

FIG. 103

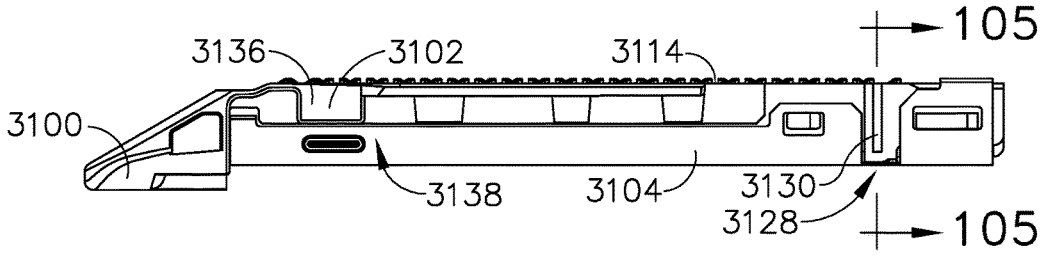

FIG. 104

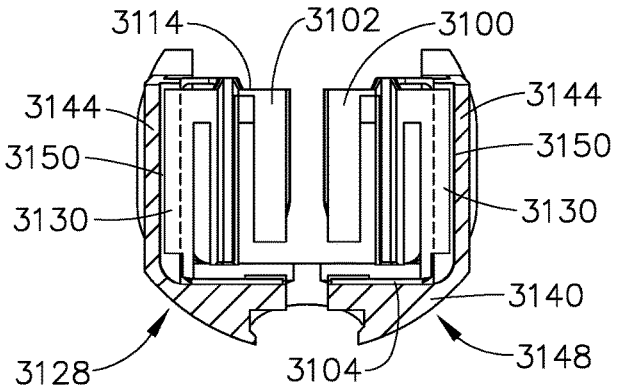

FIG. 105

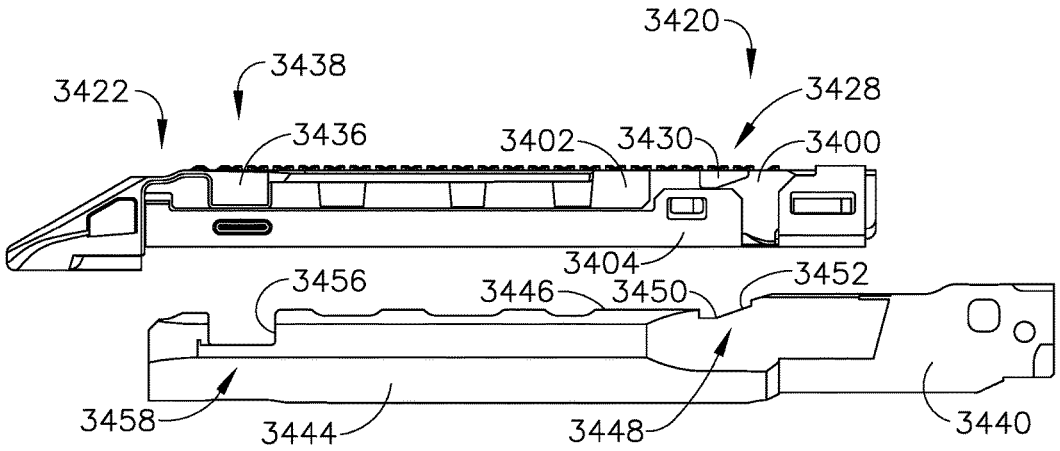

FIG. 106

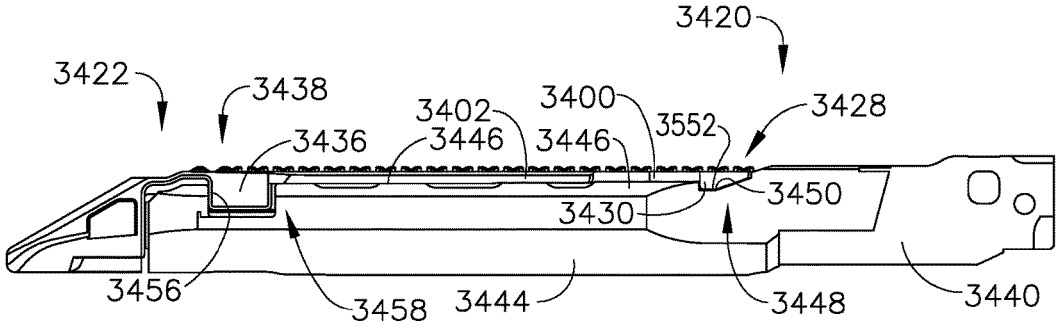

FIG. 107

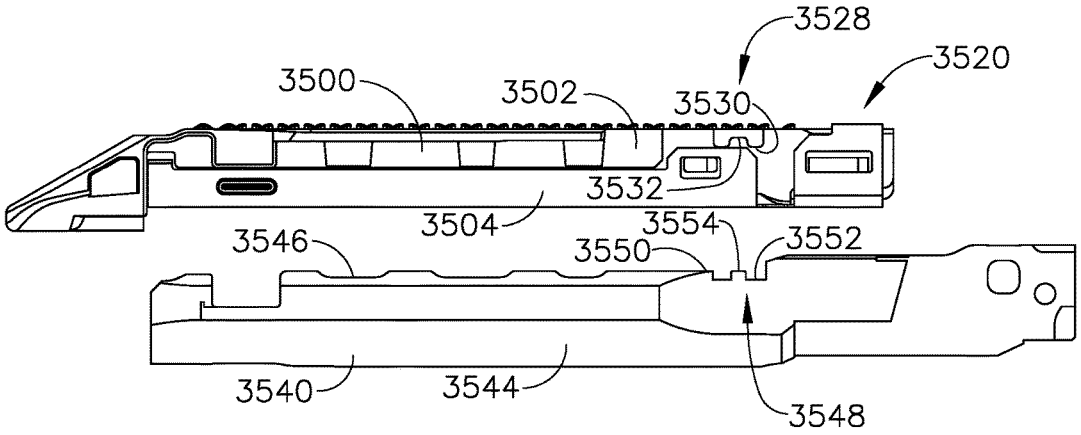

FIG. 108

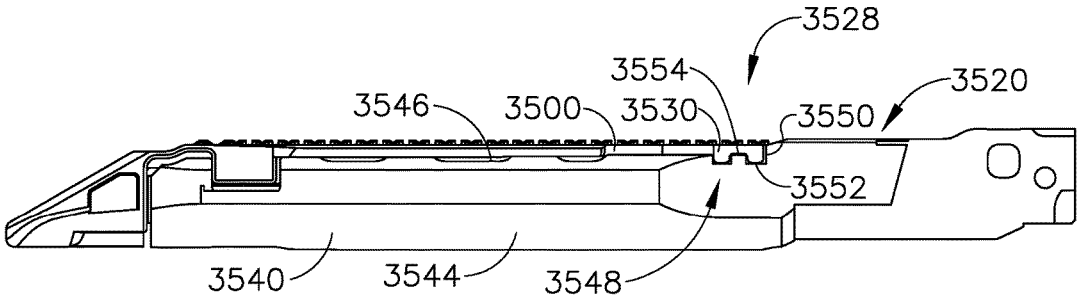

FIG. 109

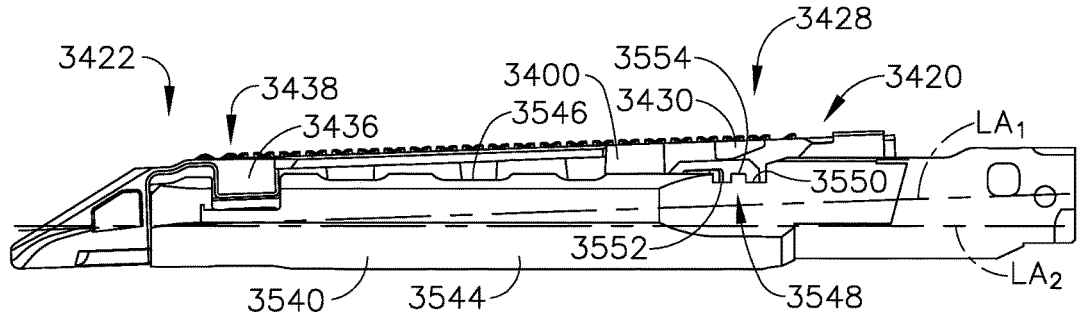

FIG. 110

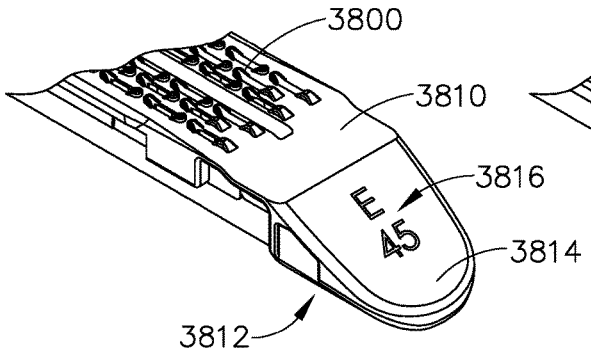

FIG. 111

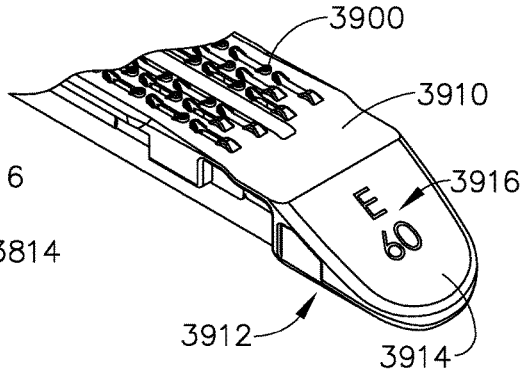

FIG. 112

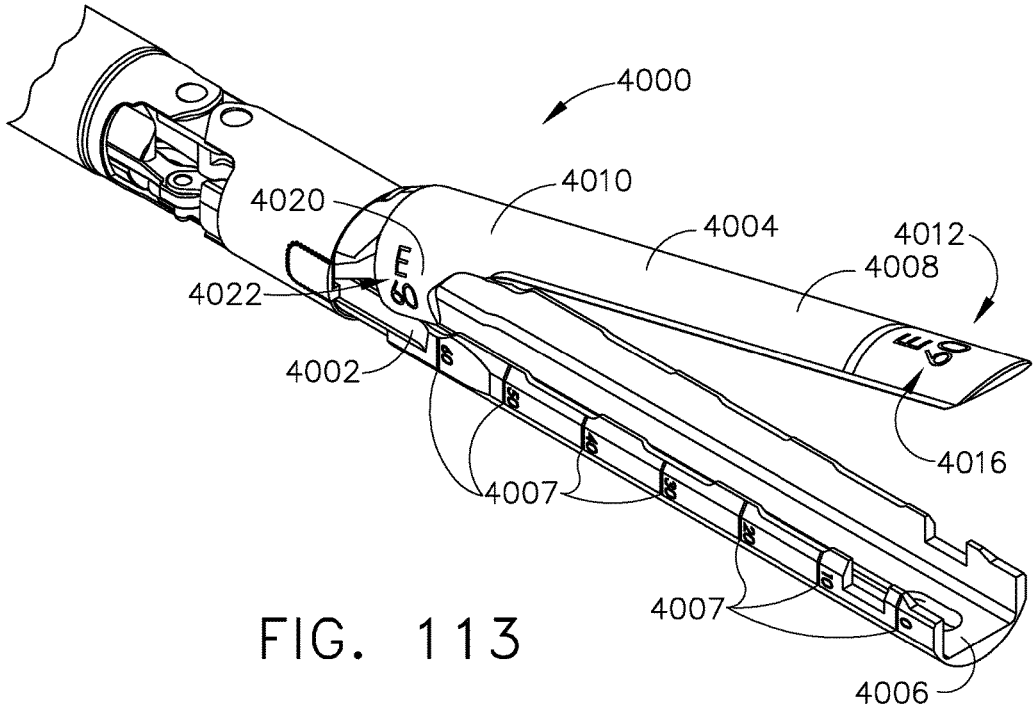

FIG. 113

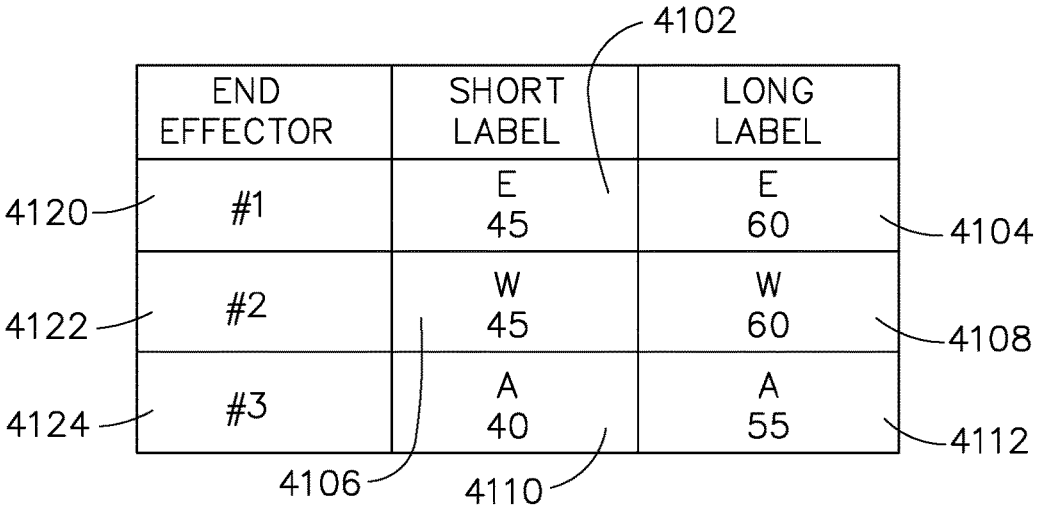

FIG. 114

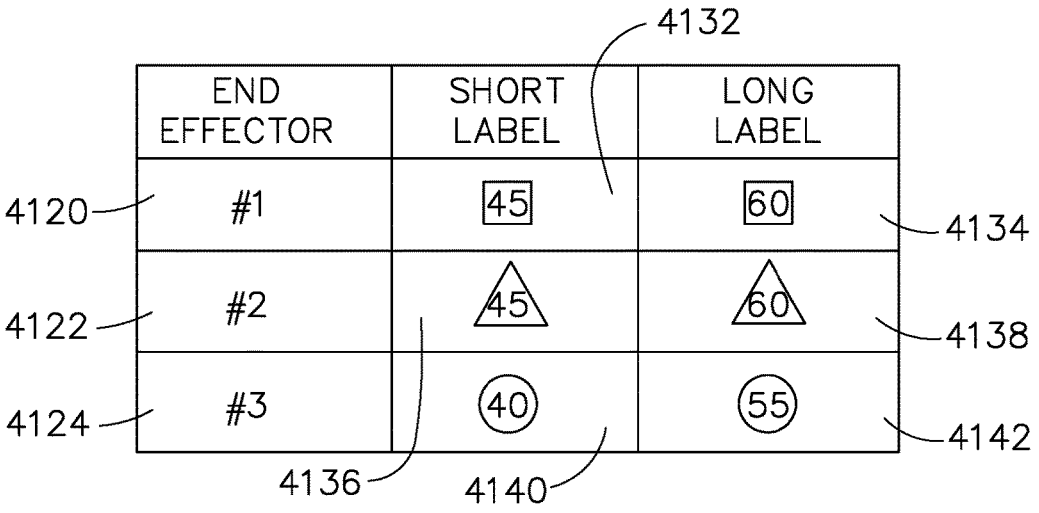

FIG. 115

SURGICAL END EFFECTOR WITH TWO SEPARATE COOPERATING OPENING FEATURES FOR OPENING AND CLOSING END EFFECTOR JAWS

BACKGROUND

[0001] The present invention relates to surgical instruments and, in various arrangements, to surgical stapling and cutting instruments and staple cartridges for use therewith that are designed to staple and cut tissue.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Various features of the embodiments described herein, together with advantages thereof, may be understood in accordance with the following description taken in conjunction with the accompanying drawings as follows:

[0003] FIG. **1** is a perspective view of an interchangeable surgical tool assembly embodiment that is operably coupled to a handle assembly embodiment;

[0004] FIG. **2** is an exploded assembly view of portions of the handle assembly and interchangeable surgical tool assembly of FIG. **1**;

[0005] FIG. **3** is a perspective view of the interchangeable surgical tool assembly embodiment depicted in FIGS. **1** and **2** with portions thereof omitted for clarity;

[0006] FIG. **4** is a perspective view of a proximal portion of the interchangeable surgical tool assembly embodiment depicted in FIGS. **1-3** with portions thereof omitted for clarity;

[0007] FIG. **5** is an exploded assembly view of proximal portions of the interchangeable surgical tool assembly of FIGS. **1-4**;

[0008] FIG. **6** is an exploded assembly view of distal portions of the interchangeable surgical tool assembly of FIGS. **1-5**;

[0009] FIG. **7** illustrates use of an interchangeable surgical tool assembly embodiment to perform a medical procedure known as a lower anterior resection within a human pelvis area;

[0010] FIG. **8** is a top view of a portion of the interchangeable surgical tool assembly depicted in FIG. **7**;

[0011] FIG. **9** is another top view of the interchangeable surgical tool assembly depicted in FIG. **8** with portions thereof shown in cross-section;

[0012] FIG. **10** is a partial perspective view of a distal portion of the interchangeable surgical tool assembly of FIG. **9**;

[0013] FIG. **11** is a cross-sectional view of the interchangeable surgical tool assembly of FIG. **10** taken along line **11-11** in FIG. **10**;

[0014] FIG. **12** is a partial perspective view of a portion of another interchangeable surgical tool assembly;

[0015] FIG. **13** is a cross-sectional end view of a shaft assembly portion of another interchangeable surgical tool embodiment;

[0016] FIG. **14** is a cross-sectional end view of a shaft assembly portion of another interchangeable surgical tool embodiment;

[0017] FIG. **15** is a top cross-sectional view of a portion of an interchangeable surgical tool embodiment in an articulated configuration;

[0018] FIG. **15**A is a top view of portions of another surgical end effector and elongate shaft assembly arrangement with the surgical end effector in an unarticulated position (solid lines) and an articulated position (phantom lines);

[0019] FIG. **16** is a perspective view of a portion of an interchangeable surgical tool end effector employing an anvil cap to cover a portion of a firing member parking area within an end effector thereof;

[0020] FIG. **17** is another perspective view of a portion of the surgical end effector of FIG. **16** with the anvil cap omitted for clarity;

[0021] FIG. **18** is a side elevational view of the surgical end effector of FIG. **16** with the anvil thereof in an open configuration;

[0022] FIG. **18**A is a cross-sectional side view of the surgical end effector of FIG. **18**;

[0023] FIG. **19** is a cross-sectional side view of the surgical end effector of FIG. **18** during initiation of an anvil closure process;

[0024] FIG. **20** is another cross-sectional side view of the surgical end effector of FIGS. **18** and **19** with the anvil thereof in a fully closed position;

[0025] FIG. **20**A is another cross-sectional side view of the surgical end effector of FIG. **20** after a firing member thereof has been advanced distally out of a firing member parking area;

[0026] FIG. **21** is a perspective view of a distal closure member embodiment;

[0027] FIG. **22** is a side elevational view of a portion of an interchangeable surgical tool assembly employing the distal closure member of FIG. **21** with an anvil of a surgical end effector portion thereof in a fully closed position;

[0028] FIG. **23** is another side elevational view of the portion of the interchangeable surgical tool assembly of FIG. **22**, with the distal closure member in an initial opening position;

[0029] FIG. **24** is another side elevational view of the portion of the interchangeable surgical tool assembly of FIG. **22**, with the distal closure member in another opening position;

[0030] FIG. **25** is another side elevational view of the portion of the interchangeable surgical tool assembly of FIG. **22**, with the anvil thereof in a fully opened position;

[0031] FIG. **26** is a perspective view of another distal closure member embodiment;

[0032] FIG. **27** is a side view of another anvil embodiment;

[0033] FIG. **28** is a partial cross-sectional side view of another interchangeable surgical tool assembly employing the distal closure member of FIG. **26** and the anvil embodiment of FIG. **27** with the anvil in a fully closed position;

[0034] FIG. **29** is another partial cross-sectional side view of the interchangeable surgical tool assembly of FIG. **28** with the anvil thereof in a fully open position;

[0035] FIG. **30** is a perspective view of another distal closure member embodiment;

[0036] FIG. **31** is a partial cross-sectional side view of another interchangeable surgical tool assembly employing the distal closure member embodiment of FIG. **30** and with an anvil thereof in a fully open position;

[0037] FIG. **32** is a partial cross-sectional side view of another interchangeable surgical tool assembly with an anvil thereof in a fully closed position;

[0038] FIG. **33** is another partial cross-sectional side view of the interchangeable surgical tool assembly of FIG. **32** with the anvil thereof in a fully open position;

[0039] FIG. **34** is a side elevational view of a portion of another interchangeable surgical tool assembly with an anvil thereof in a fully closed position;

[0040] FIG. **35** is another side elevational view of the portion of the interchangeable surgical tool assembly of FIG. **34** with the anvil thereof in a fully open position;

[0041] FIG. **36** is a side elevational view of a portion of another interchangeable surgical tool assembly with an anvil thereof in a fully closed position;

[0042] FIG. **37** is another side elevational view of the portion of the interchangeable surgical tool assembly of FIG. **36** with the anvil thereof in a partially open position;

[0043] FIG. **38** is a side elevational view of a portion of another interchangeable surgical tool assembly with an anvil thereof in a fully closed position;

[0044] FIG. **39** is another side elevational view of the portion of the interchangeable surgical tool assembly of FIG. **38** with the anvil thereof in a partially open position;

[0045] FIG. **40** is a bottom perspective view of a camming or sled assembly embodiment;

[0046] FIG. **41** a top view of a portion of a surgical end effector embodiment with an unfired surgical staple cartridge installed therein and with a camming assembly thereof in a starting position and in unlocking engagement with a firing member lock member;

[0047] FIG. **42** is a top view of a portion of the surgical end effector embodiment of FIG. **41** that has an improper unfired surgical staple cartridge installed therein with a camming assembly thereof in a starting position and with a firing member lock in locking engagement with the firing member;

[0048] FIG. **43** is an exploded perspective view of portions of an anvil, a firing member, a sled assembly and firing member lock embodiment of another interchangeable surgical tool assembly embodiment;

[0049] FIG. **44** is a partial cross-sectional view of a distal portion of the interchangeable surgical tool assembly of FIG. **43** with the firing member thereof omitted for clarity;

[0050] FIG. **45** is another partial cross-sectional view of the distal portion of the interchangeable surgical tool assembly of FIG. **44** with an unfired surgical staple cartridge properly seated within a surgical end effector thereof and with an anvil thereof in an open position and the firing member in a starting position;

[0051] FIG. **46** is another partial cross-sectional view of the distal portion of the interchangeable surgical tool assembly of FIG. **45** with the anvil in a fully closed position and the firing member in an initial firing position;

[0052] FIG. **47** is another partial cross-sectional view of the distal portion of the interchangeable surgical tool assembly of FIG. **45** with the anvil in a fully closed position and the firing member further distally advanced within the surgical end effector;

[0053] FIG. **48** is another partial cross-sectional view of the distal portion of the interchangeable surgical tool assembly of FIG. **47** with the anvil in a fully closed position and the firing member being retracted back to a starting position just prior to contacting the firing member lock;

[0054] FIG. **49** is another partial cross-sectional view of the distal portion of the interchangeable surgical tool assembly of FIG. **48** with the anvil in a fully closed position and the firing member being retracted back to a starting position after initially contacting the firing member lock;

[0055] FIG. **50** is another partial cross-sectional view of the distal portion of the interchangeable surgical tool assembly of FIG. **49** with the anvil in a fully closed position and the firing member being retracted back to the starting position;

[0056] FIG. **51** is a side cross-sectional view of a portion of another interchangeable surgical tool assembly embodiment with an unfired surgical staple cartridge loaded in a surgical end effector thereof and a firing member in a starting position or configuration;

[0057] FIG. **52** is another side cross-sectional view of the interchangeable surgical tool assembly embodiment of FIG. **51** after the firing member has started to be distally advanced through the surgical end effector;

[0058] FIG. **53** is another side cross-sectional view of the interchangeable surgical tool assembly embodiment of FIGS. **51** and **52** during the retraction of the firing member back to the starting position;

[0059] FIG. **54** is another side cross-sectional view of the interchangeable surgical tool assembly embodiment of FIGS. **51-53** after the firing member has been further retracted toward the starting position;

[0060] FIG. **55** is another side cross-sectional view of the interchangeable surgical tool assembly embodiment of FIGS. **51-54** after the firing member has been fully retracted back to the starting position;

[0061] FIG. **56** is an exploded perspective view of portions of a firing member, a sled assembly, a firing member and firing member lock member of another interchangeable surgical tool assembly embodiment;

[0062] FIG. **57** is a side cross-sectional view of a portion of the interchangeable surgical tool assembly embodiment of FIG. **56** with an anvil of a surgical end effector thereof in an open position prior to installation of an unfired surgical staple cartridge within the surgical end effector and with the firing member in a starting position;

[0063] FIG. **58** is another side cross-sectional view of a portion of the interchangeable surgical tool assembly embodiment of FIG. **57** with an unfired surgical staple cartridge installed within the surgical end effector and the anvil in a closed position;

[0064] FIG. **59** is a top cross-sectional view of the portion of the interchangeable surgical tool assembly embodiment of FIG. **58** with the firing member lock in a disengaged configuration relative to the firing member;

[0065] FIG. **60** is another side cross-sectional view of a portion of the interchangeable surgical tool assembly embodiment of FIGS. **58** and **59** after the firing member has been initially distally advanced;

[0066] FIG. **61** is another side cross-sectional view of a portion of the interchangeable surgical tool assembly embodiment of FIGS. **58-60** during retraction back to a starting position;

[0067] FIG. **62** is a top view of the portion of the interchangeable surgical tool assembly embodiment of FIG. **61**;

[0068] FIG. **63** is another side cross-sectional view of a portion of the interchangeable surgical tool assembly embodiment of FIGS. **58-62** after the firing member has been fully retracted back to a starting position and is in locking engagement with the firing member lock;

[0069] FIG. **64** is an exploded perspective view of portions of an articulation joint and articulation lock embodiment of another interchangeable surgical tool assembly embodiment;

[0070] FIG. **65** is a perspective view of a lock spring assembly embodiment of the articulation lock embodiment of FIG. **64**;

[0071] FIG. **66** is a top view of an end effector mounting assembly embodiment of the interchangeable surgical tool assembly embodiment of FIG. **64**;

[0072] FIG. **67** is a top view of portions of the interchangeable surgical tool assembly embodiment of FIG. **64** with a surgical end effector thereof in an unarticulated configuration;

[0073] FIG. **68** is another top view of the portions of the interchangeable surgical tool assembly embodiment of FIG. **67** during an initial application of an articulation motion to the articulation joint;

[0074] FIG. **69** is a bottom view of the portions of the interchangeable surgical tool assembly embodiment of FIG. **68**;

[0075] FIG. **70** is another bottom view of the portions of the interchangeable surgical tool assembly embodiment of FIG. **69** with the surgical end effector in an articulated configuration;

[0076] FIG. **71** is an exploded perspective view of portions of an articulation joint and articulation lock embodiment of another interchangeable surgical tool assembly embodiment;

[0077] FIG. **72** is a top view of an end effector mounting assembly embodiment of the interchangeable surgical tool assembly embodiment of FIG. **71**;

[0078] FIG. **73** is a top view of portions of the interchangeable surgical tool assembly embodiment of FIG. **71** with a surgical end effector thereof in an unarticulated configuration;

[0079] FIG. **74** is a partial cross-sectional view of portions of the articulation lock embodiment of FIG. **73** taken along line **74-74** in FIG. **73**;

[0080] FIG. **75** is another top view of the portions of the interchangeable surgical tool assembly embodiment of FIG. **73** during an initial application of an articulation motion to the articulation joint;

[0081] FIG. **76** is another top view of the portions of the interchangeable surgical tool assembly embodiment of FIG. **75** with the surgical end effector thereof in an articulated configuration and the articulation lock in an unlocked configuration;

[0082] FIG. **77** is another top view of the portions of the interchangeable surgical tool assembly embodiment of FIG. **75** with the surgical end effector thereof in an articulated configuration and the articulation lock in a locked configuration;

[0083] FIG. **78** is an exploded perspective view of portions of an articulation joint and articulation lock embodiment of another interchangeable surgical tool assembly embodiment;

[0084] FIG. **79** is a top view of portions of the interchangeable surgical tool assembly embodiment of FIG. **78** with a surgical end effector thereof in an unarticulated configuration;

[0085] FIG. **80** is a side cross-sectional view of the portions of the interchangeable surgical tool assembly of FIG. **79** taken along line **80-80** in FIG. **79**;

[0086] FIG. **81** is another side cross-sectional view of the portions of the interchangeable surgical tool assembly of FIG. **80** during an initial application of articulation motion to the articulation lock thereof;

[0087] FIG. **82** is another side cross-sectional view of the portions of the interchangeable surgical tool assembly of FIG. **81** with the articulation joint locked in position by the articulation lock;

[0088] FIG. **83** is an exploded perspective view of portions of a spine assembly, an articulation joint and articulation lock embodiment of another interchangeable surgical tool assembly embodiment;

[0089] FIG. **84** is a top view of a portion of a distal end of the spine assembly and the articulation lock arrangement of the interchangeable surgical tool assembly embodiment of FIG. **83**;

[0090] FIG. **85** is an exploded perspective view of portions of a spine assembly, an articulation joint and articulation lock embodiment of another interchangeable surgical tool assembly embodiment;

[0091] FIG. **86** is another exploded perspective view of portions of the spine assembly and articulation joint and articulation lock of the interchangeable surgical tool assembly of FIG. **85**;

[0092] FIG. **87** is a top cross-sectional view of the interchangeable surgical tool assembly of FIG. **85** with a surgical end effector thereof in an unarticulated configuration;

[0093] FIG. **88** is another top cross-sectional view of the interchangeable surgical tool assembly of FIG. **87** with the surgical end effector thereof in an articulated configuration and the articulation lock in an unlocked configuration;

[0094] FIG. **89** is another top cross-sectional view of the interchangeable surgical tool assembly of FIG. **88** with the surgical end effector thereof in an articulated configuration and the articulation lock in a locked configuration;

[0095] FIG. **90** is an exploded perspective view of portions of a spine assembly, an articulation joint and articulation lock embodiment of another interchangeable surgical tool assembly embodiment;

[0096] FIG. **91** is a top cross-sectional view of the interchangeable surgical tool assembly of FIG. **90** with a surgical end effector thereof in an unarticulated configuration;

[0097] FIG. **92** is another top cross-sectional view of the interchangeable surgical tool assembly of FIG. **91** with the surgical end effector thereof in an articulated configuration and the articulation lock in an unlocked configuration;

[0098] FIG. **93** is a partial cross-sectional view of the articulation lock of FIG. **92** taken along line **93-93** in FIG. **92**;

[0099] FIG. **94** is another top cross-sectional view of the interchangeable surgical tool assembly of FIG. **91** with the surgical end effector thereof in an articulated configuration and the articulation lock in a locked configuration;

[0100] FIG. **95** is a partial cross-sectional view of the articulation lock of FIG. **94** taken along line **95-95** in FIG. **94**;

[0101] FIG. **96** is a perspective view of portions of an articulation stroke multiplier embodiment;

[0102] FIG. **97** is a cross-sectional end view of a shaft assembly of an interchangeable surgical tool assembly embodiment with the articulation stroke multiplier embodiment of FIG. **96** therein;

[0103] FIG. **98**A is a top view of portions of the articulation stroke multiplier embodiment of FIG. **96** in an unactuated configuration;

[0104] FIG. **98**B is another top view of the portions of the articulation stroke multiplier of FIG. **98**A after application of an axial articulation motion thereto in a first axial direction;

[0105] FIG. **98**C is another top view of the portions of the articulation stroke multiplier of FIG. **98**A after application of another axial articulation motion thereto in a second axial direction;

[0106] FIG. **99**A is a top cross-sectional view of portions of a shaft assembly of an interchangeable surgical tool assembly embodiment with another articulation stroke multiplier embodiment in an unactuated configuration;

[0107] FIG. **99**B is another top cross-sectional view of the shaft assembly and articulation stroke multiplier of FIG. **99**A after an axial articulation motion has been applied thereto in a first axial direction;

[0108] FIG. **99**C is a top cross-sectional view of portions of a shaft assembly of another interchangeable surgical tool assembly embodiment with another articulation stroke multiplier embodiment in an unactuated configuration;

[0109] FIG. **99**D is another top cross-sectional view of the shaft assembly and articulation stroke multiplier of FIG. **99**C after an axial articulation motion has been applied thereto in a first axial direction;

[0110] FIG. **100** is an exploded perspective view of a channel and a staple cartridge;

[0111] FIG. **101** is an elevation view of the channel and the staple cartridge of FIG. **100**;

[0112] FIG. **102** is a cross-sectional elevation view of the channel and the staple cartridge of FIG. **100** taken across the plane indicated in FIG. **101**;

[0113] FIG. **103** is an exploded perspective view of a channel and a staple cartridge;

[0114] FIG. **104** is an elevation view of the staple cartridge of FIG. **103**;

[0115] FIG. **105** is a cross-sectional elevation view of the channel and the staple cartridge of FIG. **103** taken across the plane indicated in FIG. **104**;

[0116] FIG. **106** is an exploded elevation view of a channel and a staple cartridge;

[0117] FIG. **107** is an elevation view of the channel and the staple cartridge of FIG. **106** depicting the staple cartridge completely installed in the channel;

[0118] FIG. **108** is an exploded elevation view of a channel and a staple cartridge;

[0119] FIG. **109** is an elevation view of the channel and the staple cartridge of FIG. **108** depicting the staple cartridge completely installed in the channel;

[0120] FIG. **110** is an elevation view of the staple cartridge of FIG. **106** and the channel of FIG. **108** depicting the staple cartridge incompletely installed in the channel;

[0121] FIG. **111** is a perspective view of a portion of a staple cartridge;

[0122] FIG. **112** is a perspective view of a portion of a staple cartridge;

[0123] FIG. **113** is a perspective view of an end effector; and

[0124] FIGS. **114** and **115** depict tables of identifications for different types of end effectors.

[0125] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate various embodiments of the invention, in one form, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION

[0126] Applicant of the present application owns the following U.S. Patent Applications that were filed on Dec. 21, 2016 and which are each herein incorporated by reference in their respective entireties:

[0127] U.S. patent application Ser. No. 15/386,185, entitled SURGICAL STAPLING INSTRUMENTS AND REPLACEABLE TOOL ASSEMBLIES THEREOF;

[0128] U.S. patent application Ser. No. 15/386,221, entitled LOCKOUT ARRANGEMENTS FOR SURGICAL END EFFECTORS;

[0129] U.S. patent application Ser. No. 15/386,209, entitled SURGICAL END EFFECTORS AND FIRING MEMBERS THEREOF;

[0130] U.S. patent application Ser. No. 15/386,198, entitled LOCKOUT ARRANGEMENTS FOR SURGICAL END EFFECTORS AND REPLACEABLE TOOL ASSEMBLIES; and

[0131] U.S. patent application Ser. No. 15/386,240, entitled SURGICAL END EFFECTORS AND ADAPTABLE FIRING MEMBERS THEREFOR.

[0132] Applicant of the present application owns the following U.S. Patent Applications that were filed on Dec. 21, 2016 and which are each herein incorporated by reference in their respective entireties:

[0133] U.S. patent application Ser. No. 15/385,939, entitled STAPLE CARTRIDGES AND ARRANGEMENTS OF STAPLES AND STAPLE CAVITIES THEREIN;

[0134] U.S. patent application Ser. No. 15/385,941, entitled SURGICAL TOOL ASSEMBLIES WITH CLUTCHING ARRANGEMENTS FOR SHIFTING BETWEEN CLOSURE SYSTEMS WITH CLOSURE STROKE REDUCTION FEATURES AND ARTICULATION AND FIRING SYSTEMS;

[0135] U.S. patent application Ser. No. 15/385,943, entitled SURGICAL STAPLING INSTRUMENTS AND STAPLE-FORMING ANVILS;

[0136] U.S. patent application Ser. No. 15/385,950, entitled SURGICAL TOOL ASSEMBLIES WITH CLOSURE STROKE REDUCTION FEATURES;

[0137] U.S. patent application Ser. No. 15/385,945, entitled STAPLE CARTRIDGES AND ARRANGEMENTS OF STAPLES AND STAPLE CAVITIES THEREIN;

[0138] U.S. patent application Ser. No. 15/385,946, entitled SURGICAL STAPLING INSTRUMENTS AND STAPLE-FORMING ANVILS;

[0139] U.S. patent application Ser. No. 15/385,951, entitled SURGICAL INSTRUMENTS WITH JAW OPENING FEATURES FOR INCREASING A JAW OPENING DISTANCE;

[0140] U.S. patent application Ser. No. 15/385,953, entitled METHODS OF STAPLING TISSUE;

[0141] U.S. patent application Ser. No. 15/385,954, entitled FIRING MEMBERS WITH NON-PARALLEL JAW ENGAGEMENT FEATURES FOR SURGICAL END EFFECTORS;

[0142] U.S. patent application Ser. No. 15/385,955, entitled SURGICAL END EFFECTORS WITH EXPANDABLE TISSUE STOP ARRANGEMENTS;

[0143] U.S. patent application Ser. No. 15/385,948, entitled SURGICAL STAPLING INSTRUMENTS AND STAPLE-FORMING ANVILS;

[0144] U.S. patent application Ser. No. 15/385,956, entitled SURGICAL INSTRUMENTS WITH POSITIVE JAW OPENING FEATURES;

[0145] U.S. patent application Ser. No. 15/385,958, entitled SURGICAL INSTRUMENTS WITH LOCKOUT ARRANGEMENTS FOR PREVENTING FIRING SYSTEM ACTUATION UNLESS AN UNSPENT STAPLE CARTRIDGE IS PRESENT; and

[0146] U.S. patent application Ser. No. 15/385,947, entitled STAPLE CARTRIDGES AND ARRANGEMENTS OF STAPLES AND STAPLE CAVITIES THEREIN.

[0147] Applicant of the present application owns the following U.S. Patent Applications that were filed on Dec. 21, 2016 and which are each herein incorporated by reference in their respective entireties:

[0148] U.S. patent application Ser. No. 15/385,896, entitled METHOD FOR RESETTING A FUSE OF A SURGICAL INSTRUMENT SHAFT;

[0149] U.S. patent application Ser. No. 15/385,898, entitled STAPLE FORMING POCKET ARRANGEMENT TO ACCOMMODATE DIFFERENT TYPES OF STAPLES;

[0150] U.S. patent application Ser. No. 15/385,899, entitled SURGICAL INSTRUMENT COMPRISING IMPROVED JAW CONTROL;

[0151] U.S. patent application Ser. No. 15/385,901, entitled STAPLE CARTRIDGE AND STAPLE CARTRIDGE CHANNEL COMPRISING WINDOWS DEFINED THEREIN;

[0152] U.S. patent application Ser. No. 15/385,902, entitled SURGICAL INSTRUMENT COMPRISING A CUTTING MEMBER;

[0153] U.S. patent application Ser. No. 15/385,904, entitled STAPLE FIRING MEMBER COMPRISING A MISSING CARTRIDGE AND/OR SPENT CARTRIDGE LOCKOUT;

[0154] U.S. patent application Ser. No. 15/385,905, entitled FIRING ASSEMBLY COMPRISING A LOCKOUT;

[0155] U.S. patent application Ser. No. 15/385,907, entitled SURGICAL INSTRUMENT SYSTEM COMPRISING AN END EFFECTOR LOCKOUT AND A FIRING ASSEMBLY LOCKOUT;

[0156] U.S. patent application Ser. No. 15/385,908, entitled FIRING ASSEMBLY COMPRISING A FUSE; and

[0157] U.S. patent application Ser. No. 15/385,909, entitled FIRING ASSEMBLY COMPRISING A MULTIPLE FAILED-STATE FUSE.

[0158] Applicant of the present application owns the following U.S. Patent Applications that were filed on Dec. 21, 2016 and which are each herein incorporated by reference in their respective entireties:

[0159] U.S. patent application Ser. No. 15/385,920, entitled STAPLE FORMING POCKET ARRANGEMENTS;

[0160] U.S. patent application Ser. No. 15/385,913, entitled ANVIL ARRANGEMENTS FOR SURGICAL STAPLERS;

[0161] U.S. patent application Ser. No. 15/385,914, entitled METHOD OF DEFORMING STAPLES FROM TWO DIFFERENT TYPES OF STAPLE CARTRIDGES WITH THE SAME SURGICAL STAPLING INSTRUMENT;

[0162] U.S. patent application Ser. No. 15/385,893, entitled BILATERALLY ASYMMETRIC STAPLE FORMING POCKET PAIRS;

[0163] U.S. patent application Ser. No. 15/385,929, entitled CLOSURE MEMBERS WITH CAM SURFACE ARRANGEMENTS FOR SURGICAL INSTRUMENTS WITH SEPARATE AND DISTINCT CLOSURE AND FIRING SYSTEMS;

[0164] U.S. patent application Ser. No. 15/385,911, entitled SURGICAL STAPLERS WITH INDEPENDENTLY ACTUATABLE CLOSING AND FIRING SYSTEMS;

[0165] U.S. patent application Ser. No. 15/385,927, entitled SURGICAL STAPLING INSTRUMENTS WITH SMART STAPLE CARTRIDGES;

[0166] U.S. patent application Ser. No. 15/385,917, entitled STAPLE CARTRIDGE COMPRISING STAPLES WITH DIFFERENT CLAMPING BREADTHS;

[0167] U.S. patent application Ser. No. 15/385,900, entitled STAPLE FORMING POCKET ARRANGEMENTS COMPRISING PRIMARY SIDEWALLS AND POCKET SIDEWALLS;

[0168] U.S. patent application Ser. No. 15/385,931, entitled NO-CARTRIDGE AND SPENT CARTRIDGE LOCKOUT ARRANGEMENTS FOR SURGICAL STAPLERS;

[0169] U.S. patent application Ser. No. 15/385,915, entitled FIRING MEMBER PIN ANGLE;

[0170] U.S. patent application Ser. No. 15/385,897, entitled STAPLE FORMING POCKET ARRANGEMENTS COMPRISING ZONED FORMING SURFACE GROOVES;

[0171] U.S. patent application Ser. No. 15/385,922, entitled SURGICAL INSTRUMENT WITH MULTIPLE FAILURE RESPONSE MODES;

[0172] U.S. patent application Ser. No. 15/385,924, entitled SURGICAL INSTRUMENT WITH PRIMARY AND SAFETY PROCESSORS;

[0173] U.S. patent application Ser. No. 15/385,912, entitled SURGICAL INSTRUMENTS WITH JAWS THAT ARE PIVOTABLE ABOUT A FIXED AXIS AND INCLUDE SEPARATE AND DISTINCT CLOSURE AND FIRING SYSTEMS;

[0174] U.S. patent application Ser. No. 15/385,910, entitled ANVIL HAVING A KNIFE SLOT WIDTH;

[0175] U.S. patent application Ser. No. 15/385,903, entitled CLOSURE MEMBER ARRANGEMENTS FOR SURGICAL INSTRUMENTS; and

[0176] U.S. patent application Ser. No. 15/385,906, entitled FIRING MEMBER PIN CONFIGURATIONS.

[0177] Applicant of the present application owns the following U.S. Patent Applications that were filed on Dec. 21, 2016 and which are each herein incorporated by reference in their respective entireties:

[0178] U.S. patent application Ser. No. 15/386,188, entitled STEPPED STAPLE CARTRIDGE WITH ASYMMETRICAL STAPLES;

[0179] U.S. patent application Ser. No. 15/386,192, entitled STEPPED STAPLE CARTRIDGE WITH TISSUE RETENTION AND GAP SETTING FEATURES;

[0180] U.S. patent application Ser. No. 15,386,206, entitled STAPLE CARTRIDGE WITH DEFORMABLE DRIVER RETENTION FEATURES;

[0181] U.S. patent application Ser. No. 15/386,226, entitled DURABILITY FEATURES FOR END EFFECTORS AND FIRING ASSEMBLIES OF SURGICAL STAPLING INSTRUMENTS;

[0182] U.S. patent application Ser. No. 15/386,222, entitled SURGICAL STAPLING INSTRUMENTS HAVING END EFFECTORS WITH POSITIVE OPENING FEATURES; and

[0183] U.S. patent application Ser. No. 15/386,236, entitled CONNECTION PORTIONS FOR DISPOSABLE LOADING UNITS FOR SURGICAL STAPLING INSTRUMENTS.

[0184] Applicant of the present application owns the following U.S. Patent Applications that were filed on Dec. 21, 2016 and which are each herein incorporated by reference in their respective entireties:

[0185] U.S. patent application Ser. No. 15/385,887, entitled METHOD FOR ATTACHING A SHAFT ASSEMBLY TO A SURGICAL INSTRUMENT AND, ALTERNATIVELY, TO A SURGICAL ROBOT;

[0186] U.S. patent application Ser. No. 15/385,889, entitled SHAFT ASSEMBLY COMPRISING A MANUALLY-OPERABLE RETRACTION SYSTEM FOR USE WITH A MOTORIZED SURGICAL INSTRUMENT SYSTEM;

[0187] U.S. patent application Ser. No. 15/385,890, entitled SHAFT ASSEMBLY COMPRISING SEPARATELY ACTUATABLE AND RETRACTABLE SYSTEMS;

[0188] U.S. patent application Ser. No. 15/385,891, entitled SHAFT ASSEMBLY COMPRISING A CLUTCH CONFIGURED TO ADAPT THE OUTPUT OF A ROTARY FIRING MEMBER TO TWO DIFFERENT SYSTEMS;

[0189] U.S. patent application Ser. No. 15/385,892, entitled SURGICAL SYSTEM COMPRISING A FIRING MEMBER ROTATABLE INTO AN ARTICULATION STATE TO ARTICULATE AN END EFFECTOR OF THE SURGICAL SYSTEM;

[0190] U.S. patent application Ser. No. 15/385,894, entitled SHAFT ASSEMBLY COMPRISING A LOCKOUT; and

[0191] U.S. patent application Ser. No. 15/385,895, entitled SHAFT ASSEMBLY COMPRISING FIRST AND SECOND ARTICULATION LOCKOUTS.

[0192] Applicant of the present application owns the following U.S. Patent Applications that were filed on Dec. 21, 2016 and which are each herein incorporated by reference in their respective entireties:

[0193] U.S. patent application Ser. No. 15/385,916, entitled SURGICAL STAPLING SYSTEMS;

[0194] U.S. patent application Ser. No. 15/385,918, entitled SURGICAL STAPLING SYSTEMS;

[0195] U.S. patent application Ser. No. 15/385,919, entitled SURGICAL STAPLING SYSTEMS;

[0196] U.S. patent application Ser. No. 15/385,921, entitled SURGICAL STAPLE CARTRIDGE WITH MOVABLE CAMMING MEMBER CONFIGURED TO DISENGAGE FIRING MEMBER LOCKOUT FEATURES;

[0197] U.S. patent application Ser. No. 15/385,923, entitled SURGICAL STAPLING SYSTEMS;

[0198] U.S. patent application Ser. No. 15/385,925, entitled JAW ACTUATED LOCK ARRANGEMENTS FOR PREVENTING ADVANCEMENT OF A FIRING MEMBER IN A SURGICAL END EFFECTOR UNLESS AN UNFIRED CARTRIDGE IS INSTALLED IN THE END EFFECTOR;

[0199] U.S. patent application Ser. No. 15/385,926, entitled AXIALLY MOVABLE CLOSURE SYSTEM ARRANGEMENTS FOR APPLYING CLOSURE MOTIONS TO JAWS OF SURGICAL INSTRUMENTS;

[0200] U.S. patent application Ser. No. 15/385,928, entitled PROTECTIVE COVER ARRANGEMENTS FOR A JOINT INTERFACE BETWEEN A MOVABLE JAW AND ACTUATOR SHAFT OF A SURGICAL INSTRUMENT;

[0201] U.S. patent application Ser. No. 15/385,932, entitled ARTICULATABLE SURGICAL END EFFECTOR WITH ASYMMETRIC SHAFT ARRANGEMENT;

[0202] U.S. patent application Ser. No. 15/385,933, entitled ARTICULATABLE SURGICAL INSTRUMENT WITH INDEPENDENT PIVOTABLE LINKAGE DISTAL OF AN ARTICULATION LOCK;

[0203] U.S. patent application Ser. No. 15/385,934, entitled ARTICULATION LOCK ARRANGEMENTS FOR LOCKING AN END EFFECTOR IN AN ARTICULATED POSITION IN RESPONSE TO ACTUATION OF A JAW CLOSURE SYSTEM;

[0204] U.S. patent application Ser. No. 15/385,935, entitled LATERALLY ACTUATABLE ARTICULATION LOCK ARRANGEMENTS FOR LOCKING AN END EFFECTOR OF A SURGICAL INSTRUMENT IN AN ARTICULATED CONFIGURATION; and

[0205] U.S. patent application Ser. No. 15/385,936, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH ARTICULATION STROKE AMPLIFICATION FEATURES.

[0206] Applicant of the present application owns the following U.S. Patent Applications that were filed on Jun. 24, 2016 and which are each herein incorporated by reference in their respective entireties:

[0207] U.S. patent application Ser. No. 15/191,775, entitled STAPLE CARTRIDGE COMPRISING WIRE STAPLES AND STAMPED STAPLES;

[0208] U.S. patent application Ser. No. 15/191,807, entitled STAPLING SYSTEM FOR USE WITH WIRE STAPLES AND STAMPED STAPLES;

[0209] U.S. patent application Ser. No. 15/191,834, entitled STAMPED STAPLES AND STAPLE CARTRIDGES USING THE SAME;

[0210] U.S. patent application Ser. No. 15/191,788, entitled STAPLE CARTRIDGE COMPRISING OVERDRIVEN STAPLES; and

[0211] U.S. patent application Ser. No. 15/191,818, entitled STAPLE CARTRIDGE COMPRISING OFFSET LONGITUDINAL STAPLE ROWS.

[0212] Applicant of the present application owns the following U.S. Patent Applications that were filed on Jun. 24, 2016 and which are each herein incorporated by reference in their respective entireties:

[0213] U.S. Design patent application Ser. No. 29/569,218, entitled SURGICAL FASTENER;

[0214] U.S. Design patent application Ser. No. 29/569,227, entitled SURGICAL FASTENER;

[0215] U.S. Design patent application Ser. No. 29/569,259, entitled SURGICAL FASTENER CARTRIDGE; and

[0216] U.S. Design patent application Ser. No. 29/569,264, entitled SURGICAL FASTENER CARTRIDGE.

[0217] Applicant of the present application owns the following patent applications that were filed on Apr. 1, 2016 and which are each herein incorporated by reference in their respective entireties:

[0218] U.S. patent application Ser. No. 15/089,325, entitled METHOD FOR OPERATING A SURGICAL STAPLING SYSTEM;

[0219] U.S. patent application Ser. No. 15/089,321, entitled MODULAR SURGICAL STAPLING SYSTEM COMPRISING A DISPLAY;

[0220] U.S. patent application Ser. No. 15/089,326, entitled SURGICAL STAPLING SYSTEM COMPRISING A DISPLAY INCLUDING A RE-ORIENTABLE DISPLAY FIELD;

[0221] U.S. patent application Ser. No. 15/089,263, entitled SURGICAL INSTRUMENT HANDLE ASSEMBLY WITH RECONFIGURABLE GRIP PORTION;

[0222] U.S. patent application Ser. No. 15/089,262, entitled ROTARY POWERED SURGICAL INSTRUMENT WITH MANUALLY ACTUATABLE BAILOUT SYSTEM;

[0223] U.S. patent application Ser. No. 15/089,277, entitled SURGICAL CUTTING AND STAPLING END EFFECTOR WITH ANVIL CONCENTRIC DRIVE MEMBER;

[0224] U.S. patent application Ser. No. 15/089,296, entitled INTERCHANGEABLE SURGICAL TOOL ASSEMBLY WITH A SURGICAL END EFFECTOR THAT IS SELECTIVELY ROTATABLE ABOUT A SHAFT AXIS;

[0225] U.S. patent application Ser. No. 15/089,258, entitled SURGICAL STAPLING SYSTEM COMPRISING A SHIFTABLE TRANSMISSION;

[0226] U.S. patent application Ser. No. 15/089,278, entitled SURGICAL STAPLING SYSTEM CONFIGURED TO PROVIDE SELECTIVE CUTTING OF TISSUE;

[0227] U.S. patent application Ser. No. 15/089,284, entitled SURGICAL STAPLING SYSTEM COMPRISING A CONTOURABLE SHAFT;

[0228] U.S. patent application Ser. No. 15/089,295, entitled SURGICAL STAPLING SYSTEM COMPRISING A TISSUE COMPRESSION LOCKOUT;

[0229] U.S. patent application Ser. No. 15/089,300, entitled SURGICAL STAPLING SYSTEM COMPRISING AN UNCLAMPING LOCKOUT;

[0230] U.S. patent application Ser. No. 15/089,196, entitled SURGICAL STAPLING SYSTEM COMPRISING A JAW CLOSURE LOCKOUT;

[0231] U.S. patent application Ser. No. 15/089,203, entitled SURGICAL STAPLING SYSTEM COMPRISING A JAW ATTACHMENT LOCKOUT;

[0232] U.S. patent application Ser. No. 15/089,210, entitled SURGICAL STAPLING SYSTEM COMPRISING A SPENT CARTRIDGE LOCKOUT;

[0233] U.S. patent application Ser. No. 15/089,324, entitled SURGICAL INSTRUMENT COMPRISING A SHIFTING MECHANISM;

[0234] U.S. patent application Ser. No. 15/089,335, entitled SURGICAL STAPLING INSTRUMENT COMPRISING MULTIPLE LOCKOUTS;

[0235] U.S. patent application Ser. No. 15/089,339, entitled SURGICAL STAPLING INSTRUMENT;

[0236] U.S. patent application Ser. No. 15/089,253, entitled SURGICAL STAPLING SYSTEM CONFIGURED TO APPLY ANNULAR ROWS OF STAPLES HAVING DIFFERENT HEIGHTS;

[0237] U.S. patent application Ser. No. 15/089,304, entitled SURGICAL STAPLING SYSTEM COMPRISING A GROOVED FORMING POCKET;

[0238] U.S. patent application Ser. No. 15/089,331, entitled ANVIL MODIFICATION MEMBERS FOR SURGICAL STAPLERS;

[0239] U.S. patent application Ser. No. 15/089,336, entitled STAPLE CARTRIDGES WITH ATRAUMATIC FEATURES;

[0240] U.S. patent application Ser. No. 15/089,312, entitled CIRCULAR STAPLING SYSTEM COMPRISING AN INCISABLE TISSUE SUPPORT;

[0241] U.S. patent application Ser. No. 15/089,309, entitled CIRCULAR STAPLING SYSTEM COMPRISING ROTARY FIRING SYSTEM; and

[0242] U.S. patent application Ser. No. 15/089,349, entitled CIRCULAR STAPLING SYSTEM COMPRISING LOAD CONTROL.

[0243] Applicant of the present application also owns the U.S. Patent Applications identified below which were filed on Dec. 31, 2015 which are each herein incorporated by reference in their respective entireties:

[0244] U.S. patent application Ser. No. 14/984,488, entitled MECHANISMS FOR COMPENSATING FOR BATTERY PACK FAILURE IN POWERED SURGICAL INSTRUMENTS;

[0245] U.S. patent application Ser. No. 14/984,525, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS; and

[0246] U.S. patent application Ser. No. 14/984,552, entitled SURGICAL INSTRUMENTS WITH SEPARABLE MOTORS AND MOTOR CONTROL CIRCUITS.

[0247] Applicant of the present application also owns the U.S. Patent Applications identified below which were filed on Feb. 9, 2016 which are each herein incorporated by reference in their respective entireties:

[0248] U.S. patent application Ser. No. 15/019,220, entitled SURGICAL INSTRUMENT WITH ARTICULATING AND AXIALLY TRANSLATABLE END EFFECTOR;

[0249] U.S. patent application Ser. No. 15/019,228, entitled SURGICAL INSTRUMENTS WITH MULTIPLE LINK ARTICULATION ARRANGEMENTS;

[0250] U.S. patent application Ser. No. 15/019,196, entitled SURGICAL INSTRUMENT ARTICULATION MECHANISM WITH SLOTTED SECONDARY CONSTRAINT;

[0251] U.S. patent application Ser. No. 15/019,206, entitled SURGICAL INSTRUMENTS WITH AN END EFFECTOR THAT IS HIGHLY ARTICULATABLE RELATIVE TO AN ELONGATE SHAFT ASSEMBLY;

[0252] U.S. patent application Ser. No. 15/019,215, entitled SURGICAL INSTRUMENTS WITH NON-SYMMETRICAL ARTICULATION ARRANGEMENTS;

[0253] U.S. patent application Ser. No. 15/019,227, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH SINGLE ARTICULATION LINK ARRANGEMENTS;

[0254] U.S. patent application Ser. No. 15/019,235, entitled SURGICAL INSTRUMENTS WITH TENSIONING ARRANGEMENTS FOR CABLE DRIVEN ARTICULATION SYSTEMS;

[0255] U.S. patent application Ser. No. 15/019,230, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH OFF-AXIS FIRING BEAM ARRANGEMENTS; and

[0256] U.S. patent application Ser. No. 15/019,245, entitled SURGICAL INSTRUMENTS WITH CLOSURE STROKE REDUCTION ARRANGEMENTS.

[0257] Applicant of the present application also owns the U.S. Patent Applications identified below which were filed on Feb. 12, 2016 which are each herein incorporated by reference in their respective entireties:

[0258] U.S. patent application Ser. No. 15/043,254, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS;

[0259] U.S. patent application Ser. No. 15/043,259, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS;

[0260] U.S. patent application Ser. No. 15/043,275, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS; and

[0261] U.S. patent application Ser. No. 15/043,289, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS.

[0262] Applicant of the present application owns the following patent applications that were filed on Jun. 18, 2015 and which are each herein incorporated by reference in their respective entireties:

[0263] U.S. patent application Ser. No. 14/742,925, entitled SURGICAL END EFFECTORS WITH POSITIVE JAW OPENING ARRANGEMENTS;

[0264] U.S. patent application Ser. No. 14/742,941, entitled SURGICAL END EFFECTORS WITH DUAL CAM ACTUATED JAW CLOSING FEATURES;

[0265] U.S. patent application Ser. No. 14/742,914, entitled MOVABLE FIRING BEAM SUPPORT ARRANGEMENTS FOR ARTICULATABLE SURGICAL INSTRUMENTS;

[0266] U.S. patent application Ser. No. 14/742,900, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH COMPOSITE FIRING BEAM STRUCTURES WITH CENTER FIRING SUPPORT MEMBER FOR ARTICULATION SUPPORT;

[0267] U.S. patent application Ser. No. 14/742,885, entitled DUAL ARTICULATION DRIVE SYSTEM ARRANGEMENTS FOR ARTICULATABLE SURGICAL INSTRUMENTS; and

[0268] U.S. patent application Ser. No. 14/742,876, entitled PUSH/PULL ARTICULATION DRIVE SYSTEMS FOR ARTICULATABLE SURGICAL INSTRUMENTS.

[0269] Applicant of the present application owns the following patent applications that were filed on Mar. 6, 2015 and which are each herein incorporated by reference in their respective entireties:

[0270] U.S. patent application Ser. No. 14/640,746, entitled POWERED SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2016/0256184;

[0271] U.S. patent application Ser. No. 14/640,795, entitled MULTIPLE LEVEL THRESHOLDS TO MODIFY OPERATION OF POWERED SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2016/02561185;

[0272] U.S. patent application Ser. No. 14/640,832, entitled ADAPTIVE TISSUE COMPRESSION TECHNIQUES TO ADJUST CLOSURE RATES FOR MULTIPLE TISSUE TYPES, now U.S. Patent Application Publication No. 2016/0256154;

[0273] U.S. patent application Ser. No. 14/640,935, entitled OVERLAID MULTI SENSOR RADIO FREQUENCY (RF) ELECTRODE SYSTEM TO MEASURE TISSUE COMPRESSION, now U.S. Patent Application Publication No. 2016/0256071;

[0274] U.S. patent application Ser. No. 14/640,831, entitled MONITORING SPEED CONTROL AND PRECISION INCREMENTING OF MOTOR FOR POWERED SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2016/0256153;

[0275] U.S. patent application Ser. No. 14/640,859, entitled TIME DEPENDENT EVALUATION OF SENSOR DATA TO DETERMINE STABILITY, CREEP, AND VISCOELASTIC ELEMENTS OF MEASURES, now U.S. Patent Application Publication No. 2016/0256187;

[0276] U.S. patent application Ser. No. 14/640,817, entitled INTERACTIVE FEEDBACK SYSTEM FOR POWERED SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2016/0256186;

[0277] U.S. patent application Ser. No. 14/640,844, entitled CONTROL TECHNIQUES AND SUB-PROCESSOR CONTAINED WITHIN MODULAR SHAFT WITH SELECT CONTROL PROCESSING FROM HANDLE, now U.S. Patent Application Publication No. 2016/0256155;

[0278] U.S. patent application Ser. No. 14/640,837, entitled SMART SENSORS WITH LOCAL SIGNAL PROCESSING, now U.S. Patent Application Publication No. 2016/0256163;

[0279] U.S. patent application Ser. No. 14/640,765, entitled SYSTEM FOR DETECTING THE MIS-INSERTION OF A STAPLE CARTRIDGE INTO A SURGICAL STAPLER, now U.S. Patent Application Publication No. 2016/0256160;

[0280] U.S. patent application Ser. No. 14/640,799, entitled SIGNAL AND POWER COMMUNICATION SYSTEM POSITIONED ON A ROTATABLE SHAFT, now U.S. Patent Application Publication No. 2016/0256162; and

[0281] U.S. patent application Ser. No. 14/640,780, entitled SURGICAL INSTRUMENT COMPRISING A LOCKABLE BATTERY HOUSING, now U.S. Patent Application Publication No. 2016/0256161.

[0282] Applicant of the present application owns the following patent applications that were filed on Feb. 27, 2015, and which are each herein incorporated by reference in their respective entireties:

[0283] U.S. patent application Ser. No. 14/633,576, entitled SURGICAL INSTRUMENT SYSTEM COMPRIS-

ING AN INSPECTION STATION, now U.S. Patent Application Publication No. 2016/0249919;

[0284] U.S. patent application Ser. No. 14/633,546, entitled SURGICAL APPARATUS CONFIGURED TO ASSESS WHETHER A PERFORMANCE PARAMETER OF THE SURGICAL APPARATUS IS WITHIN AN ACCEPTABLE PERFORMANCE BAND, now U.S. Patent Application Publication No. 2016/0249915;

[0285] U.S. patent application Ser. No. 14/633,560, entitled SURGICAL CHARGING SYSTEM THAT CHARGES AND/OR CONDITIONS ONE OR MORE BATTERIES, now U.S. Patent Application Publication No. 2016/0249910;

[0286] U.S. patent application Ser. No. 14/633,566, entitled CHARGING SYSTEM THAT ENABLES EMERGENCY RESOLUTIONS FOR CHARGING A BATTERY, now U.S. Patent Application Publication No. 2016/0249918;

[0287] U.S. patent application Ser. No. 14/633,555, entitled SYSTEM FOR MONITORING WHETHER A SURGICAL INSTRUMENT NEEDS TO BE SERVICED, now U.S. Patent Application Publication No. 2016/0249916;

[0288] U.S. patent application Ser. No. 14/633,542, entitled REINFORCED BATTERY FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2016/0249908;

[0289] U.S. patent application Ser. No. 14/633,548, entitled POWER ADAPTER FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2016/0249909;

[0290] U.S. patent application Ser. No. 14/633,526, entitled ADAPTABLE SURGICAL INSTRUMENT HANDLE, now U.S. Patent Application Publication No. 2016/0249945;

[0291] U.S. patent application Ser. No. 14/633,541, entitled MODULAR STAPLING ASSEMBLY, now U.S. Patent Application Publication No. 2016/0249927; and

[0292] U.S. patent application Ser. No. 14/633,562, entitled SURGICAL APPARATUS CONFIGURED TO TRACK AN END-OF-LIFE PARAMETER, now U.S. Patent Application Publication No. 2016/0249917.

[0293] Applicant of the present application owns the following patent applications that were filed on Dec. 18, 2014 and which are each herein incorporated by reference in their respective entireties:

[0294] U.S. patent application Ser. No. 14/574,478, entitled SURGICAL INSTRUMENT SYSTEMS COMPRISING AN ARTICULATABLE END EFFECTOR AND MEANS FOR ADJUSTING THE FIRING STROKE OF A FIRING MEMBER, now U.S. Patent Application Publication No. 2016/0174977;

[0295] U.S. patent application Ser. No. 14/574,483, entitled SURGICAL INSTRUMENT ASSEMBLY COMPRISING LOCKABLE SYSTEMS, now U.S. Patent Application Publication No. 2016/0174969;

[0296] U.S. patent application Ser. No. 14/575,139, entitled DRIVE ARRANGEMENTS FOR ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2016/0174978;

[0297] U.S. patent application Ser. No. 14/575,148, entitled LOCKING ARRANGEMENTS FOR DETACHABLE SHAFT ASSEMBLIES WITH ARTICULATABLE SURGICAL END EFFECTORS, now U.S. Patent Application Publication No. 2016/0174976;

[0298] U.S. patent application Ser. No. 14/575,130, entitled SURGICAL INSTRUMENT WITH AN ANVIL THAT IS SELECTIVELY MOVABLE ABOUT A DISCRETE NON-MOVABLE AXIS RELATIVE TO A STAPLE CARTRIDGE, now U.S. Patent Application Publication No. 2016/0174972;

[0299] U.S. patent application Ser. No. 14/575,143, entitled SURGICAL INSTRUMENTS WITH IMPROVED CLOSURE ARRANGEMENTS, now U.S. Patent Application Publication No. 2016/0174983;

[0300] U.S. patent application Ser. No. 14/575,117, entitled SURGICAL INSTRUMENTS WITH ARTICULATABLE END EFFECTORS AND MOVABLE FIRING BEAM SUPPORT ARRANGEMENTS, now U.S. Patent Application Publication No. 2016/0174975;

[0301] U.S. patent application Ser. No. 14/575,154, entitled SURGICAL INSTRUMENTS WITH ARTICULATABLE END EFFECTORS AND IMPROVED FIRING BEAM SUPPORT ARRANGEMENTS, now U.S. Patent Application Publication No. 2016/0174973;

[0302] U.S. patent application Ser. No. 14/574,493, entitled SURGICAL INSTRUMENT ASSEMBLY COMPRISING A FLEXIBLE ARTICULATION SYSTEM, now U.S. Patent Application Publication No. 2016/0174970; and

[0303] U.S. patent application Ser. No. 14/574,500, entitled SURGICAL INSTRUMENT ASSEMBLY COMPRISING A LOCKABLE ARTICULATION SYSTEM, now U.S. Patent Application Publication No. 2016/0174971.

[0304] Applicant of the present application owns the following patent applications that were filed on Mar. 1, 2013 and which are each herein incorporated by reference in their respective entireties:

[0305] U.S. patent application Ser. No. 13/782,295, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH CONDUCTIVE PATHWAYS FOR SIGNAL COMMUNICATION, now U.S. Patent Application Publication No. 2014/0246471;

[0306] U.S. patent application Ser. No. 13/782,323, entitled ROTARY POWERED ARTICULATION JOINTS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0246472;

[0307] U.S. patent application Ser. No. 13/782,338, entitled THUMBWREEL SWITCH ARRANGEMENTS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0249557;

[0308] U.S. patent application Ser. No. 13/782,499, entitled ELECTROMECHANICAL SURGICAL DEVICE WITH SIGNAL RELAY ARRANGEMENT, now U.S. Pat. No. 9,358,003;

[0309] U.S. patent application Ser. No. 13/782,460, entitled MULTIPLE PROCESSOR MOTOR CONTROL FOR MODULAR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0246478;

[0310] U.S. patent application Ser. No. 13/782,358, entitled JOYSTICK SWITCH ASSEMBLIES FOR SURGICAL INSTRUMENTS, now U.S. Pat. No. 9,326,767;

[0311] U.S. patent application Ser. No. 13/782,481, entitled SENSOR STRAIGHTENED END EFFECTOR DURING REMOVAL THROUGH TROCAR, now U.S. Pat. No. 9,468,438;

[0312] U.S. patent application Ser. No. 13/782,518, entitled CONTROL METHODS FOR SURGICAL

INSTRUMENTS WITH REMOVABLE IMPLEMENT PORTIONS, now U.S. Patent Application Publication No. 2014/0246475;

[0313] U.S. patent application Ser. No. 13/782,375, entitled ROTARY POWERED SURGICAL INSTRUMENTS WITH MULTIPLE DEGREES OF FREEDOM, now U.S. Pat. No. 9,398,911; and

[0314] U.S. patent application Ser. No. 13/782,536, entitled SURGICAL INSTRUMENT SOFT STOP, now U.S. Pat. No. 9,307,986.

[0315] Applicant of the present application also owns the following patent applications that were filed on Mar. 14, 2013 and which are each herein incorporated by reference in their respective entireties:

[0316] U.S. patent application Ser. No. 13/803,097, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING A FIRING DRIVE, now U.S. Patent Application Publication No. 2014/0263542;

[0317] U.S. patent application Ser. No. 13/803,193, entitled CONTROL ARRANGEMENTS FOR A DRIVE MEMBER OF A SURGICAL INSTRUMENT, now U.S. Pat. No. 9,332,987;

[0318] U.S. patent application Ser. No. 13/803,053, entitled INTERCHANGEABLE SHAFT ASSEMBLIES FOR USE WITH A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0263564;

[0319] U.S. patent application Ser. No. 13/803,086, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK, now U.S. Patent Application Publication No. 2014/0263541;

[0320] U.S. patent application Ser. No. 13/803,210, entitled SENSOR ARRANGEMENTS FOR ABSOLUTE POSITIONING SYSTEM FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0263538;

[0321] U.S. patent application Ser. No. 13/803,148, entitled MULTI-FUNCTION MOTOR FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0263554;

[0322] U.S. patent application Ser. No. 13/803,066, entitled DRIVE SYSTEM LOCKOUT ARRANGEMENTS FOR MODULAR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0263565;

[0323] U.S. patent application Ser. No. 13/803,117, entitled ARTICULATION CONTROL SYSTEM FOR ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Pat. No. 9,351,726;

[0324] U.S. patent application Ser. No. 13/803,130, entitled DRIVE TRAIN CONTROL ARRANGEMENTS FOR MODULAR SURGICAL INSTRUMENTS, now U.S. Pat. No. 9,351,727; and

[0325] U.S. patent application Ser. No. 13/803,159, entitled METHOD AND SYSTEM FOR OPERATING A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0277017.

[0326] Applicant of the present application also owns the following patent application that was filed on Mar. 7, 2014 and is herein incorporated by reference in its entirety:

[0327] U.S. patent application Ser. No. 14/200,111, entitled CONTROL SYSTEMS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0263539.

[0328] Applicant of the present application also owns the following patent applications that were filed on Mar. 26, 2014 and are each herein incorporated by reference in their respective entireties:

[0329] U.S. patent application Ser. No. 14/226,106, entitled POWER MANAGEMENT CONTROL SYSTEMS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2015/0272582;

[0330] U.S. patent application Ser. No. 14/226,099, entitled STERILIZATION VERIFICATION CIRCUIT, now U.S. Patent Application Publication No. 2015/0272581;

[0331] U.S. patent application Ser. No. 14/226,094, entitled VERIFICATION OF NUMBER OF BATTERY EXCHANGES/PROCEDURE COUNT, now U.S. Patent Application Publication No. 2015/0272580;

[0332] U.S. patent application Ser. No. 14/226,117, entitled POWER MANAGEMENT THROUGH SLEEP OPTIONS OF SEGMENTED CIRCUIT AND WAKE UP CONTROL, now U.S. Patent Application Publication No. 2015/0272574;

[0333] U.S. patent application Ser. No. 14/226,075, entitled MODULAR POWERED SURGICAL INSTRUMENT WITH DETACHABLE SHAFT ASSEMBLIES, now U.S. Patent Application Publication No. 2015/0272579;

[0334] U.S. patent application Ser. No. 14/226,093, entitled FEEDBACK ALGORITHMS FOR MANUAL BAILOUT SYSTEMS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2015/0272569;

[0335] U.S. patent application Ser. No. 14/226,116, entitled SURGICAL INSTRUMENT UTILIZING SENSOR ADAPTATION, now U.S. Patent Application Publication No. 2015/0272571;

[0336] U.S. patent application Ser. No. 14/226,071, entitled SURGICAL INSTRUMENT CONTROL CIRCUIT HAVING A SAFETY PROCESSOR, now U.S. Patent Application Publication No. 2015/0272578;

[0337] U.S. patent application Ser. No. 14/226,097, entitled SURGICAL INSTRUMENT COMPRISING INTERACTIVE SYSTEMS, now U.S. Patent Application Publication No. 2015/0272570;

[0338] U.S. patent application Ser. No. 14/226,126, entitled INTERFACE SYSTEMS FOR USE WITH SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2015/0272572;

[0339] U.S. patent application Ser. No. 14/226,133, entitled MODULAR SURGICAL INSTRUMENT SYSTEM, now U.S. Patent Application Publication No. 2015/0272557;

[0340] U.S. patent application Ser. No. 14/226,081, entitled SYSTEMS AND METHODS FOR CONTROLLING A SEGMENTED CIRCUIT, now U.S. Patent Application Publication No. 2015/0277471;

[0341] U.S. patent application Ser. No. 14/226,076, entitled POWER MANAGEMENT THROUGH SEGMENTED CIRCUIT AND VARIABLE VOLTAGE PROTECTION, now U.S. Patent Application Publication No. 2015/0280424;

[0342] U.S. patent application Ser. No. 14/226,111, entitled SURGICAL STAPLING INSTRUMENT SYSTEM, now U.S. Patent Application Publication No. 2015/0272583; and

[0343] U.S. patent application Ser. No. 14/226,125, entitled SURGICAL INSTRUMENT COMPRISING A ROTATABLE SHAFT, now U.S. Patent Application Publication No. 2015/0280384.

[0344] Applicant of the present application also owns the following patent applications that were filed on Sep. 5, 2014 and which are each herein incorporated by reference in their respective entireties:

[0345] U.S. patent application Ser. No. 14/479,103, entitled CIRCUITRY AND SENSORS FOR POWERED MEDICAL DEVICE, now U.S. Patent Application Publication No. 2016/0066912;

[0346] U.S. patent application Ser. No. 14/479,119, entitled ADJUNCT WITH INTEGRATED SENSORS TO QUANTIFY TISSUE COMPRESSION, now U.S. Patent Application Publication No. 2016/0066914;

[0347] U.S. patent application Ser. No. 14/478,908, entitled MONITORING DEVICE DEGRADATION BASED ON COMPONENT EVALUATION, now U.S. Patent Application Publication No. 2016/0066910;

[0348] U.S. patent application Ser. No. 14/478,895, entitled MULTIPLE SENSORS WITH ONE SENSOR AFFECTING A SECOND SENSOR'S OUTPUT OR INTERPRETATION, now U.S. Patent Application Publication No. 2016/0066909;

[0349] U.S. patent application Ser. No. 14/479,110, entitled POLARITY OF HALL MAGNET TO DETECT MISLOADED CARTRIDGE, now U.S. Patent Application Publication No. 2016/0066915;

[0350] U.S. patent application Ser. No. 14/479,098, entitled SMART CARTRIDGE WAKE UP OPERATION AND DATA RETENTION, now U.S. Patent Application Publication No. 2016/0066911;

[0351] U.S. patent application Ser. No. 14/479,115, entitled MULTIPLE MOTOR CONTROL FOR POWERED MEDICAL DEVICE, now U.S. Patent Application Publication No. 2016/0066916; and

[0352] U.S. patent application Ser. No. 14/479,108, entitled LOCAL DISPLAY OF TISSUE PARAMETER STABILIZATION, now U.S. Patent Application Publication No. 2016/0066913.

[0353] Applicant of the present application also owns the following patent applications that were filed on Apr. 9, 2014 and which are each herein incorporated by reference in their respective entireties:

[0354] U.S. patent application Ser. No. 14/248,590, entitled MOTOR DRIVEN SURGICAL INSTRUMENTS WITH LOCKABLE DUAL DRIVE SHAFTS, now U.S. Patent Application Publication No. 2014/0305987;

[0355] U.S. patent application Ser. No. 14/248,581, entitled SURGICAL INSTRUMENT COMPRISING A CLOSING DRIVE AND A FIRING DRIVE OPERATED FROM THE SAME ROTATABLE OUTPUT, now U.S. Patent Application Publication No. 2014/0305989;

[0356] U.S. patent application Ser. No. 14/248,595, entitled SURGICAL INSTRUMENT SHAFT INCLUDING SWITCHES FOR CONTROLLING THE OPERATION OF THE SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0305988;

[0357] U.S. patent application Ser. No. 14/248,588, entitled POWERED LINEAR SURGICAL STAPLER, now U.S. Patent Application Publication No. 2014/0309666;

[0358] U.S. patent application Ser. No. 14/248,591, entitled TRANSMISSION ARRANGEMENT FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0305991;

[0359] U.S. patent application Ser. No. 14/248,584, entitled MODULAR MOTOR DRIVEN SURGICAL INSTRUMENTS WITH ALIGNMENT FEATURES FOR ALIGNING ROTARY DRIVE SHAFTS WITH SURGICAL END EFFECTOR SHAFTS, now U.S. Patent Application Publication No. 2014/0305994;

[0360] U.S. patent application Ser. No. 14/248,587, entitled POWERED SURGICAL STAPLER, now U.S. Patent Application Publication No. 2014/0309665;

[0361] U.S. patent application Ser. No. 14/248,586, entitled DRIVE SYSTEM DECOUPLING ARRANGEMENT FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0305990; and

[0362] U.S. patent application Ser. No. 14/248,607, entitled MODULAR MOTOR DRIVEN SURGICAL INSTRUMENTS WITH STATUS INDICATION ARRANGEMENTS, now U.S. Patent Application Publication No. 2014/0305992.

[0363] Applicant of the present application also owns the following patent applications that were filed on Apr. 16, 2013 and which are each herein incorporated by reference in their respective entireties:

[0364] U.S. Provisional Patent Application Ser. No. 61/812,365, entitled SURGICAL INSTRUMENT WITH MULTIPLE FUNCTIONS PERFORMED BY A SINGLE MOTOR;

[0365] U.S. Provisional Patent Application Ser. No. 61/812,376, entitled LINEAR CUTTER WITH POWER;

[0366] U.S. Provisional Patent Application Ser. No. 61/812,382, entitled LINEAR CUTTER WITH MOTOR AND PISTOL GRIP;

[0367] U.S. Provisional Patent Application Ser. No. 61/812,385, entitled SURGICAL INSTRUMENT HANDLE WITH MULTIPLE ACTUATION MOTORS AND MOTOR CONTROL; and

[0368] U.S. Provisional Patent Application Ser. No. 61/812,372, entitled SURGICAL INSTRUMENT WITH MULTIPLE FUNCTIONS PERFORMED BY A SINGLE MOTOR.

[0369] Numerous specific details are set forth to provide a thorough understanding of the overall structure, function, manufacture, and use of the embodiments as described in the specification and illustrated in the accompanying drawings. Well-known operations, components, and elements have not been described in detail so as not to obscure the embodiments described in the specification. The reader will understand that the embodiments described and illustrated herein are non-limiting examples, and thus it can be appreciated that the specific structural and functional details disclosed herein may be representative and illustrative. Variations and changes thereto may be made without departing from the scope of the claims.

[0370] The terms "comprise" (and any form of comprise, such as "comprises" and "comprising"), "have" (and any form of have, such as "has" and "having"), "include" (and any form of include, such as "includes" and "including") and "contain" (and any form of contain, such as "contains" and "containing") are open-ended linking verbs. As a result, a surgical system, device, or apparatus that "comprises," "has," "includes" or "contains" one or more elements pos-

sesses those one or more elements, but is not limited to possessing only those one or more elements. Likewise, an element of a system, device, or apparatus that "comprises," "has," "includes" or "contains" one or more features possesses those one or more features, but is not limited to possessing only those one or more features.

[0371] The terms "proximal" and "distal" are used herein with reference to a clinician manipulating the handle portion of the surgical instrument. The term "proximal" refers to the portion closest to the clinician and the term "distal" refers to the portion located away from the clinician. It will be further appreciated that, for convenience and clarity, spatial terms such as "vertical", "horizontal", "up", and "down" may be used herein with respect to the drawings. However, surgical instruments are used in many orientations and positions, and these terms are not intended to be limiting and/or absolute.

[0372] Various exemplary devices and methods are provided for performing laparoscopic and minimally invasive surgical procedures. However, the reader will readily appreciate that the various methods and devices disclosed herein can be used in numerous surgical procedures and applications including, for example, in connection with open surgical procedures. As the present Detailed Description proceeds, the reader will further appreciate that the various instruments disclosed herein can be inserted into a body in any way, such as through a natural orifice, through an incision or puncture hole formed in tissue, etc. The working portions or end effector portions of the instruments can be inserted directly into a patient's body or can be inserted through an access device that has a working channel through which the end effector and elongate shaft of a surgical instrument can be advanced.

[0373] A surgical stapling system can comprise a shaft and an end effector extending from the shaft. The end effector comprises a first jaw and a second jaw. The first jaw comprises a staple cartridge. The staple cartridge is insertable into and removable from the first jaw; however, other embodiments are envisioned in which a staple cartridge is not removable from, or at least readily replaceable from, the first jaw. The second jaw comprises an anvil configured to deform staples ejected from the staple cartridge. The second jaw is pivotable relative to the first jaw about a closure axis; however, other embodiments are envisioned in which first jaw is pivotable relative to the second jaw. The surgical stapling system further comprises an articulation joint configured to permit the end effector to be rotated, or articulated, relative to the shaft. The end effector is rotatable about an articulation axis extending through the articulation joint. Other embodiments are envisioned which do not include an articulation joint.

[0374] The staple cartridge comprises a cartridge body. The cartridge body includes a proximal end, a distal end, and a deck extending between the proximal end and the distal end. In use, the staple cartridge is positioned on a first side of the tissue to be stapled and the anvil is positioned on a second side of the tissue. The anvil is moved toward the staple cartridge to compress and clamp the tissue against the deck. Thereafter, staples removably stored in the cartridge body can be deployed into the tissue. The cartridge body includes staple cavities defined therein wherein staples are removably stored in the staple cavities. The staple cavities are arranged in six longitudinal rows. Three rows of staple cavities are positioned on a first side of a longitudinal slot and three rows of staple cavities are positioned on a second side of the longitudinal slot. Other arrangements of staple cavities and staples may be possible.

[0375] The staples are supported by staple drivers in the cartridge body. The drivers are movable between a first, or unfired position, and a second, or fired, position to eject the staples from the staple cavities. The drivers are retained in the cartridge body by a retainer which extends around the bottom of the cartridge body and includes resilient members configured to grip the cartridge body and hold the retainer to the cartridge body. The drivers are movable between their unfired positions and their fired positions by a sled. The sled is movable between a proximal position adjacent the proximal end and a distal position adjacent the distal end. The sled comprises a plurality of ramped surfaces configured to slide under the drivers and lift the drivers, and the staples supported thereon, toward the anvil.

[0376] Further to the above, the sled is moved distally by a firing member. The firing member is configured to contact the sled and push the sled toward the distal end. The longitudinal slot defined in the cartridge body is configured to receive the firing member. The anvil also includes a slot configured to receive the firing member. The firing member further comprises a first cam which engages the first jaw and a second cam which engages the second jaw. As the firing member is advanced distally, the first cam and the second cam can control the distance, or tissue gap, between the deck of the staple cartridge and the anvil. The firing member also comprises a knife configured to incise the tissue captured intermediate the staple cartridge and the anvil. It is desirable for the knife to be positioned at least partially proximal to the ramped surfaces such that the staples are ejected ahead of the knife.

[0377] FIG. **1** depicts one form of an interchangeable surgical tool assembly **1000** that is operably coupled to a motor driven handle assembly **500**. The interchangeable surgical tool assembly **1000** may also be effectively employed with a tool drive assembly of a robotically controlled or automated surgical system. For example, the surgical tool assemblies disclosed herein may be employed with various robotic systems, instruments, components and methods such as, but not limited to, those disclosed in U.S. Pat. No. 9,072,535, entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, which is hereby incorporated by reference herein in its entirety. The handle assembly **500**, as well as the tool drive assembly of a robotic system may also be referred to herein as "control systems" or "control units".

[0378] FIG. **2** illustrates attachment of the interchangeable surgical tool assembly **1000** to the handle assembly **500**. The handle assembly **500** may comprise a handle housing **502** that includes a pistol grip portion **504** that can be gripped and manipulated by the clinician. The handle assembly **500** may further include a frame **506** that operably supports the plurality of drive systems. For example, the frame **506** can operably support a "first" or closure drive system, generally designated as **510**, which may be employed to apply closing and opening motions to the interchangeable surgical tool assembly **1000** that is operably attached or coupled to the handle assembly **500**. In at least one form, the closure drive system **510** may include an actuator in the form of a closure trigger **512** that is pivotally supported by the frame **506**. Such arrangement enables the closure trigger **512** to be manipulated by a clinician such that when the clinician grips

the pistol grip portion **504** of the handle assembly **500**, the closure trigger **512** may be easily pivoted from a starting or "unactuated" position to an "actuated" position and more particularly to a fully compressed or fully actuated position. In various forms, the closure drive system **510** further includes a closure linkage assembly **514** that is pivotally coupled to the closure trigger **512** or otherwise operably interfaces therewith. As will be discussed in further detail below, in the illustrated example, the closure linkage assembly **514** includes a transverse attachment pin **516** that facilitates attachment to a corresponding drive system on the surgical tool assembly. In use, to actuate the closure drive system **510**, the clinician depresses the closure trigger **512** towards the pistol grip portion **504**. As described in further detail in U.S. patent application Ser. No. 14/226,142, entitled SURGICAL INSTRUMENT COMPRISING A SENSOR SYSTEM, now U.S. Patent Application Publication No. 2015/0272575, which is hereby incorporated by reference in its entirety herein, when the clinician fully depresses the closure trigger **512** to attain a "full" closure stroke, the closure drive system **510** is configured to lock the closure trigger **512** into the fully depressed or fully actuated position. When the clinician desires to unlock the closure trigger **512** to permit it to be biased to the unactuated position, the clinician simply activates a closure release button assembly **518** which enables the closure trigger **512** to return to the unactuated position. The closure release button assembly **518** may also be configured to interact with various sensors that communicate with a microcontroller **520** in the handle assembly **500** for tracking the position of the closure trigger **512**. Further details concerning the configuration and operation of the closure release button assembly **518** may be found in U.S. Patent Application Publication No. 2015/0272575.

[0379] In at least one form, the handle assembly **500** and the frame **506** may operably support another drive system referred to herein as a firing drive system **530** that is configured to apply axial or firing motions to corresponding portions of the interchangeable surgical tool assembly that is attached thereto. As was described in detail in U.S. Patent Application Publication No. 2015/0272575, the firing drive system **530** may employ an electric motor **505** that is located in the pistol grip portion **504** of the handle assembly **500**. In various forms, the motor **505** may be a DC brushed driving motor having a maximum rotation of, approximately, **25,000** RPM, for example. In other arrangements, the motor **505** may include a brushless motor, a cordless motor, a synchronous motor, a stepper motor, or any other suitable electric motor. The motor **505** may be powered by a power source **522** that in one form may comprise a removable power pack. The power pack may support a plurality of Lithium Ion ("LI") or other suitable batteries therein. A number of batteries may be connected in series may be used as the power source **522** for the handle assembly **500**. In addition, the power source **522** may be replaceable and/or rechargeable.

[0380] The electric motor **505** is configured to axially drive a longitudinally movable drive member **540** in distal and proximal directions depending upon the polarity of the motor. For example, when the motor **505** is driven in one rotary direction, the longitudinally movable drive member **540** will be axially driven in the distal direction "DD". When the motor **505** is driven in the opposite rotary direction, the longitudinally movable drive member **540** will be axially driven in a proximal direction "PD". The handle assembly **500** can include a switch **513** which can be configured to reverse the polarity applied to the electric motor **505** by the power source **522** or otherwise control the motor **505**. The handle assembly **500** can also include a sensor or sensors (not shown) that is configured to detect the position of the drive member **540** and/or the direction in which the drive member **540** is being moved. Actuation of the motor **505** can be controlled by a firing trigger **532** that is pivotally supported on the handle assembly **500**. The firing trigger **532** may be pivoted between an unactuated position and an actuated position. The firing trigger **532** may be biased into the unactuated position by a spring (not shown) or other biasing arrangement such that when the clinician releases the firing trigger **532**, it may be pivoted or otherwise returned to the unactuated position by the spring or biasing arrangement. In at least one form, the firing trigger **532** can be positioned "outboard" of the closure trigger **512** as was discussed above. As discussed in U.S. Patent Application Publication No. 2015/0272575, the handle assembly **500** may be equipped with a firing trigger safety button (not shown) to prevent inadvertent actuation of the firing trigger **532**. When the closure trigger **512** is in the unactuated position, the safety button is contained in the handle assembly **500** where the clinician cannot readily access it and move it between a safety position preventing actuation of the firing trigger **532** and a firing position wherein the firing trigger **532** may be fired. As the clinician depresses the closure trigger **512**, the safety button and the firing trigger **532** may pivot down wherein they can then be manipulated by the clinician.

[0381] In at least one form, the longitudinally movable drive member **540** may have a rack of teeth (not shown) formed thereon for meshing engagement with a corresponding drive gear arrangement (not shown) that interfaces with the motor **505**. Further details regarding those features may be found in U.S. Patent Application Publication No. 2015/0272575. At least one form also includes a manually-actuatable "bailout" assembly that is configured to enable the clinician to manually retract the longitudinally movable drive member **540** should the motor **505** become disabled. The bailout assembly may include a lever or bailout handle assembly that is stored within the handle assembly **500** under a releasable door **550**. The lever is configured to be manually pivoted into ratcheting engagement with the teeth in the drive member **540**. Thus, the clinician can manually retract the drive member **540** by using the bailout handle assembly to ratchet the drive member **540** in the proximal direction "PD". U.S. patent application Ser. No. 12/249,117, entitled POWERED SURGICAL CUTTING AND STAPLING APPARATUS WITH MANUALLY RETRACTABLE FIRING SYSTEM, now U.S. Patent Application Publication No. 2010/0089970, the entire disclosure of which is hereby incorporated by reference herein discloses bailout arrangements and other components, arrangements and systems that may also be employed with the tool assembly **1000**.

[0382] Turning now to FIGS. **5** and **6**, the interchangeable surgical tool assembly **1000** includes a shaft mounting portion **1300** that is operably attached to an elongate shaft assembly **1400**. A surgical end effector **1100** that comprises an elongate channel **1102** that is configured to operably support a surgical staple cartridge **1150** therein is operably attached to the elongate shaft assembly **1400**. See FIGS. **3**

and **6**. The surgical end effector **1100** may further include an anvil **1130** that is pivotally supported relative to the elongate channel **1102**. The elongate channel **1102** with a staple cartridge **1150** installed therein and the anvil **1130** may also be referred to as the end effector "jaws". The interchangeable surgical tool assembly **1000** may further include an articulation joint **1200** and an articulation lock **1210** (FIGS. **3** and **6**) which can be configured to releasably hold the surgical end effector **1100** in a desired articulated position about an articulation axis B-B which is transverse to a shaft axis SA. Many details regarding the construction and operation of the articulation lock **1210** may be found in in U.S. patent application Ser. No. 13/803,086, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK, now U.S. Patent Application Publication No. 2014/0263541, the entire disclosure of which is hereby incorporated by reference herein. Additional details concerning the articulation lock **1210** may also be found in U.S. patent application Ser. No. 15/019,196, filed Feb. 9, 2016, entitled SURGICAL INSTRUMENT ARTICULATION MECHANISM WITH SLOTTED SECONDARY CONSTRAINT, the entire disclosure of which is hereby incorporated by reference herein.

[0383] As can be seen in FIGS. **5** and **6**, the shaft mounting portion **1300** includes a proximal housing or nozzle **1301** comprised of nozzle portions **1302**, **1304** as well as an actuator wheel portion **1306** that is configured to be coupled to the assembled nozzle portions **1302**, **1304** by snaps, lugs, screws, etc. In the illustrated embodiment, the interchangeable surgical tool assembly **1000** further includes a closure assembly **1406** which can be utilized to close and/or open the anvil **1130** relative to the elongate channel **1102** of the surgical end effector **1100** as will be discussed in further detail below. In addition, the illustrated interchangeable surgical tool assembly **1000** includes a spine assembly **1500** which operably supports the articulation lock **1210**. The spine assembly **1500** is configured to, one, slidably support a firing member assembly **1600** therein and, two, slidably support the closure assembly **1406** which extends around the spine assembly **1500** or is otherwise movably supported thereby.

[0384] In the illustrated arrangement, the surgical end effector **1100** is operably coupled to the elongate shaft assembly **1400** by an articulation joint **1200** that facilitates selective articulation of the surgical end effector **1100** about an articulation axis B-B that is transverse to the shaft axis SA. See FIG. **1**. As can be seen in FIGS. **5** and **6**, the spine assembly **1500** slidably supports a proximal articulation driver **1700** that operably interfaces with an articulation lock **1210**. The articulation lock **1210** is supported on a distal frame segment **1560** that also comprises a portion of the spine assembly **1500**. As can be seen in FIG. **6**, the distal frame segment **1560** comprises a distal spine extension **1562** that is pivotally coupled to the elongate channel **1102** by an end effector mounting assembly **1230**. In one arrangement, for example, a distal end **1563** of the distal frame segment **1560** has a spine attachment pin **1564** formed thereon. The spine attachment pin **1564** is adapted to be pivotally received within a spine attachment hole **1234** that is formed in the end effector mounting assembly **1230**. See FIG. **6**.

[0385] Referring again to FIG. **6**, in the illustrated embodiment, the proximal articulation driver **1700** has a distal end **1702** that is configured to operably engage the articulation lock **1210**. The articulation lock **1210** includes an articulation frame **1212** that is pivotally coupled or pinned to a distal articulation link **1710** that is also configured to be pivotally attached to the end effector mounting assembly **1230**. In particular, as can be seen in FIG. **6**, a distal end **1712** of the distal articulation link **1710** includes an articulation pin **1714** that is configured to be pivotally received within corresponding articulation holes **1236** in the end effector mounting assembly **1230**. The distal articulation link **1710** is slidably supported by the distal spine extension **1562**. The end effector mounting assembly **1230** is attached to a proximal end **1103** of the elongate channel **1102** by a spring pin connector **1235** that extends through a transverse mounting hole **1231** in the end effector mounting assembly **1230** to be received within channel or jaw mounting holes **1106** that are provided in the proximal end **1103** of the elongate channel **1102**. The spine attachment pin **1564** defines an articulation axis B-B that is transverse to the shaft axis SA. Such arrangement facilitates pivotal travel (i.e., articulation) of the surgical end effector **1100** about the articulation axis B-B relative to the spine assembly **1500**. As indicated above, further details regarding the operation of the articulation lock **1210** and the articulation frame **1212** may be found in U.S. patent application Ser. No. 13/803,086, now U.S. Patent Application Publication No. 2014/0263541.

[0386] In various circumstances, the spine assembly **1500** further comprises an intermediate spine segment **1510** that is attached to the distal frame segment **1560** of the articulation lock **1210**. The spine assembly **1500** further comprises a proximal spine mounting segment **1530** that includes a proximal end portion **1532** that has opposing notches **1535** (only one can be seen in FIG. **5**) for receiving a corresponding mounting lug **1308** (shown in FIG. **4**) that protrude inwardly from each of the nozzle portions **1302**, **1304**. Such arrangement facilitates rotation of the proximal spine assembly **1500** about the shaft axis SA by rotating the nozzle **1301** about the shaft axis SA. The interchangeable surgical tool assembly **1000** includes a chassis **1800** that rotatably supports the shaft assembly **1400**. The proximal end portion **1532** of the proximal spine mounting segment is rotatably supported in a central shaft hole **1801** that is formed in the chassis **1800**. See FIG. **5**. In one arrangement, for example, the proximal end portion **1532** has threads **1533** thereon for attachment to a spine bearing (not shown) or other wise supported in a spine bearing that is mounted within the chassis **1800**. Such an arrangement facilitates rotatable attachment of the spine assembly **1500** to the chassis **1800** such that the spine assembly **1500** may be selectively rotated about a shaft axis SA relative to the chassis **1800**.

[0387] The closure assembly **1406** comprises an elongate proximal closure member **1410** and a distal closure member **1430**. In the illustrated arrangement, the proximal closure member **1410** comprises a hollow tubular member that is slidably supported on the spine assembly **1500**. Hence, the proximal closure member **1410** may also be referred to herein as the "proximal closure tube". Similarly, the distal closure member **1430** may also be referred to as the "distal closure tube". Referring primarily to FIG. **5**, the interchangeable surgical tool assembly **1000** includes a closure shuttle **1420** that is slidably supported within the chassis **1800** such that it may be axially moved relative thereto. In one form, the closure shuttle **1420** includes a pair of proximally-protruding hooks **1421** that are configured for attachment to the transverse attachment pin **516** (FIG. **2**) that is attached to the closure linkage assembly **514** of the handle

assembly **500**. Thus, when the hooks **1421** are hooked over the transverse attachment pin **516**, actuation of the closure trigger **512** will result in the axial movement of the closure shuttle **1420** and ultimately, the closure assembly **1406** on the spine assembly **1500**. A closure spring (not shown) may also be journaled on the closure assembly **1406** and serves to bias the closure assembly **1406** in the proximal direction "PD" which can serve to pivot the closure trigger **512** into the unactuated position when the surgical tool assembly **1000** is operably coupled to the handle assembly **500**. In use, the closure assembly **1406** is translated distally (direction DD) to close the jaws **1130**, **1102** for example, in response to the actuation of the closure trigger **512**.

[0388] The closure linkage assembly **514** may also be referred to herein as a "closure actuator" and the closure linkage assembly **514** and the closure shuttle **1420** may be collectively referred to herein as a "closure actuator assembly". A proximal end **1412** of the proximal closure member **1410** is coupled to the closure shuttle **1420** for relative rotation thereto. For example, a U-shaped connector **1424** is inserted into an annular slot **1414** in the proximal end **1412** of the proximal closure member **1410** and is retained within vertical slots **1422** in the closure shuttle **1420**. See FIG. **5**. Such arrangement serves to attach the proximal closure member **1410** to the closure shuttle **1420** for axial travel therewith while enabling the closure assembly **1406** to rotate relative to the closure shuttle **1420** about the shaft axis SA.

[0389] As indicated above, the illustrated interchangeable surgical tool assembly **1000** includes an articulation joint **1200**. As can be seen in FIG. **6**, upper and lower tangs **1415**, **1416** protrude distally from a distal end of the proximal closure member **1410** to be movably coupled to the distal closure member **1430**. As can also be seen in FIG. **6**, the distal closure member **1430** includes upper and lower tangs **1434**, **1436** that protrude proximally from a proximal end thereof. The proximal closure member **1410** and the distal closure member **1430** are coupled together by an upper double pivot link **1220**. The upper double pivot link **1220** includes proximal and distal pins that engage corresponding holes in the upper tangs **1415**, **1434** of the proximal closure member **1410** and distal closure member **1430**, respectively. The proximal closure member **1410** and the distal closure member **1430** are also coupled together by a lower double pivot link **1222**. The lower double pivot link **1222** includes proximal and distal pins that engage corresponding holes in the lower tangs **1416** and **1436** of the proximal closure member **1410** and distal closure member **1430**, respectively. As will be discussed in further detail below, distal and proximal axial translation of the closure assembly **1406** will result in the closing and opening of the anvil **1130**.

[0390] The interchangeable surgical tool assembly **1000** depicted in FIGS. **1-6** includes a surgical end effector **1100** that is capable of articulating about the articulation axis B-B in one direction. As noted above, the articulation axis B-B is defined by the spine attachment pin **1564** that is rotatably received within the spine attachment hole **1234** that is formed in the end effector mounting assembly **1230**. In the illustrated arrangement, the spine attachment hole **1234** may be transversely axially aligned with the shaft axis SA. In other arrangements, the spine attachment hole **1234** may be slightly laterally offset from the shaft axis. In the illustrated example, the articulation axis B-B is transverse to and intersects the shaft axis SA. The illustrated example only employs a proximal articulation driver **1700** that interfaces with a single distal articulation link **1710** (through the articulation lock **1210**) that operably interfaces with the end effector mounting assembly **1230** to apply articulation motions thereto. For example, distally advancing the distal articulation link **1710** will cause the surgical end effector **1100** to articulate in a single "first" articulation direction. In one arrangement, for example, the surgical end effector **1100** may be selectively articulatable from a first unarticulated position wherein the surgical end effector **1100** is axially aligned with the shaft assembly **1400** (for insertion through a trocar or other access opening) through an articulation angle of approximately 110° (after the surgical end effector **1100** has exited the trocar into the patient). Other articulation angle arrangements may be achieved.

[0391] As can be seen in FIG. **7**, for example, the interchangeable surgical tool assembly **1000** may be well-suited for use in connection with a medical procedure known as a lower anterior resection "LAR". Such procedure commonly involves removal of a diseased portion of the colon. For example, this procedure may comprise removal of the blood vessels and lymph nodes associated with this portion of the bowel. The surgeon then re-joins the remaining colon and the remaining part of the rectum (which may be referred to as an anastomosis). One challenge commonly facing the surgeon during this procedure is associated with getting the end effector into the pelvic area far enough to complete the procedure. FIG. **7** illustrates a desired position of the surgical end effector **1100** within the pelvis **400** of a patient during the resection of the patient's colon **410**. Lines BTL in FIG. **7** may illustrate travel limits commonly created by the patient's pelvic bone structure and associated tissue. In the illustrated arrangement, the surgical tool assembly **1000** employs an "asymmetric" proximal closure member **1410** that is configured to provide additional clearance and maneuverability for the surgical tool assembly **1000** within that region.

[0392] As can be seen in FIG. **7**, in one example, the proximal closure member **1410** of the shaft assembly **1400** includes an elongate proximal end portion **1417** and an elongate distal end portion **1411** that extends from the proximal end portion **1417**. As can be seen in FIGS. **7-9**, to facilitate more clearance between the shaft assembly **1400** and the pelvic structure for example, an asymmetric cut out or notched area **1418** is provided in the distal end portion **1411** of the proximal closure member **1410**. In at least one example, the notched area **1418** extends for the entire distal end portion **1411**. In such arrangement, an axial length of the distal end portion is less than an axial length of the proximal end portion **1417**.

[0393] Referring now to FIG. **11**, in the illustrated example, the proximal end portion **1417** has an uninterrupted or "continuous" "proximal" outer perimeter or perimetrical shape **1417**P. At least a portion of the distal end portion **1411** has a discontinuous or interrupted "distal" outer perimeter or outer perimetrical shape **1411**P. As can also be seen in FIG. **9**, for example, the distal spine extension **1562** has a similar notched area **1568** therein. Also, the intermediate spine segment **1510** may also have an asymmetric notch **1516** therein that matches the notched areas **1418** and **1568**. See FIGS. **10** and **11**. Such arrangement may permit the clinician to position the shaft assembly **1400** and the surgical end effector **1100** into the position shown in FIG. **7** within the pelvic region. In the illustrated arrangement, for example, the articulation angle AA may be

approximately 110°. Thus, such arrangement may afford the clinician the ability to position the surgical end effector **1100** deeper within the pelvic region as compared with other tool and end effector arrangements. In the illustrated arrangement, the notched areas **1418**, **1516**, **1568** are located on the opposite side of the shaft axis SA from which the end effector **1100** articulates (e.g., direction of articulation DA). In other arrangements, however, it is conceivable that the notched areas **1418**, **1516**, **1568** are provided on the same side of the shaft axis SA from which the surgical end effector articulates.

[0394] In one example, to maintain the proximal closure member **1410** in axial alignment on the spine assembly **1500** as it moves axially thereon and to retard or prevent buckling of the shaft components during articulation and closing of the end effector jaws **1130**, **1102**, opposed closure alignment members **1413** are employed. In one arrangement, for example, a pair of diametrically-opposed alignment pins **1413** are attached to and extend inwardly from the proximal closure member **1410** to be slidably received within corresponding alignment slots **1514**, **1566** in the intermediate spine segment **1510** and the distal spine extension **1562**, respectively. See FIGS. **10** and **11**. As can also be seen in FIG. **11**, the distal spine extension **1562** may have a recessed area **1567** for receiving a downwardly protruding lug portion **1518** that is formed on the underside of the intermediate spine segment **1510**. Such arrangement may serve to somewhat laterally interlock the intermediate spine segment **1510** and the distal spine extension **1562** together to thereby resist any lateral deflection from occurring between those components. FIG. **12** illustrates an alternative proximal closure member **1410'** that is identical to the proximal closure member **1410** described above, except that the proximal closure member **1410'** includes a connector bridge **1419** that extends between the upper and lower tangs **1415** and **1416** which may serve to limit any tendency of the upper and lower tangs **1415**, **1416** from spreading apart during use.

[0395] FIG. **13** illustrates another arrangement that is configured to prevent or limit the opening of a proximal closure member **1410"** in the directions OD when a lateral load LL is applied laterally to the shaft assembly **1400** in the notched areas. The proximal closure member **1410"** may be identical to proximal closure member **1410** except for the differences noted herein. As can be seen in FIG. **13**, the proximal closure member **1410"** additionally includes a pair of inwardly protruding, somewhat diametrically opposed flexure tabs **1425**. One flexure tab **1425** is slidably received within a corresponding axially extending slot **1519** and the other flexure tab **1425** is slidably received within a corresponding axial slot **1569** in the distal spine extension **1562**. Such arrangement serves to slidably interlock the proximal closure member **1410"** on the spine assembly **1500'** to thereby cause the proximal closure member **1410"** to resist opening (in the OD directions) when a lateral load LL is applied thereto. FIG. **14** illustrates an alternative arrangement that employs flexure tabs **1425'** are somewhat L-shaped and are slidably received within corresponding L-shaped slots **1514'** and **1569'**.

[0396] As mentioned above, the interchangeable surgical tool assembly **1000** further includes a firing member assembly **1600** that is supported for axial travel within the spine assembly **1500**. In the illustrated embodiment, the firing member assembly **1600** includes a proximal firing shaft segment **1602** and a distal cutting portion or distal firing bar **1620**. The firing member assembly **1600** may also be referred to herein as a "second shaft" and/or a "second shaft assembly". As can be seen in FIG. **5**, the proximal firing shaft segment **1602** includes a proximal attachment lug **1604** that protrudes proximally from a proximal end thereof that is configured to be operably received within the firing shaft attachment cradle **542** in the longitudinally movable drive member **540** that is supported in the handle assembly **500**. See FIG. **2**.

[0397] Referring again to FIG. **5**, a distal end **1606** of the proximal firing shaft segment **1602** includes a longitudinal slot **1608** which is configured to receive a tab (not shown) on the proximal end of the distal firing bar **1620**. The longitudinal slot **1608** and the proximal end of the distal firing bar **1620** can be sized and configured to permit relative movement therebetween and can comprise a slip joint **1622**. The slip joint **1622** can permit the proximal firing shaft segment **1602** to move during the articulation actuation without moving, or at least substantially moving, the distal firing bar **1620**. Once the end effector **1100** has been suitably oriented, the proximal firing shaft segment **1602** can be advanced distally until a proximal end wall of the slot **1608** comes into contact with the tab on the distal firing bar **1620** to advance the distal firing bar **1620** and fire the surgical staple cartridge **1150** that is positioned within the elongate channel **1102**. As can be further seen in FIG. **5**, the intermediate spine segment **1510** includes a channel **1512** for slidably supporting the proximal firing shaft segment **1602** therein. To facilitate assembly of the proximal firing shaft segment **1602** and the spine assembly **1500**, a top spine cover **1527** may be engaged with the intermediate spine segment **1510** to enclose those portions of the firing member assembly **1600** therein.

[0398] FIG. **15** illustrates the surgical end effector **1100** in an articulated position. As can be seen in FIG. **15**, as well as in FIG. **6**, a middle support member **1614** is employed to provide lateral support to the distal firing bar **1620** as it flexes to accommodate articulation of the surgical end effector **1100**. In one example, a distal pivot pin **1615** protrudes from a distal end of the middle support member **1614** and is received within a spine attachment hole **1234** in the end effector mounting assembly **1230**. A proximal pivot pin **1616** is received within an elongate slot **1569** in the distal spine extension **1562**. In addition, the middle support member **1614** includes a passageway **1618** therein that provides lateral support to the distal firing bar **1620** as the surgical end effector **1100** is articulated. Further details concerning the middle support member and alternative knife bar support arrangements are disclosed in U.S. patent application Ser. No. 15/019,245 which has been herein incorporated by reference in its entirety.

[0399] FIG. **15A** illustrates an alternative articulation joint **1200'** that facilitates articulation of the surgical end effector **1100** about an articulation axis B-B that is transverse to a shaft axis SA that is defined by the elongate shaft assembly **1400'** to which it is operably attached. In the illustrated example, the surgical end effector **1100** is selectively articulatable to one side of the shaft axis SA. Such articulation direction is represented by arrow LD. Similar to the embodiment described above, an end effector mounting assembly **1230** is pivotally attached to a proximal end **1103** of an elongate channel **1102** of the surgical end effector **1100**. The end effector mounting assembly **1230** is pivotally attached to a distal spine extension **1562** of a distal frame segment **1560**

of the elongate shaft assembly **1400'**. Similar to the above described embodiment, the distal frame segment **1560** may operably support an articulation lock **1210** (FIG. **6**) that is actuated by a proximal articulation driver **1700** (FIG. **6**) that operably interfaces with a source of articulation and retraction motions as described in detail herein. In the example illustrated in FIG. **15**A, the end effector mounting assembly **1230** is pivotally attached to the distal spine extension **1562** by a distal support link **1570**. In one arrangement for example, the end effector mounting assembly **1230** is pinned to a distal end **1572** of the distal support link **1570** by an articulation pin **1580** that defines the articulation axis B-B. A proximal end **1574** of the distal support link **1570** is attached to a distal end **1563** of the distal spine extension **1562** for axial and pivotal travel relative thereto.

[0400] As can be further seen in FIG. **15**A, the proximal end **1574** of the distal support link **1570** includes an axial slot **1576** that is sized to slidably and pivotally receive therein a proximal attachment pin **1578** that is attached to the distal spine extension **1562**. Such arrangement serves to couple the surgical end effector **1100** to the distal frame segment **1560** for selective pivotal travel (articulation) about the articulation axis B-B as well as some limited axial travel relative thereto. In the illustrated arrangement, articulation motions are applied to the surgical end effector **1100** by a distal articulation link **1710** that is pivotally coupled to or otherwise operably interfaces with the articulation lock **1210**. Axial movement of the distal articulation link **1710** in the proximal direction PD (which is constrained to move axially along one side of the shaft axis SA), will cause the surgical end effector **1100** to articulate in the left direction LD from an unarticulated position wherein the surgical end effector **1100** is axially aligned on the shaft axis SA to articulated positions on the left side of the shaft axis SA (represented in phantom lines in FIG. **15**A). Axial movement of the distal articulation link **1710** in the distal direction DD will move the surgical end effector **1100** from an articulated position towards the unactuated position (arrow RD). In one arrangement, a stop member or stop formation **1232** is formed or otherwise attached to the end effector mounting assembly **1230** to contact the distal end **1563** of the distal spine extension when the surgical end effector **1100** has attained the unactuated position to prevent any further travel thereof in the right direction RD. Such articulation joint arrangement may provide improved articulation travel and closure stability.

[0401] Further to the above, the interchangeable surgical tool assembly **1000** includes a clutch assembly **1640** which can be configured to selectively and releasably couple the proximal articulation driver **1700** to the firing member assembly **1600**. In one form, the clutch assembly **1640** includes a rotary lock assembly that, in at least one embodiment, comprises a lock collar, or lock sleeve **1650** that is positioned around the firing member assembly **1600**. The lock sleeve **1650** is configured to be rotated between an engaged position in which the lock sleeve **1650** couples the proximal articulation driver **1700** to the firing member assembly **1600** and a disengaged position in which the proximal articulation driver **1700** is not operably coupled to the firing member assembly **1600**. When lock sleeve **1650** is in its engaged position, distal movement of the firing member assembly **1600** can move the proximal articulation driver **1700** distally and, correspondingly, proximal movement of the firing member assembly **1600** can move the proximal articulation driver **1700** proximally. When lock sleeve **1650** is in its disengaged position, movement of the firing member assembly **1600** is not transmitted to the proximal articulation driver **1700** and, as a result, the firing member assembly **1600** can move independently of the proximal articulation driver **1700**. In various circumstances, the proximal articulation driver **1700** can be held in position by the articulation lock **1210** when the proximal articulation driver **1700** is not being moved in the proximal or distal directions by the firing member assembly **1600**.

[0402] Referring primarily to FIGS. **4** and **5**, the lock sleeve **1650** comprises a cylindrical, or an at least substantially cylindrical, body that includes a longitudinal aperture **1652** that is configured to receive the proximal firing shaft segment **1602** of the firing member assembly **1600**. The lock sleeve **1650** also has two diametrically-opposed, inwardly-facing lock protrusions **1654** and an outwardly protruding second lock member **1656** formed thereon. The lock protrusions **1654** can be configured to be selectively engaged with the proximal firing shaft segment **1602** of the firing member assembly **1600**. More particularly, when the lock sleeve **1650** is in its engaged position, the lock protrusions **1654** are positioned within a drive notch **1603** that is provided in the proximal firing shaft segment **1602** such that a distal pushing force and/or a proximal pulling force can be transmitted from the firing member assembly **1600** to the lock sleeve **1650**. When the lock sleeve **1650** is in its engaged position, the second lock member **1656** is received within a drive notch **1704** that is defined in the proximal articulation driver **1700** such that the distal pushing force and/or the proximal pulling force applied to the lock sleeve **1650** can be transmitted to the articulation driver **1700**. In effect, the firing member assembly **1600**, the lock sleeve **1650**, and the proximal articulation driver **1700** will move together when the lock sleeve **1650** is in its engaged position. On the other hand, when the lock sleeve **1650** is in its disengaged position, the lock protrusions **1654** may not be positioned within the drive notch **1603** of the proximal firing shaft segment **1602** of the firing member assembly **1600** and, as a result, a distal pushing force and/or a proximal pulling force may not be transmitted from the firing member assembly **1600** to the lock sleeve **1650**. Correspondingly, the distal pushing force and/or the proximal pulling force may not be transmitted to the proximal articulation driver **1700**. In such circumstances, the firing member assembly **1600** can be slid proximally and/or distally relative to the lock sleeve **1650** and the proximal articulation driver **1700**.

[0403] The clutch assembly **1640** further includes a switch drum **1630** that interfaces with the lock sleeve **1650**. Further details concerning the operation of the switch drum **1630** and lock sleeve **1650** may be found in U.S. patent application Ser. No. 13/803,086 and U.S. patent application Ser. No. 15/019,196, which have each been herein incorporated by reference in their respective entireties. The switch drum **1630** can further comprise at least partially circumferentially extending openings **1632** defined therein which can receive circumferential mounts **1305** that extend from the nozzle portions **1302**, **1304** and permit relative rotation, but not translation, between the switch drum **1630** and the proximal nozzle **1301**. See FIG. **6**. Rotation of the nozzle **1301** to a point where the mounts reach the end of their respective openings **1632** in the switch drum **1630** will result in rotation of the switch drum **1630** about the shaft axis SA. Rotation of the switch drum **1630** will ultimately result in the move-

ment of the lock sleeve **1650** between its engaged and disengaged positions. Thus, in essence, the nozzle **1301** may be employed to operably engage and disengage the articulation drive system with the firing drive system in the various manners described in further detail in U.S. patent application Ser. No. 13/803,086 and U.S. patent application Ser. No. 15/019,196.

[0404] In the illustrated arrangement, the switch drum **1630** includes an L-shaped slot **1636** that extends into a distal opening **1637** in the switch drum **1630**. The distal opening **1637** receives a transverse switch pin **1639** of a shifter plate **1638**. In one example, the shifter plate **1638** is received within a longitudinal slot (not shown) that is provided in the lock sleeve **1650** to facilitate axial movement of the lock sleeve **1650** when engaged with the proximal articulation driver **1700**. Further details regarding the operation of the shifter plate and shift drum arrangements may be found in U.S. patent application Ser. No. 14/868,718, filed Sep. 28, 2015, entitled SURGICAL STAPLING INSTRUMENT WITH SHAFT RELEASE, POWERED FIRING AND POWERED ARTICULATION, the entire disclosure of which is hereby incorporated by reference herein.

[0405] Also in the illustrated embodiment, the switch drum **1630** includes a magnet support arm **1665** that supports a magnet or other sensor arrangement that is configured to operably interface with a Hall effect sensor **1662** that interfaces with a slip ring assembly **1660** that is operably mounted to the chassis **1800**. The slip ring assembly **1660** is configured to conduct electrical power to and/or from the interchangeable surgical tool assembly **1000** and/or communicate signals to and/or from the interchangeable surgical tool assembly **1000** components back to the microcontroller **520** in the handle assembly **500** (FIG. **2**) or robotic system controller, for example. Further details concerning the slip ring assembly **1660** and associated connectors may be found in U.S. patent application Ser. No. 13/803,806 and U.S. patent application Ser. No. 15/019,196 which have each been herein incorporated by reference in their respective entireties as well as in U.S. patent application Ser. No. 13/800,067, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, now U.S. Patent Application Publication No. 2014/0263552, which is hereby incorporated by reference herein in its entirety. The magnet or magnets supported on the magnet support arm **1665** cooperate with the Hall effect sensor **1662** or other sensor arrangement to detect the rotary position of the switch drum **1630** and convey that information to the microcontroller **520** which may serve to provide an indication or indications to the user in the various manners discussed in the aforementioned incorporated references. Other sensor arrangements may also be employed.

[0406] Referring again to FIGS. **2** and **5**, the chassis **1800** includes at least one, and preferably two, tapered attachment portions **1802** that are formed thereon and are adapted to be received within corresponding dovetail slots **507** that are formed within the distal end portion of the frame **506** of the handle assembly **500**. As can be further seen in FIG. **2**, a shaft attachment lug **1607** is formed on the proximal end of the proximal firing shaft segment **1602**. As will be discussed in further detail below, when the interchangeable surgical tool assembly **1000** is coupled to the handle assembly **500**, the shaft attachment lug **1607** is received in a firing shaft attachment cradle **542** that is formed in the distal end of the longitudinally movable drive member **540**. See FIG. **2**.

[0407] The interchangeable surgical tool assembly **1000** employs a latch system **1810** for removably coupling the interchangeable surgical tool assembly **1000** to the frame **506** of the handle assembly **500**. As can be seen in FIG. **5**, for example, in at least one form, the latch system **1810** includes a lock member or lock yoke **1812** that is movably coupled to the chassis **1800**. In the illustrated embodiment, for example, the lock yoke **1812** has a U-shape and includes two downwardly extending legs **1814**. The legs **1814** each have a pivot lug (not shown) formed thereon that is adapted to be received in corresponding holes **1816** that are formed in the chassis **1800**. Such arrangement facilitates pivotal attachment of the lock yoke **1812** to the chassis **1800**. The lock yoke **1812** may include two proximally protruding lock lugs **1818** that are configured for releasable engagement with corresponding lock detents or grooves **509** in the distal end of the frame **506** of the handle assembly **500**. See FIG. **2**. In various forms, the lock yoke **1812** is biased in the proximal direction by a spring or biasing member **1819**. Actuation of the lock yoke **1812** may be accomplished by a latch button **1820** that is slidably mounted on a latch actuator assembly **1822** that is mounted to the chassis **1800**. The latch button **1820** may be biased in a proximal direction relative to the lock yoke **1812**. The lock yoke **1812** may be moved to an unlocked position by biasing the latch button **1820** in the distal direction which also causes the lock yoke **1812** to pivot out of retaining engagement with the distal end of the frame **506**. When the lock yoke **1812** is in "retaining engagement" with the distal end of the frame **506**, the lock lugs **1818** are retainingly seated within the corresponding lock detents or grooves **509** in the distal end of the frame **506**.

[0408] In the illustrated arrangement, the lock yoke **1812** includes at least one and preferably two lock hooks **1824** that are adapted to contact corresponding lock lug portions **1426** that are formed on the closure shuttle **1420**. When the closure shuttle **1420** is in an unactuated position, the lock yoke **1812** may be pivoted in a distal direction to unlock the interchangeable surgical tool assembly **1000** from the handle assembly **500**. When in that position, the lock hooks **1824** do not contact the lock lug portions **1426** on the closure shuttle **1420**. However, when the closure shuttle **1420** is moved to an actuated position, the lock yoke **1812** is prevented from being pivoted to an unlocked position. Stated another way, if the clinician were to attempt to pivot the lock yoke **1812** to an unlocked position or, for example, the lock yoke **1812** was inadvertently bumped or contacted in a manner that might otherwise cause it to pivot distally, the lock hooks **1824** on the lock yoke **1812** will contact the lock lugs **1426** on the closure shuttle **1420** and prevent movement of the lock yoke **1812** to an unlocked position. See FIG. **5**. Further details concerning the latching system may be found in U.S. Patent Application Publication No. 2014/0263541.

[0409] Attachment of the interchangeable surgical tool assembly **1000** to the handle assembly **500** will now be described with reference to FIG. **2**. To commence the coupling process, the clinician may position the chassis **1800** of the interchangeable surgical tool assembly **1000** above or adjacent to the distal end of the frame **506** such that the tapered attachment portions **1802** formed on the chassis **1800** are aligned with the dovetail slots **507** in the frame **506**. The clinician may then move the surgical tool assembly

1000 along an installation axis IA that is perpendicular to the shaft axis SA to seat the tapered attachment portions **1802** in "operable engagement" with the corresponding dovetail receiving slots **507** in the distal end of the frame **506**. In doing so, the shaft attachment lug **1606** on the proximal firing shaft segment **1602** will also be seated in the cradle **542** in the longitudinally movable drive member **540** and the portions of the transverse attachment pin **516** on the closure linkage assembly **514** will be seated in the corresponding hooks **1421** in the closure shuttle **1420**. As used herein, the term "operable engagement" in the context of two components means that the two components are sufficiently engaged with each other so that upon application of an actuation motion thereto, the components may carry out their intended action, function and/or procedure.

[0410] Referring again to FIGS. **11** and **15**, the distal firing bar **1620** may comprise a laminated beam structure that includes at least two beam layers. Such beam layers may comprise, for example, stainless steel bands that are interconnected by, for example, welding or pinning together at their proximal ends and/or at other locations along their length. In alternative embodiments, the distal ends of the bands are not connected together to allow the laminates or bands to splay relative to each other when the end effector is articulated. Such arrangement permits the distal firing bar **1620** to be sufficiently flexible to accommodate articulation of the end effector. Various other suitable laminated knife bar arrangements are disclosed in U.S. patent application Ser. No. 15/019,245. As can also be seen in FIG. **4**, a middle support member **1614** is employed to provide lateral support to the distal firing bar **1620** as it flexes to accommodate articulation of the surgical end effector **1100**. Further details concerning the middle support member and alternative knife bar support arrangements are disclosed in U.S. patent application Ser. No. 15/019,245.

[0411] After the interchangeable surgical tool assembly **1000** has been operably coupled to the handle assembly **500** (FIG. **1**), the clinician may operate the surgical tool assembly **1000** as follows. As discussed above, when the closure drive system **510** is in its unactuated position (i.e., the closure trigger **512** has not been actuated), a torsion spring **1642** has biased the clutch assembly **1640** and, more particularly, the switch pin **1639** and the lock sleeve **1650** into the articulation position. When in that mode, the magnet or magnets in the magnet support arm **1665** may cooperate with the Hall effect sensor **1662** or other sensor arrangements as to indicate to the microcontroller **520** that the surgical tool assembly **1000** is in the articulation mode. When the clinician actuates the firing trigger **532**, the motor drives the proximal firing shaft segment **1602** distally. As mentioned above, however, the slip joint **1622** facilitates movement of the proximal firing shaft segment **1602** without moving, or at least substantially moving, the distal firing bar **1620**. Because the lock sleeve **1650** is in operable engagement with the proximal firing shaft segment **1602** and the proximal articulation driver **1700** is in engagement with the lock sleeve **1650**, actuation of the proximal firing shaft segment **1602** results in the distal movement of the proximal articulation driver **1700**. Distal movement of the proximal articulation driver **1700** causes the surgical end effector **1100** to articulate around the articulation axis B-B. During this time, the clinician can also partially close the jaws of the surgical end effector **1100** by partially depressing the closure trigger. Such arrangement facilitates axial movement of the proximal closure member **1410** without automatically shifting the clutch assembly **1640** to the firing mode. This feature may enable the clinician to use the jaws to grasp and manipulate tissue prior to clamping onto the target tissue.

[0412] Once the clinician has articulated the surgical end effector **1100** into a desired position and the jaws have been positioned in a desired orientation relative to the target tissue, the clinician releases the firing trigger **532** which will discontinue the motorized movement of the proximal firing shaft segment **1602** as well as the proximal articulation driver **1700**. The articulation lock **1210** will lock the proximal articulation driver **1700** in that position to prevent further articulation of the surgical end effector **1100**. The clinician may clamp the target tissue between the jaws by depressing the closure trigger **512** to the fully depressed position. Such action moves the proximal closure member **1410** distally. Such distal movement of the proximal closure member **1410** causes the shifter plate **1638** to rotate the lock sleeve **1650** to rotate to a disengaged position with the proximal firing shaft segment **1602**. When in that position, the lock protrusions **1654** have disengaged from the drive notch **1603** in the proximal firing shaft segment **1602**. Thus, the proximal firing shaft segment **1602** can move axially without moving the lock sleeve **1650** and the proximal articulation driver **1700**. As the proximal closure member **1410** is moved distally to the fully actuated position (by depressing the closure trigger **512**), the proximal and distal closure members **1410** and **1430** move distally to close the jaws **1130**, **1102**. When in this position, the closure drive system **510** in the handle assembly **500** may be locked and the clinician can release the closure trigger **512**. When the clutch assembly **1640** has been moved to this firing mode, the magnet or other sensors in the magnet support arm **1665** or other portion is in communication with the Hall effect sensor **1662** to indicate the position of the clutch assembly **1640** to the microcontroller **520**.

[0413] The microcontroller **520** may provide the clinician with an indication of the position of the distal firing bar **1620** as it is advanced distally through the target tissue that is clamped between the end effector jaws. Once the distal firing bar **1620** and, more specifically, the firing member or knife member attached thereto has been advanced to a fully fired position, the microcontroller **520**, by means of sensor arrangements, detects the position of a portion of the firing member assembly **1600** and may then reverse the motor to retract the distal firing bar **1620** to its starting position. This action may be automatic or the clinician may have to depress the firing trigger **532** during the retraction process. Once the distal firing bar **1620** has been fully retracted to its starting position, the microcontroller **520** may provide the clinician with an indication that the distal firing bar **1620** has been fully retracted and the closure trigger **512** may be unlocked to enable the closure assembly **1406** to be returned to the unactuated position which thereby moves the jaws to the open position.

[0414] In one example, the elongate channel **1102** is roughly C-shaped with two upstanding sidewall portions **1104**. The anvil **1130** includes an anvil body portion **1132** and an anvil mounting portion **1134**. The anvil mounting portion **1134** comprises a pair of anvil mounting walls **1136** that are separated by a slot **1138** (FIG. **6**). As discussed above, the end effector mounting assembly **1230** is pivotally attached to the proximal end **1103** of the elongate channel **1102** by a spring pin connector **1235** that extends through a

transverse mounting hole **1231** in the end effector mounting assembly **1230** to be received within channel mounting holes **1106** provided in the sidewalls **1104** of the elongate channel **1102**. Each of the anvil mounting walls **1136** has an anvil trunnion **1137** protruding therefrom that are each adapted to be rotatably received within a corresponding anvil mounting hole **1107** in the proximal end **1103** of the elongate channel **1102**. As can be seen in FIGS. **16** and **17**, each of the channel sidewalls **1104** may have a vertical slot or relieved area **1108** that corresponds to each anvil mounting hole **1107** that enables the anvil trunnions **1137** to be vertically dropped into each slot **1108** for ease of assembly. The anvil trunnions define a pivot axis PA about which the anvil **1130** is selectively pivotable relative to the elongate channel **1102**. In various examples, the pivot axis PA is transverse to the shaft axis SA. See FIG. **16**.

[0415] The elongate channel **1102** is configured to removably support a surgical staple cartridge **1150** therein. The surgical staple cartridge **1150** includes a cartridge body **1151** that defines a deck surface **1152** that faces a staple-forming undersurface **1133** of the anvil body portion **1132**. The cartridge body **1151** has an elongate slot **1154** extending therethrough for permitting the passage of a firing member **1670** that is attached to a distal end of the distal firing bar **1620**. The cartridge body **1151** has a plurality of anvil pockets **1156** that are serially arranged in lines on both sides of the elongate slot **1154**. See FIG. **6**. Housed within these pockets **1156** are staple drivers that operably support one or more surgical staples or fasteners thereon. When the target tissue is clamped between the staple forming undersurface **1133** of the anvil body portion **1132** and the staple cartridge deck surface **1152**, the target tissue must be positioned so that the tissue that is severed is stapled on each side of the cut line. To avoid the target tissue from being positioned proximal of the proximal most staples or fasteners, the anvil **1130** may include two downwardly extending tissue stops **1140**. See FIG. **18**. The tissue stops **1140** when extending downward past the cartridge deck surface **1152** serve to block the target tissue from getting too far proximal between the anvil **1130** and the surgical staple cartridge **1150**.

[0416] Still referring to FIGS. **18** and **19**, in the illustrated example the anvil mounting walls **1136** are somewhat elongated and extend proximally. In one example, one or both of the anvil mounting walls **1136** include an opening limiter **1139** (FIG. **18**) formed thereon that is configured to contact the end effector mounting assembly **1230** to prevent the anvil **1130** from opening too far. See FIG. **18**.

[0417] Such anvil opening limiter **1139** may prevent the anvil **1130** from being too loose and sloppy on the elongate channel **1102**. In addition, the opening limiter **1139** prevents the anvil **1130** from opening to a position wherein the tissue stops **1140** extend above the cartridge deck surface **1152**. If that were to occur, tissue could be permitted to extend too far proximally between the anvil **1130** and the surgical staple cartridge **1150** and potentially be severed but not stapled. Such arrangement may also serve to prevent the anvil from being perceived as being too loose and sloppy relative to the elongate channel.

[0418] Referring again to FIG. **17**, the anvil mounting portion **1134** defines a firing member "parking area" **1141** which accommodates the firing member **1670** therein when the firing member **1670** is in a starting (unfired) position. In the illustrated arrangement, at least a portion of the parking area **1141** is proximal to the pivot axis. See, for example, FIG. **19**. Such arrangement may reduce the negative moment arm that is created from the tissue that is clamped between the anvil **1130** and the surgical staple cartridge **1150** that is supported in the elongate channel **1102**. In one example, an anvil cap or cover **1142** is attached to the anvil mounting portion **1134** to provide a pre-closure surface **1143** for contact by a distal camming ramp or surface **1440** formed on a distal end **1431** of the distal closure member **1430**. See FIG. **20**. In one arrangement, the anvil cap **1142** includes a pair of downwardly extending legs **1144** that are configured to snappingly engage attachment lugs **1145** that are formed on the anvil mounting walls **1136**. As can be seen in FIG. **16**, for example, the anvil cap **1142** includes a distally extending transition portion **1146** that extends between the anvil mounting walls **1136** and covers the firing member **1670** when it is in the firing member parking area **1141**. The transition portion **1146** extends between the anvil mounting walls **1136** and forms a transition from the pre-closure surface **1143** and an anvil cam surface **1147** formed on the anvil mounting portion **1134**. In addition, the anvil cap **1142** may minimize pinch points that may otherwise be present between the anvil mounting portion **1134** and the distal end **1431** of the distal closure member **1430** when the anvil **1130** is in its fully opened position.

[0419] Operation of the closure process employed in this example will now be described with reference to FIGS. **18**A, **19** and **20**A. In the illustrated arrangement, the anvil body portion **1132** defines an upper anvil surface **1135**. As can be seen in FIG. **18**A, the cam area or cam surface **1147** that is formed on the anvil mounting portion **1134** gradually transitions to the upper anvil surface **1135**. More specifically, in the illustrated arrangement, the cam surface **1147** comprises two surface portions: a proximal cam surface portion **1147**P and a distal cam surface portion **1147**D. In at least one example, the proximal cam surface portion **1147**P extends from a proximal end of the anvil body portion **1132** to the distal cam surface portion **1147**D. The distal cam surface portion **1147**D extends from the proximal cam surface portion **1147**P to the upper anvil surface **1135**. In one arrangement, the proximal cam surface portion **1147**P may have a slightly steeper angle than the distal cam surface portion **1147**D. In other arrangements, the cam surface on the anvil mounting portion may comprise one continuous cam surface oriented relative to the outer surface at a single cam angle.

[0420] As can be seen in FIG. **19**, the distal closure member **1430** has a distal end surface **1431** formed on a distal end thereof. A distal camming surface **1440** extends at an obtuse cam angle CA relative to the distal end surface **1431**. In the illustrated arrangement, the distal closure member **1430** comprises a distal closure tube that has an outer surface **1433** and an inner surface **1435** that defines a cross-sectional thickness CT therebetween. The distal end surface **1431** comprises a portion of the cross-sectional thickness CT. The distal camming surface **1440** extends from the distal end surface **1431** to the inner surface **1435** of the distal closure member **1430**. An initial cam area **1437** comprises the line or point of intersection between the distal end surface **1431** and the distal camming surface **1440**.

[0421] FIG. **18**A illustrates the distal closure member **1430** in a starting position with the anvil **1130** in an open position. As can be seen in FIG. **18**A, the distal camming surface **1440** is in contact with the pre-closure surface **1143** on the anvil cap **1142**. To begin the closure process, the distal

closure member **1430** is axially advanced in the distal direction DD. When the initial cam area **1437** and/or the distal end surface **1431** initially contacts the cam surface **1147** (proximal cam surface portion **1147**P) an initial closure motion or initial closure force ICF is applied thereto. See FIG. **19**. This initial closure force ICF is normal or perpendicular to the proximal cam surface portion **1147**P. Continued axial advancement of the distal closure member **1430** brings the distal camming surface **1440** into camming engagement with the cam surface **1147** (distal cam surface **1147**D) and essentially applies a closure force CF that is essentially parallel to the shaft axis SA. See FIG. **20**A.

[0422] In the above-described example, the anvil mounting walls **1136** may have a length that is somewhat longer than the anvil mounting configurations employed by other anvil arrangements. Such elongated anvil mounting walls **1136** serve to enable the pivot axis to be located relatively close to the articulation axis that is defined by the articulation joint **1200**. This arrangement facilitates establishment of a longer initial moment arm MAI (FIG. **19**) between the pivot axis PA and the initial closure force ICF. Such arrangement also facilitates the location of the pivot axis PA in a position that is slightly closer to the bottom of the elongate channel **1102** when compared to other anvil/channel mounting arrangements. Thus, in the illustrated arrangement, the distance between the pivot axis PA and the axis along which the closure force CF is applied is somewhat greater than other arrangements (larger moment arm). This arrangement may also lead to the establishment of a greater closure force CF when compared to other anvil mounting arrangements. Thus, the anvil mounting arrangement of the illustrated example may offer a larger mechanical closure advantage than is commonly attainable with other anvil mounting arrangements. Another advantage that may be gained by the foregoing example, is that locating at least a portion of the firing member parking area **1141** proximal to the pivot axis PA may help to reduce the "negative" moment arm that is applied to the anvil by the tissue that is clamped between the anvil and the cartridge.

[0423] Turning now to FIGS. **21-25**, the distal closure member **1430** is formed with at least one and preferably two, positive jaw opening hooks or tabs **1442**. Tabs **1442** may also be referred to herein as "primary positive jaw opening tabs". In one example, the positive jaw opening tabs are integrally formed into the distal closure member **1430**. For example, the positive jaw opening tabs **1442** are cut out of the walls of the tubular structure comprising the distal closure member **1430**. Each of the positive jaw opening tabs **1442** include an upwardly protruding hook portion **1444** that has a rounded camming end **1445** formed thereon that is configured for camming engagement with a corresponding anvil opening ramp **1148** extending downwardly from the anvil body portion **1132**. FIG. **22** illustrates the position of the anvil **1130** and distal closure member **1430** when the anvil **1130** is in a closed orientation. FIG. **23** illustrates the beginning of the opening process wherein the distal closure member **1430** has started to be retracted in the proximal direction PD. As can be seen in FIG. **23**, the camming end **1445** has initially contacted the anvil opening ramp **1148**. FIG. **24** illustrates the anvil **1130** in a partially opened position and FIG. **25** illustrates the anvil **1130** in a fully opened position. As can be seen in FIG. **25**, the camming end **1445** is on the bottom end **1149** of the anvil opening ramp to retain the anvil **1130** in the fully opened position. Such use of features on the distal closure member to effectuate the opening of the anvil from a fully closed position to a fully open position may be referred to herein as "positive jaw opening" features. Other suitable positive jaw opening arrangements are disclosed in U.S. patent application Ser. No. 14/742,925, entitled SURGICAL END EFFECTORS WITH POSITIVE JAW OPENING ARRANGEMENTS, which has been incorporated by reference in its entirety herein.

[0424] FIGS. **26-29** illustrate an alternative distal closure member **1430'** that employs secondary positive jaw opening tabs **1448** that are configured to cooperate with secondary jaw opening features **1160** that are formed on the anvil mounting walls **1136**. See FIGS. **16**, **17** and **27**. As can be seen in FIG. **26**, the secondary positive jaw opening tabs **1448** may be cut into the walls of the distal closure tube or member **1430'** and bent inward so as to be able to contact the secondary jaw opening features **1160** on the anvil **1130** as the distal closure tube or member **1430'** is moved in the proximal direction PD. FIG. **29** illustrates the anvil **1130** in a fully opened position. As the distal closure member **1430'** is moved proximally, the primary positive jaw opening tabs **1442** cam up the corresponding anvil opening ramp **1148** on the anvil **1130** and begin to pivot the anvil open. Thereafter, during the closing process, the secondary positive jaw opening tabs **1448** in the distal closure member **1430'** contact the secondary jaw opening features **1160** that are formed on the anvil mounting walls **1136** to further assist with moving the anvil **1130** to the fully opened position. As can be seen in FIG. **26** the secondary positive jaw opening tabs **1448** generally follow the contour of the distal closure tube **1430'**.

[0425] FIG. **30** illustrates an alternative distal closure member **1430'** wherein the secondary positive jaw opening tabs **1448'** are integrally formed into the wall of the distal closure tube **1430'**, but they extend proximally inward to contact the secondary jaw opening features **1160** on the anvil **1130** as the distal closure tube or member **1430'** is moved in the proximal direction PD. FIG. **31** illustrates the anvil **1130** in a fully opened position. Such primary and secondary anvil opening or jaw opening features may therefore serve to sequentially apply opening motions to the anvil as the distal closure member moves from a fully actuated position which corresponds to the fully closed position of the anvil to an unactuated position which corresponds to the fully open position of the anvil. In such arrangement, as the distal closure tube **1430'** is moved in the proximal direction, the primary positive jaw opening tabs **1442** cam the anvil into a "mostly open" position. The secondary positive jaw opening tabs **1448** serve to assure that the anvil is moved into its fully open position when the distal closure member is moved back to the unactuated position.

[0426] FIGS. **32** and **33** illustrate an alternative secondary positive jaw opening arrangement wherein the anvil mounting walls **1136** include a proximal anvil extension **1162** that cooperates with a corresponding secondary anvil biasing spring **1164** to bias the anvil into an open position. As the distal closure member **1430** is moved proximally, the primary positive jaw opening tabs **1442** cam up the corresponding anvil opening ramp **1148** on the anvil **1130** and begin to pivot the anvil open. In addition, the secondary anvil biasing spring **1164** applies a biasing force to the proximal anvil extension **1162** to further assist with moving the anvil **1130** to the fully opened position. In prior jaw opening arrange-

ments, there is commonly a "lag time" between actuation of the jaw opening system (e.g., firing trigger) and the active opening of the jaws. In the above-described example, the secondary anvil biasing spring **1164** is located proximal to the pivot axis PA about which the anvil pivots relative to the elongate channel. Such arrangement may serve to increase the biasing (opening) motion to the anvil as well as to minimize the occurrence of any "dead zone" that might otherwise occur between initial retraction of the closure member and a point wherein the closure member actually starts to apply a sufficient amount of opening motion to the anvil to cause the anvil to move to the open position.

[0427] FIGS. **34** and **35** illustrate an alternative distal closure member **1430"** that employs a positive jaw biasing member **1450** on each of the positive jaw opening tabs **1442**. The positive jaw biasing members **1450** may form leaf-type spring arrangements formed from metal or the like and serve to apply additional opening forces to the anvil opening ramps **1148** on the anvil **1130** as the distal closure member **1430"** is moved in the proximal direction PD. FIG. **34** illustrates the anvil **1130** in a fully closed position and FIG. **35** illustrates the anvil **1130** in a fully opened position. FIGS. **36** and **37** illustrate an alternative distal closure member **1430"** that employs another form of positive jaw biasing member **1452** on each of the positive jaw opening tabs **1442**. The positive jaw biasing members **1452** may have a somewhat V-shape configuration and be formed from spring steel or the like. FIG. **36** illustrates the anvil **1130** in a fully closed position and FIG. **37** illustrates the anvil **1130** in a partially opened position as the distal closure member **1430"** initially moves in the proximal direction. The positive jaw biasing members **1452** serve to ensure that the anvil **1130** is raised against the distal closure member **1430"** from the beginning of the opening process.

[0428] FIGS. **38** and **39** illustrate an alternative distal closure member **1430"** wherein each of the positive jaw opening tabs **1442** have a compliant portion **1454** thereon that serves to ensure that the anvil **1130** is raised against the distal closure member **1430"** from the beginning of the opening process. The compliant portion **1454** may comprise rubber or similar material formed onto the hook portions **1444** of the positive jaw opening tabs **1442**. In other arrangements, the portions **1454** may not be formed from compliant material, but instead may be formed from a hardened material to prevent wear on the positive jaw opening tabs **1442**. FIG. **38** illustrates the anvil **1130** in a fully closed position and FIG. **39** illustrates the anvil **1130** in a partially opened position. Such compliant arrangements and biasing member arrangements may serve to urge the anvil open while the closure member cam features remain in camming engagement with the cam ramps on the anvil to minimize any dead zone lag occurring between actuation of the closure system (to open the anvil) and the actual opening of the anvil. Such configurations may also serve to establish solid camming surfaces that would enable the user to overpower an anvil jam by operating the closure trigger.

[0429] Turning next to FIGS. **40-42**, the firing member **1670** is configured to operably interface with a sled or cam assembly **1120** that is operably supported within the body **1151** of the surgical staple cartridge **1150**. The cam assembly **1120** is slidably displaceable within the surgical staple cartridge body **1151** from a proximal starting position adjacent the proximal end **1153** of the cartridge body **1151** to an ending position adjacent a distal end **1155** of the cartridge body **1151**. The cartridge body **1151** operably supports therein a plurality of staple drivers (not shown) that are aligned in rows on each side of a centrally disposed slot **1154**. The centrally disposed slot **1154** enables the firing member **1670** to pass therethrough and cut the tissue that is clamped between the anvil **1130** and the surgical staple cartridge **1150**. The drivers are associated with corresponding pockets **1156** that open through the upper deck surface **1152** of the cartridge body **1151**. Each of the staple drivers supports one or more surgical staple or fastener (not shown) thereon. Thus, a plurality of surgical staples are arranged in lines or rows situated on both sides of the slot **1154**. The cam assembly **1120** includes a plurality of sloped or wedge-shaped cams **1122** wherein each cam **1122** corresponds to a particular line of fasteners or drivers located on a side of the slot **1154**. When the firing member **1670** is fired or driven distally, the firing member **1670** drives the cam assembly **1120** distally as well. As the firing member **1670** moves distally through the surgical staple cartridge **1150**, the tissue cutting feature **1676** cuts the tissue that is clamped between the anvil **1130** and the surgical staple cartridge **1150** and the cam assembly **1120** drives the drivers upwardly in the cartridge which drive the corresponding staples or fasteners into forming contact with the anvil **1130**.

[0430] In those embodiments wherein the firing member includes a tissue cutting surface or tissue cutting feature, it may be desirable for the elongate shaft assembly to be configured in such a way so as to prevent the inadvertent advancement of the firing member unless an unfired or new staple cartridge is properly supported in the elongate channel **1102** of the surgical end effector **1100**. If, for example, no staple cartridge is present at all and the firing member is distally advanced through the end effector, the tissue would be severed, but not stapled. Similarly, if a spent staple cartridge (i.e., a staple cartridge wherein at least some of the staples have already been fired therefrom) is present in the end effector and the firing member is advanced, the tissue may be severed, but may not be completely stapled, if at all. It will be appreciated that such occurrences could lead to undesirable catastrophic results during the surgical procedure. U.S. Pat. No. 6,988,649 entitled SURGICAL STAPLING INSTRUMENT HAVING A SPENT CARTRIDGE LOCKOUT, U.S. Pat. No. 7,044,352 entitled SURGICAL STAPLING INSTRUMENT HAVING A SINGLE LOCKOUT MECHANISM FOR PREVENTION OF FIRING, and U.S. Pat. No. 7,380,695 entitled SURGICAL STAPLING INSTRUMENT HAVING A SINGLE LOCKOUT MECHANISM FOR PREVENTION OF FIRING, and U.S. patent application Ser. No. 14/742,933, entitled SURGICAL STAPLING INSTRUMENTS WITH LOCKOUT ARRANGEMENTS FOR PREVENTING FIRING SYSTEM ACTUATION WHEN A CARTRIDGE IS SPENT OR MISSING each disclose various firing member lockout arrangements that may be employed. Each of those references is hereby incorporated by reference in their entireties herein.

[0431] An "unfired", "unspent", "fresh" or "new" surgical staple cartridge **1150** means herein that the surgical staple cartridge **1150** has all of its fasteners in their "ready-to-be-fired" positions when properly loaded within the end effector. When in that position, the cam assembly **1120** is located in its starting position. The new surgical staple cartridge **1150** is seated within the elongate channel **1102** and may be retained therein by snap features on the cartridge body that

are configured to retainingly engage corresponding portions of the elongate channel **1102**. FIG. **41** illustrates portions of the surgical end effector **1100** with a new or unfired surgical staple cartridge **1150** seated therein. As can be seen in FIG. **41**, the cam assembly **1120** is in the starting position. To prevent the firing system from being activated and, more precisely, to prevent the firing member **1670** from being distally driven through the end effector **1100** unless an unfired or new surgical staple cartridge has been properly seated within the elongate channel **1102**, the illustrated interchangeable surgical tool assembly **1000** employs a firing member lockout system generally designated as **1730** that, in certain aspects, may be similar to the lockout systems disclosed in U.S. patent application Ser. No. 15/385,958, filed on Dec. 21, 2016, entitled SURGICAL INSTRUMENTS WITH LOCKOUT ARRANGEMENTS FOR PREVENTING FIRING SYSTEM ACTUATION UNLESS AN UNSPENT STAPLE CARTRIDGE IS PRESENT, the entire disclosure of which is hereby incorporated by reference herein in its entirety.

[0432] In the illustrated example, the firing member lockout system **1730** includes a movable lock member **1732** that is configured to retainingly engage the firing member **1670** when an unspent or unfired surgical staple cartridge **1150** is not properly seated within the elongate channel **1102**. The lock member **1732** comprises a pair of lateral spring arms **1733** that are interconnected by a central mount tab feature **1734**. As can be seen in FIG. **41**, each of the lateral spring arms **1733** are laterally offset from the shaft axis SA. When the lock member **1732** is installed, the mount tab feature **1734** is configured to bias the lock member **1732** upward. In addition, the lock member **1732** includes two lateral anvil spring arms **1736** that angle upward to engage the bottom surface of a corresponding anvil mounting wall **1136** on the anvil mounting portion **1134** to bias the lock member **1732** downward when the anvil **1130** is closed. The distal portion of each lateral spring arm **1733** terminates in a sled tab **1738** that are each further laterally offset from the shaft axis SA. Each of the sled tabs **1738** are oriented to contact a corresponding unlocking feature or sled boss **1124** that is formed on the proximal end portion **1121** of the cam assembly **1120**. As can be seen in FIG. **40**, for example, in the illustrated arrangement, the cam assembly **1120** has a central axis CA. When the sled assembly **1120** is in its starting position within an unfired staple cartridge that is properly supported in the elongate channel, the central axis CA is laterally aligned with the shaft axis SA. As can be seen in FIG. **40**, the sled bosses are laterally offset from the central axis CA (and ultimately the shaft axis SA) so as to define a central area **1123** therebetween. When the firing member is distally advanced through the end effector, the firing member contacts the cam assembly **1120** in the central area to drive the cam assembly **1120** distally through the cartridge body. In alternative arrangements, only one lateral spring arm **1733** may be employed and therefore only one lateral sled tab **1738** is provided. In such arrangement, only one corresponding sled boss **1124** is formed on the cam assembly **1120**. In still other arrangements, the lock member **1732** may have two lateral spring arms **1733**, but only one of the lateral spring arms may be provided with a sled tab **1738**. In the illustrated arrangement, each of the proximally facing sled bosses **1124** includes a ramp **1127** to facilitate easier interfacing between the sled bosses **1124** and the lateral sled tabs **1738** during installation of the cartridge in the elongate channel.

[0433] Each of the lateral spring arms **1733** includes a lock notch therein that is configured to lockingly engage a corresponding central lock lug **1674** that extends laterally from a firing member body portion **1672**. FIG. **41** illustrates the cam assembly **1120** in a starting position wherein the sled bosses **1124** have lifted the lock member **1732** out of locking engagement with the lock lugs **1674**. FIG. **42** illustrates an improper surgical staple cartridge **1150**W installed in relation to the lock member **1732**. As can be seen in FIG. **42**, although the cartridge **1150**W has a cam assembly **1120**W with proximally extending features **1124**W that are laterally offset from a central axis of the cam assembly, the features **1124**W are in not in unlocking engagement with the sled tabs **1738** of the lock member **1732**. Thus, the cam assembly **1120**W, even though in its starting position, will not move the lock member **1732** out of locking engagement with the firing member **1670**.

[0434] In alternative arrangements, the lock member may be configured to complete an electrical circuit when it is moved down into contact with a corresponding portion of a sled of a properly loaded unfired cartridge (when the sled is in its proper firing position). In such arrangement, for example, when the circuit is open, the motor is inoperable. In one arrangement, the lock member may also be able to mechanically engage the firing member in the above-described manner to thereby facilitate both mechanical and electrical lockout features/capabilities.

[0435] FIGS. **43-50** illustrate another firing member lockout system **1740** that may be employed in connection with the various end effector embodiments disclosed herein. In this embodiment, the firing member lockout system **1740** includes a firing member lock **1742** that is supported for pivotal travel between a locked position wherein the firing member lock **1742** is in locking engagement with the firing member **1670** and an unlocked position wherein the firing member **1670** is free to be distally advanced through the surgical staple cartridge **1150**. As can be seen in FIG. **43**, the firing member lock **1742** includes a mounting portion **1743** that has a pivot member **1744** protruding laterally from each side thereof. The pivot members **1744** are pivotally captured within pivot notches **1238** provided in the underside of the end effector mounting assembly **1230**. See FIG. **44**. As can be seen in FIG. **44**, the pivot members **1744** are rotatably captured in the pivot notches **1238** by the lower double pivot link **1222**. As can also be seen in FIG. **43**, a pair of hook arms **1746** extends distally from the mounting portion **1743**. Each hook arm **1746** includes a lock notch **1748** that is formed in the underside thereof that is configured to engage a corresponding one of the central lock lugs **1674** on the firing member **1670**. The firing member lockout system **1740** further includes a pair of biasing members **1749** in the form of leaf springs or the like that engage the corresponding anvil mounting walls **1136** on the anvil **1130** and the firing member lock **1742** to bias the firing member lock **1742** downwardly.

[0436] FIG. **45** illustrates the surgical end effector **1100** with the anvil **1130** and the elongate channel **1102** in their fully opened position which occurs during the loading of an unspent or unfired surgical staple cartridge **1150** therein. When in the open position, the firing member **1670** cannot be distally advanced at least due to the misalignment of

portions of the firing member with corresponding passages within the anvil **1130**. In addition, the instrument may employ various sensor arrangements that are configured to detect the position of the anvil and/or configurations of other portions of the anvil closure system to prevent actuation of firing system components unless the anvil is in a fully closed position. As can be seen in FIG. **45**, when in the open position, the hook arms **1746** are oriented in an unactuated position wherein a portion of each of the hook arms **1746** is received on the corresponding central lock lug **1674** of the firing member **1670** such that the lock notch **1748** is not in position to engage the corresponding central lock lug **1674**.

[0437] FIG. **46** illustrates the end effector after an unfired surgical staple cartridge **1150** with a sled assembly or cam assembly **1120** has been properly installed in the elongate channel **1102** and the anvil **1130** has been is closed. When in such configuration, the biasing member **1749** applies a downward biasing motion onto the firing member lock **1742**, which is now in contact with the sled bosses **1124** as well as the central lock lug **1674** on the firing member **1670**. As can be further seen in FIG. **46**, the sled bosses **1124** on the sled assembly **1120** serve to lift the firing member lock **1742** upward so that the lock notches **148** therein are out of locking engagement with the central lock lugs **1674** on the firing member **1670**. Thus, the firing member **1670** is free to be distally advanced as illustrated in FIG. **47**. As can be seen in FIG. **47**, the firing member lock **1742** is out of engagement with the firing member **1670** as well as the sled assembly **1120** and the biasing members **1749** have pivoted the firing member lock **1742** downward.

[0438] FIGS. **48-50** illustrate the retraction of the firing member **1670**. FIG. **48** shows the position of the firing member **1670** and the firing member lock **1742** at the beginning of the retraction process. FIG. **49** illustrates the position of the firing member **1670** after the tapered proximal ends **1675** of the central lock lugs **1674** have contacted the angled surfaces on the distal ends of the hook arms **1746** and pivoted the hook arms **1746** upward (arrow U). FIG. **50** illustrates the firing member **1670** in its fully retracted or starting position. As can be seen in FIG. **50**, the hook arms **1746** have pivoted downward into a "pre-locked" position. When the lock member is in the pre-locked position, the firing member **1670** can be moved distally until the central lock lugs **1674** thereon lockingly engage the hook harms **1746** which serve to prevent further distal advancement of the firing member **1670**. Thus, in the illustrated example, the firing member lock **1742** will not be moved from an unlocked or un-activated position to an actuated position unless the anvil is first moved to a closed position. In this context, the term "closed position" means that the anvil is moved to a position relative to the cartridge and firing member that would otherwise enable the firing member to be distally advanced therein but for the firing member lockout system, for example.

[0439] FIGS. **51-55** illustrate another firing member lockout system **1750** that may be employed in connection with the various end effector embodiments disclosed herein. In this embodiment, the firing member lockout system **1750** includes at least one firing member lock **1752** that is supported for vertical travel along a lock axis LA that is transverse to the shaft axis SA. In one example, a firing member lock **1752** corresponds to each of the anvil mounting walls **1136**. In other examples, only one firing member lock **1752** may be employed. Only one firing member lock **1752** is shown in the Figures for clarity purposes. In the illustrated example, each firing member lock **1752** has an L-shape and a latch portion **1754**. The firing member lock **1752** is movably journaled on a corresponding mounting rod **1751** that is attached to the corresponding anvil mounting wall **1136** or other portion of the anvil. A corresponding lock spring or biasing member **1756** biases the firing member lock **1752** downward (arrow D in FIGS. **52** and **53**). FIG. **51** illustrates the surgical end effector **1100** with the anvil **1130** and the elongate channel **1102** in their fully closed position with an unspent or unfired surgical staple cartridge **1150** properly supported therein. As can be seen in FIG. **51**, a tapered end **1755** of each of the latch portions **1754** has been engaged by corresponding unlocking features **1125** on the sled assembly **1120**. The unlocking features **1125** serve to vertically displace the latch portions **1754** so that the central lock lugs **1674** on the firing member **1670** may pass thereunder. Thus, the firing member **1670** is free to be distally advanced. FIG. **52** illustrates the position of the firing member **1670** at the beginning of the firing process wherein it has been advanced distally from its starting position. As can be seen in FIG. **52**, the unlocking features **1125** are no longer in contact with the latch portions **1754**.

[0440] FIGS. **53-55** illustrate the retraction of the firing member **1670**. FIG. **53** shows the position of the firing member **1670** and the firing member lock **1752** at the beginning of the retraction process. FIG. **54** illustrates the position of the firing member **1670** after the tapered proximal ends **1675** of the central lock lugs **1674** have contacted the angled surfaces or tapered ends **1755** of the latch portions **1754** to vertically displace the firing member lock **1752** in the up direction (arrow U—FIGS. **54** and **55**). FIG. **55** illustrates the firing member **1670** in its fully retracted or starting position. As can be seen in FIG. **55**, the firing member lock **1752** is in a locked or bottom position wherein, if the firing member **1670** were to be moved distally, the central lock lug **1674** on the firing member **1670** would contact the latch portions **1754** of the corresponding firing member lock **1752**. When in that position, the firing member **1670** cannot be distally advanced. Because the firing member locks **1752** are attached to the anvil, when the anvil is in an open position, the firing member locks **1752** are not in a locked position wherein they can prevent the axial advancement of the firing member **1670**. Thus, to actuate the firing member lockout system **1750**, the anvil **1130** must first be moved to a closed position. In this context, the term "closed position" means that the anvil is moved to a position relative to the cartridge and firing member that would otherwise enable the firing member to be distally advanced therein, but for the firing member lockout system, for example.

[0441] FIGS. **56-63** illustrate another firing member lockout system **1760** that includes a movable lock member **1762** that is configured to retainingly engage the firing member **1670** when a surgical staple cartridge **1150** is not properly seated within the elongate channel **1102**. The lock member **1762** comprises at least one laterally moving locking portion **1764** that is configured to retainingly engage a corresponding portion of the firing member when the sled assembly **1120** is not present within the surgical staple cartridge **1150** in its starting position. In the illustrated arrangement, the lock member **1762** employs two laterally moving locking portions **1764** wherein each locking portion **1764** engages a laterally extending portion of the firing member **1670**.

[0442] In the illustrated embodiment, the lock member **1762** comprises a generally U-shaped spring member wherein each laterally movable leg or locking portion **1764** extends from a central spring portion **1763** and is configured to move in lateral directions represented by arrows "L" in FIGS. **56**, **59** and **62**. It will be appreciated that the term "lateral directions" refers to directions that are transverse to the shaft axis SA. The spring or lock member **1762** may be fabricated from high strength spring steel or similar material. The central spring portion **1763** may include a proximally extending spring tab **1767** that is retained within a notch **1240** in the end effector mounting assembly **1230**. See FIG. **57**. In the illustrated example, the spring tab **1767** serves to bias the lock member **1762** into an unlocked configuration when the anvil **1130** is in an open position. FIG. **57** illustrates the anvil **1130** in an open position ready for an unfired or new cartridge to be installed in the elongate channel **1102**. As can be seen in FIG. **57**, the mounting tab **1767** biases the lock member **1762** in an upward direction (arrow U). When in that unlocked position, the lock member **1762** is not in a position to prevent the distal advancement of the firing member **1762**. The instrument may, however, employ other sensors and lockout arrangements to detect the position of the anvil and otherwise prevent actuation of the firing system unless the anvil has been moved to a closed position.

[0443] FIG. **58** illustrates a portion of the surgical end effector **1100** with an unfired staple cartridge **1150** loaded or properly supported within the elongate channel **1102** and after the anvil **1130** has been moved to a closed position. As the anvil **1130** is moved to the closed position, the anvil mounting walls **1136** contact corresponding laterally extending anvil tabs **1766** that are formed on the lock member **1762**. See FIG. **56**. The anvil mounting walls **1136** thereby serve to move the lock member **1762** from a disengaged position to a locked position wherein the lock member **1762** is in locking engagement with the firing member **1670**. In one example, each of the laterally movable legs or locking portions **1764** of the lock member **1762** includes a locking window **1768** therein. When the lock member **1762** is in a locked position, the central lock lug **1674** on each lateral side of the firing member **1670** extends into the corresponding locking window **1768** to retainingly prevent the firing member **1670** from being distally axially advanced.

[0444] As can be seen in FIG. **56**, the sled or cam assembly **1120** includes an unlocking feature **1125** that corresponds to each of the laterally movable locking portions **1764**. In the illustrated arrangement, an unlocking feature **1125** is provided on, or extends proximally from, each of the central wedge-shaped cams **1122**. In alternative arrangements, the unlocking feature **1125** may comprise a proximally protruding portion of the corresponding wedge-shaped cam **1122**. As can be seen in FIG. **59**, when the sled assembly **1120** is in its starting position, the unlocking features **1125** engage and bias the corresponding locking portions **1764** laterally in a direction that is transverse to the shaft axis SA (arrows L). When the locking portions **1764** are in those unlocked orientations, the central lock lugs **1674** are not in retaining engagement with their corresponding locking window **1768**. When in those orientations, the firing member **1670** may be distally axially advanced (fired). However, when an unfired surgical staple cartridge **1150** is not present in the elongate channel **1102** or the sled assembly **1120** has been moved out of its starting position (which may mean that the cartridge is at least partially or completely fired), the locking portions **1764** spring laterally into retaining engagement with the firing member **1670**. When in that position as illustrated in FIG. **58**, the central lock lugs **1674** are received within their respective locking windows **1768** and are prevented from moving distally by a lockout stop **1769**. When in such position, the firing member **1670** cannot be moved distally.

[0445] FIG. **61** illustrates the firing member **1670** as it is being retracted to its starting or unfired position. As the tapered or tapered proximal ends **1675** of the central lock lugs **1674** contact the radiused distal ends **1765** of the movable locking portions **1764**, the movable locking portions **1764** are biased laterally outward as shown in FIG. **62** until each of the central lock lugs **1674** once again are completely received within the lock window portions **1768** in the locking portions **1764** (FIG. **63**). When the firing member **1670** has been fully retracted to the starting position shown in FIG. **63**, the firing member **1670** is once again locked in place by the lock member **1762** and prevented from being distally advanced until another fresh cartridge has been properly loaded into the elongate channel **1102** as described above. When the anvil **1130** is opened, the spring tab **1767** once again biases the lock member **1762** back to the unlocked or pre-actuated position. Thus, to actuate the firing member lockout system **1760**, the user must first move the anvil to a closed position. In this context, the term "closed position" means that the anvil is moved to a position relative to the cartridge and firing member that would otherwise enable the firing member to be distally advanced therein, but for the firing member lockout system, for example.

[0446] FIGS. **64-70** illustrate an alternative articulation lock arrangement **1910** for locking a surgical end effector **1100'** in an articulated position about an articulation axis B-B relative to a shaft axis SA. In the illustrated example, the surgical end effector **1100'** is pivotally coupled to a spine assembly **1500'**. The spine assembly **1500'** may be attached to the chassis **1800** (FIG. **4**) in the above described manner. A distal end portion **1540** of the spine assembly **1500'** is formed with a downwardly protruding articulation pin **1542** that defines the articulation axis B-B. The articulation pin **1542** is configured to be rotatably or pivotally received within a spine attachment hole **1254** that is provided in a mounting base **1252** of an end effector mounting assembly **1250**. The end effector mounting assembly **1250** is attached to a proximal end **1103** of the elongate channel **1102** by a spring pin connector **1235** (FIG. **6**) that extends through a transverse mounting hole **1251** in the mounting assembly **1250** to be received within the channel mounting holes **1106** (FIG. **6**) that are provided in the proximal end **1103** of the elongate channel **1102**.

[0447] Referring to FIGS. **64** and **65**, in one example, the articulation lock arrangement **1910** comprises a lock spring assembly **1920** that includes a central spring body portion **1922** that defines a central pin hole **1924** and which includes bottom release ring segments **1930** and **1932** and top release ring segments **1940** and **1942**. The lock spring assembly **1920** is sized to be rotatably received within the spine attachment hole **1254** in the mounting base **1252**. In one example, an upper release stop **1256** and a lower release stop **1258** each protrude inwardly within the spine attachment hole **1254**. The articulation lock arrangement **1910** further includes a release pin assembly **1950** that includes an upper release arm **1952** and a lower release arm **1954**. The release

pin assembly **1950** is attached to a distal articulation link **1960** that is pinned to a distal end of the distal articulation link **1710'** by a link pin **1962**. The distal articulation link **1710'** may interface with the articulation systems described herein for axially moving the distal articulation link **1710'** in the distal and proximal directions depending upon the direction of articulation desired. A bottom portion (not shown) of the release pin assembly **1950** is configured to be pivotally and slidably supported within a lower arcuate release pin slot **1260** that is formed in the end effector mounting assembly **1250**. A second upper release arm slot **1270** is also formed in the end effector mounting assembly and is configured to movably accommodate the upper and lower release arms **1952** and **1954**. As can be seen in FIG. **67**, an upper balance formation **1272** protrudes into the second upper release arm slot **1270** and is configured to operably interface with the upper release arm **1952**. Likewise, a lower balance formation **1274** protrudes into the second upper release arm slot **1270** and is configured to operably interface with the lower release arm **1954**.

[0448] In the illustrated example, the articulation pin **1542** is rotatably received within the central pin hole **1924** in the lock spring assembly **1920**. The lock spring assembly **1920** is received within the spine attachment hole **1254** in the end effector mounting assembly **1250** such that the upper release stop **1256** is received within an upper lock space **1941** that is formed between the top release ring segments **1940** and **1942** and the lower release stop **1258** is located within a lower lock space **1931** formed between the bottom release ring segments **1930** and **1932**. FIG. **67** illustrates the surgical end effector **1100** in an unarticulated position. As can be seen in FIG. **67**, the upper release stop **1256** is in abutting engagement with the top release ring segment **1940**. The lower release stop **1258** may also be in abutting engagement with the bottom release ring segment **1932**. Such configuration retains the lock spring assembly **1920** in frictional engagement with the articulation pin **1542** to retain the surgical end effector **1100** in the unarticulated position.

[0449] FIG. **68** is a top view of the articulation lock arrangement **1910** upon initiation of articulation of the surgical end effector to the right (arrow RD) about the articulation axis. As can be seen in FIG. **68**, the right articulation process is initiated by axially advancing the distal articulation link **1710'** in the distal direction DD. Distal advancement of the distal articulation link **1710'** causes the distal articulation link **1960** to move the release pin assembly **1950** distally such that the upper release arm **1952** is brought into abutting engagement with the upper balance formation **1272** on the end effector mounting assembly **1250**. Such contact between the upper balance formation **1272** and the upper release arm **1952** causes the upper release arm **1952** to contact the top release ring segment **1942** and apply the right articulation force RAF thereto. Such movement causes the top release ring segment **1942** to move counterclockwise CCW to thereby cause the lock spring assembly **1920** to open or expand to disengage from frictional engagement with the articulation pin **1542**. FIG. **69** is a bottom view of the articulation lock arrangement **1910** as illustrated in FIG. **68**. As can be seen in FIG. **69**, the lower release stop **1258** is in abutting engagement with the bottom release ring segment **1930** which prevents the bottom release ring segment **1930** from moving. As a result, the lock spring assembly **1920** expands to release the articulation pin **1542**. Further distal advancement of the distal articulation link **1710'** causes the release pin assembly **1950** to apply the articulation motion to the surgical end effector mounting assembly **1250** in the right direction RD while also moving the lock spring assembly **1920** out of locking engagement with the articulation pin **1542**. See FIG. **70**. To articulate the surgical end effector **1100** in the left direction, the distal articulation link **1710'** is moved in the proximal direction which causes the release pin assembly to expand the lock spring assembly **1920** and move the surgical end effector mounting assembly **1250** in the left direction in an opposite, but similar manner. Thus, as may be appreciated from the forgoing description, the locking spring assembly essentially comprises a spring assembly that is expandable from a first locked or retention configuration wherein the lock spring assembly **1920** is in frictional retaining engagement with the articulation pin **1542** and a second unlocked position wherein the lock spring assembly **1920** is free to pivot about the articulation pin **1542** with the surgical end effector mounting assembly **1250** as articulation motions are applied thereto.

[0450] FIGS. **71-77** illustrate an alternative articulation lock arrangement **2010** for locking a surgical end effector **1100** in an articulated position about an articulation axis B-B relative to a shaft axis SA. In the illustrated example, the surgical end effector **1100** is pivotally coupled to a spine assembly **1500'**. The spine assembly **1500'** may be attached to the chassis **1800** (FIG. **4**) in the above described manner. A distal end portion **1540** of the spine assembly **1500'** is formed with a downwardly protruding articulation pin **1542** that defines the articulation axis B-B. The articulation pin **1542** is configured to be rotatably or pivotally received within a spine attachment hole **1254** that is provided in a mounting base **1252'** of an end effector mounting assembly **1250'**. The end effector mounting assembly **1250'** is attached to a proximal end **1103** of the elongate channel **1102** by a spring pin connector **1235** (FIG. **6**) that extends through a transverse mounting hole **1251** in the mounting assembly **1250'** to be received within the channel mounting holes **1106** (FIG. **6**) that are provided in the proximal end **1103** of the elongate channel **1102**.

[0451] Referring to FIGS. **71** and **73**, in one example, the articulation lock arrangement **2010** comprises a ball lock assembly **2020** that includes a ball retainer base **2022** that has a central pivot hole **2024** therein that is configured to receive the articulation pin **1542** therethrough. The ball retainer base **2022** is attached to an articulation lock link **1960** by an articulation pin **2023** that extends through a pin hole **2025** in the ball retainer base **2022** into an articulation slot **1264** in the mounting base **1252'** of the surgical end effector mounting assembly **1250'**. The articulation lock link **1960** is pinned to a distal end of the distal articulation link **1710'** by a link pin **1962**. The distal articulation link **1710'** may interface with the articulation systems described herein for axially moving the distal articulation link **1710'** in the distal and proximal directions depending upon the direction of articulation desired. The ball retainer base **2022** further includes two upstanding ball stop members **2026** and **2028** that serve to retain two locking balls **2030** and **2032** between a distal locking surface **1263** formed on a locking cradle **1262** on the surgical end effector mounting assembly **1250'** and a proximal locking surface **1541** formed on the distal end portion **1540** of the spine assembly **1500'**. The ball

retainer base **2022** further includes two centering springs **2034** and **2036** that serve to also support the locking balls **2030**, **2032**, respectively.

[0452] FIG. **73** illustrates the surgical end effector **1100** in an unarticulated position. As can be seen in FIG. **73**, the locking balls **2030**, **2032** are captured in locking engagement between the distal locking surface **1263** on the locking cradle **1262** and the proximal locking surface **1541** on the distal end portion **1540** of the spine assembly **1500'** to retain the surgical end effector **1100** in the unarticulated position. FIG. **74** illustrates a locking plane LP that extends through the points of contact between the locking ball **2030** and the distal locking surface **1263** on the locking cradle **1262** and the proximal locking surface **1541**. FIG. **75** is a top view of the articulation lock arrangement **2010** upon initiation of articulation of the surgical end effector to the right (arrow RD) about the articulation axis. As can be seen in FIG. **75**, the right articulation process is initiated by axially advancing the distal articulation link **1710'** in the distal direction DD. Distal advancement of the distal articulation link **1710'** causes the articulation lock link **1960** to move the articulation pin **2023** distally within the articulation slot **1264** in the mounting base **1252'** of the end effector mounting assembly **1250'** while also applying a release load RL to the ball retainer base **2022**. Movement of the ball retainer base **2022** in the right direction RD causes the ball stop **2026** to move the locking ball **2032** out of locking engagement with the distal locking surface **1263** on the locking cradle **1262**. Although the ball stop **2026** has moved out of engagement with locking ball **2030**, initially, the locking ball **2030** remains in temporary engagement with the distal locking surface **1263** on the locking cradle **1262** and the proximal locking surface **1541**. Further distal advancement of the distal articulation link **1710'** causes the articulation pin **2023** to apply the articulation motion to the surgical end effector mounting assembly **1250'** in the right direction RD while also moving the ball retainer base **2022** in the right direction RD. The articulation angle AA represents the amount of articulation experienced by the surgical end effector **1100**. As the ball retainer base **2022** moves in the right direction RD, the locking ball **2030** also moves out of locking engagement with the distal locking surface **1263** and the proximal locking surface **1541**. Ball stop **2028** also holds the locking ball **2032** out of locking engagement with the distal locking surface **1263** and the proximal locking surface **1541** during articulation. Once the surgical end effector **1100** has been articulated to a desired position, the distal advancement of the distal articulation link **1710'** is discontinued. Thereafter, the centering springs **2034** and **2036** urge the locking balls **2030** and **2032** into locking engagement with the distal locking surface **1263** and the proximal locking surface **1541** to retain the surgical end effector **1100** in the articulated position. As can be seen in FIG. **76**, when in the locked articulated position, the act of the centering springs biasing the locking balls **2030**, **2032** into retaining engagement with the distal locking surface **1263** and the proximal locking surface **1541**, also results in the movement of the articulation pin **2023** to a neutral position within the articulation slot **1264**. To articulate the surgical end effector **1100** in the left direction, the distal articulation link **1710'** is moved in the proximal direction which causes the ball lock assembly **2020** and the surgical end effector **1100** to pivot in the left direction and operates in a similar manner.

[0453] FIGS. **78-82** illustrate an alternative articulation lock arrangement **2110** for locking a surgical end effector **1100** in an articulated position about an articulation axis B-B relative to a shaft axis SA. In the illustrated example, the surgical end effector **1100** is pivotally coupled to a spine assembly **1500"**. The spine assembly **1500"** may be attached to the chassis **1800** (FIG. **4**) in the above described manner. A distal end portion **1540'** of the spine assembly **1500"** includes a pivot hole **1543** that defines the articulation axis B-B. An end effector mounting assembly **1250"** is attached to a proximal end **1103** of the elongate channel **1102** by a spring pin connector **1235** (FIGS. **80-82**) that extends through a transverse mounting hole **1251** in the mounting assembly **1250"** to be received within the channel mounting holes **1106** (FIG. **6**) that are provided in the proximal end **1103** of the elongate channel **1102**. In the illustrated example, the surgical end effector mounting assembly **1250"** includes a tapered mounting column **1253** that extends upward from the mounting base **1252** to be received within the pivot hole **1543** in the spine assembly **1500"**. In one arrangement, the tapered mounting column **1253** tapers away from the mounting base **1252**. Stated another way, the cross-sectional area of the end **1255** of the tapered mounting column **1253** is smaller than the cross-sectional area of the portion of the tapered mounting column **1253** adjacent the mounting base **1252**.

[0454] The articulation lock arrangement **2110** comprises at least one locking member or locking shoe that is movably supported between the mounting column **1253** and an inner wall **1545** of the pivot hole **1543**. In the illustrated arrangement, the mounting column **1253** has a triangular cross sectional shape that defines three column sides **1280**, **1282**, **1284**. Thus, (in the illustrated example), three locking members or locking shoes **2112**, **2114**, **2116** are employed wherein locking shoe **2112** is arranged adjacent the column wall **1282** and locking shoe **2114** is arranged adjacent column wall **1284** and locking shoe **2116** is adjacent column wall **1280**. Mounting columns having other shapes and other numbers of locking shoes may also be employed. Each of the locking shoes **2112**, **2114**, **2116** are received on a wave washer **2120** that is mounted on the mounting base **1252** of the end effector mounting assembly **1250"**. The illustrated arrangement includes a proximal closure member **2410** that may be axially advanced and retracted in the various manners described herein with respect to proximal closure member **1410**, for example. The proximal closure member **2410** is pivotally coupled to a distal closure member **2430** that is similar in construction and operation to distal closure member **1430**. As can be seen in FIGS. **80-82**, the distal closure member **2430** is coupled to the proximal closure member **2410** by an upper double pivot link **1220** and a lower double pivot link **1222'**. In one embodiment, the lower double pivot link **1222'** is formed with a tapered ramp **1226** on the upper surface **1224** thereof. See FIG. **78**. The illustrated arrangement employs two articulation links **1710**R and **1710**L to apply left and right articulation motions to the surgical end effector **1100**. See FIG. **79**. To articulate the surgical end effector **1100** to the right, the articulation link **1710**R is axially retracted in the proximal direction PD and the articulation link **1710**L is axially advanced in the distal direction DD. Conversely, to articulate the surgical end effector **1100** in the left direction, the articulation link **1710**L is axially retracted in the proximal direction PD and the articulation link **1710**R is axially advanced in the distal

direction DD. The articulation control motions may be generated and applied to the articulation links **1710**R, **1710**L by various known articulation system arrangements and other articulation system arrangements disclosed herein. The articulation link **1710**R has a slotted end portion **1711**R that is received on a right articulation pin **1266**R that is attached to the end effector mounting assembly **1250"**. Likewise, the articulation link **1710**L has a slotted end portion **1711**L that is received on a left articulation pin **1266**L that is attached to the end effector mounting assembly **1250"**.

[0455] Turning now to FIG. **80**, in the illustrated arrangement, the wave washer **2120** biases the mounting base **1252** of the end effector mounting assembly **1250"** downward (arrow D) when the closure system is in an unactuated state. In FIG. **80**, the proximal closure member **2410** is in a proximal position. Likewise, the lower double pivot link **1222'** is also in a proximal position which permits the mounting base **1252** to be driven downward. Because the mounting base **1252** is in its down-most or unlocked position, the tapered mounting column **1253** has released the locking shoes **2112**, **2114**, **2116** from retaining engagement with the distal end portion **1540'** of the spine assembly **1500"** (first unlocked position). Thus, when in that position, the surgical end effector **1100** may be articulated about the articulation axis B-B by the articulation links **1710**R, **1710**L. Once the surgical end effector **1100** has been articulated to a desired position, the articulation lock arrangement **2110** may be reactivated by distally advancing the proximal closure member **2410**.

[0456] FIG. **81** illustrates the initiation of the locking process. As can be seen in that Figure, the proximal closure member **2410**, as well as the lower double pivot link **1222'**, has been initially moved in the distal direction DD. As the lower double pivot link **1222'** moves distally, the ramp **1226** thereon drives the mounting base **1252** of the end effector mounting assembly **1250"** upward to collapse the wave washer **2120**. As the mounting base **1252** moves upward (arrow U), the tapered mounting column **1253** urges the locking shoes **2112**, **2114**, **2116** from a first unlocked position into retaining locking engagement with the distal end portion **1540'** of the spine assembly **1500"** (second locked position) to lock the surgical end effector **1100** in the articulated position. This locking of the surgical end effector **1100** takes place before the jaws of the surgical end effector are fully closed. FIG. **82** illustrates the positions of the proximal closure member **2410**, the lower double pivot link **1222'**, and the articulation lock arrangement **2110** when the closure system components have been moved to the fully closed position wherein the end effector has been fully closed. Thus, the articulation lock arrangement **2110** may be actuated or moved between a locked state and an unlocked state by actuating the closure system a small amount. Alternative arrangements are contemplated wherein the mounting column is attached to the distal end of the spine assembly and the pivot hole is provide in a proximal portion of the surgical end effector.

[0457] FIGS. **83** and **84** illustrate an alternative articulation lock arrangement **2110'** for locking a surgical end effector **1100** in an articulated position about an articulation axis B-B relative to a shaft axis SA. In the illustrated example, the surgical end effector **1100** is pivotally coupled to a spine assembly **1500"**. The spine assembly **1500"** may be attached to the chassis **1800** (FIG. **4**) in the above described manner. A distal end portion **1540'** of the spine assembly **1500"** includes a pivot hole **1543** that defines the articulation axis B-B. An end effector mounting assembly **1250"** is attached to a proximal end **1103** of the elongate channel **1102** by a spring pin connector **1235** (FIG. **6**) that extends through a transverse mounting hole **1251** in the mounting assembly **1250"** to be received within the channel mounting holes **1106** (FIG. **6**) that are provided in the proximal end **1103** of the elongate channel **1102**. The surgical end effector mounting assembly **1250"** includes a mounting column **1253'** that extends upward from the mounting base **1252** to be received within the pivot hole **1543** in the spine assembly **1500"**. In this embodiment, the mounting column **1253'** may not be tapered.

[0458] This embodiment also includes a plurality of locking shoes **2112'**, **2114'**, **2116'** that are each fabricated from electrically activated polymer material (EAP). Such material, for example, may expand when it has been electrically excited. For example, electrical current may be applied to one or more of the locking shoes **2112'**, **2114'**, **2116'** by a conductor (not shown) that extends from the housing or handle arrangement or robotic control system, etc. Thus, once the surgical end effector **1100** has been articulated to a desired position, one or more of the locking shoes **2112'**, **2114'**, **2116'** are expanded by applying an electrical current thereto. In other arrangements, one or more of the locking shoes **2112'**, **2114'**, **2116'** may be configured to be pneumatically or hydraulically inflated. In other arrangements, the locking shoes **2112'**, **2114'**, **2116'** may not be expandable. In such arrangements, the mounting column **1253** may be fabricated from EAP and be selectively expandable by applying an electrical current thereto. In other arrangements, the mounting column **1253** may be selectively pneumatically or hydraulically expandable.

[0459] FIGS. **85-89** illustrate an alternative articulation lock arrangement **2210** for locking a surgical end effector **1100** in an articulated position about an articulation axis B-B relative to a shaft axis SA. In the illustrated example, the surgical end effector **1100** is pivotally coupled to a spine assembly **1500'**. The spine assembly **1500'** may be attached to the chassis **1800** (FIG. **4**) in the above described manner. A distal end portion **1540** of an upper portion **1539** of the spine assembly **1500'** is formed with a downwardly protruding articulation pin **1542** that defines the articulation axis B-B. The articulation pin **1542** is configured to be rotatably or pivotally received within a spine attachment hole **1254** that is provided in a mounting base **1252** of an end effector mounting assembly **1250"**. The end effector mounting assembly **1250"** is attached to a proximal end **1103** of the elongate channel **1102** by a spring pin connector **1235** (FIG. **6**) that extends through a transverse mounting hole **1251** in the mounting assembly **1250"** to be received within the channel mounting holes **1106** (FIG. **6**) that are provided in the proximal end **1103** of the elongate channel **1102**.

[0460] Referring to FIG. **85**, the illustrated arrangement employs two articulation links **1710**R' and **1710**L' to apply left and right articulation motions to the surgical end effector **1100**. In other examples, however, only one articulation link may be employed. In the illustrated arrangement, to articulate the surgical end effector **1100** to the right, the articulation link **1710**R' is axially retracted in the proximal direction PD and the articulation link **1710**L' is axially advanced in the distal direction DD. Conversely, to articulate the surgical end effector **1100** in the left direction, the articulation link **1710**L' is axially retracted in the proximal direction PD and

the articulation link **1710**R' is axially advanced in the distal direction DD. The articulation link **1710**R' has a slotted end portion **1711**R that is received on a right articulation pin **1266**R that is attached to the end effector mounting assembly **1250"**. Likewise, the articulation link **1710**L' has a slotted end portion **1711**L that is received on a left articulation pin **1266**L that is attached to the end effector mounting assembly **1250"**.

[0461] Still referring to FIG. **85**, the articulation lock arrangement **2210** in the illustrated embodiment includes a locking assembly **2220** that includes a distal end **2222** that has a right locking member or fork **2224** and a left locking member or fork **2228** protruding therefrom. The right locking member **2224** includes a right locking gear rack **2226** that is laterally adjacent to and in confronting relationship therewith a corresponding right articulation gear rack **1720** that is formed on a downwardly extending portion of the right articulation link **1710**R'. Similarly, the left locking member **2228** includes a left locking gear rack **2230** that is laterally adjacent to and in confronting relationship with a corresponding left articulation gear rack **1723** that is formed on a downwardly extending portion **1722** of the left articulation link **1710**L'. In an unactuated state, the right locking member **2224** and the left locking member **2228** are centrally located between the right articulation link **1710**R' and the left articulation link **1710**L' and are not in engagement therewith. As can also be seen in FIG. **85**, the locking assembly **2220** is supported between a lower distal spine portion **1550** and the upper spine portion **1539**. The lower distal spine portion **1550** includes an upwardly extending distal support pin **1554** that extends through a mounting hole **2223** in the distal end **2222** of the locking assembly **2220** to be received in a distal boss **1544** formed on the underside of the upper spine portion **1539**. See FIG. **86**. The lower distal spine portion **1550** further includes an upwardly extending proximal support pin **1556** that extends through a locking opening **2225** between the right and left locking members **2224**, **2228** to be received in a proximal boss **1546** formed on the underside of the upper spine portion **1539**.

[0462] In the illustrated arrangement, the articulation lock arrangement **2210** also includes an axially movable locking bar assembly **2240** that operably interfaces with an articulation transmission **2250** that is operably supported within the shaft assembly **1400'**. The locking bar assembly **2240** includes a locking wedge **2244** that is formed on a distal end **2242** thereof. The articulation transmission **2250** is configured to operably interface with the distal firing bar **1620** that is operably supported in the shaft assembly **1400'**. In this context, the distal firing bar **1620** may comprise a firing actuator.

[0463] Turning now to FIGS. **85-87**, in the illustrated arrangement, one form of the articulation transmission **2250** includes a firing rack **1624** that is formed on a portion of the distal firing bar **1620** and which is configured to operably engage a shifter drive rack **2254** that is formed on a shifter **2252**. A proximal end **2253** of the shifter **2252** is configured to operably interface with a lock bar coupler **2246** that is formed on the locking bar assembly **2240**. As can also be seen in FIGS. **85-87**, the shifter **2252** further includes a shifter driven rack **2256** that is in meshing engagement with an articulation pinion gear **2262** that is attached to an articulation sprocket gear **2260**. The articulation sprocket gear **2260** is rotatably supported within the shaft assembly **1400'** and is in meshing engagement with a right articulation drive rack **1724** that is formed on or attached to the right distal articulation link **1710**R' as well as in meshing engagement with a left articulation drive rack **1726** that is formed on or otherwise attached to the left distal articulation link **1710**L'.

[0464] Operation of the articulation transmission **2250** as well as the articulation lock arrangement **2210** will be explained with reference to FIGS. **87-89**. FIG. **87** illustrates the surgical end effector **1100** in an unarticulated position. The locking bar assembly **2240** is in its distal-most "unlocked position" wherein the locking wedge **2244** is received within the locking opening **2225** located between the right and left locking members **2224**, **2228**. The right and left locking members **2224**, **2228** are in their unactuated state and not in engagement with the right and left articulation links **1710**R', **1710**L'. Thus, the right locking gear rack **2226** on the right locking member **2224** is out of engagement with the right articulation gear rack **1720** on the right distal articulation link **1710**R' and the left locking gear rack **2230** is out of meshing engagement with the left articulation gear rack **1723** on the left distal articulation link **1710**L'. As such, the articulation lock arrangement **2210** is in an "unlocked" configuration. However, friction between the various components may keep the surgical end effector **1100** from flopping or rotating about the articulation axis B-B.

[0465] FIG. **88** illustrates initiation of the articulation process. As can be seen in FIG. **88**, the proximal end **2253** of the shifter **2252** is operably engaged with the lock bar coupler **2246** and the locking bar assembly **2240** is in the unlocked orientation. When the shifter **2252** is engaged with the locking bar assembly **2240** in this manner, the shifter drive rack **2254** is in meshing engagement with the firing rack **1624** on the distal firing bar **1620**. The articulation process is then initiated by axially moving the distal firing bar **1620**. In the example shown in FIG. **88**, the end effector **1100** is articulated about the articulation axis in the right direction RD by axially moving the distal firing bar **1620** in the proximal direction PD. Axial actuation of the distal firing bar **1620** in the proximal and distal directions has been discussed in detail herein. Because the lock bar coupler **2246** is retaining the shifter drive rack **2254** in meshing engagement with the firing rack **1624** on the distal firing bar **1620**, the shifter **2252** moves proximally with the distal firing bar **1620**. Movement of the shifter **2252** in the proximal direction PD, by virtue of the meshing engagement of the shifter driven rack **2256** with the articulation pinion gear **2262**, causes the articulation pinion gear **2262** and the articulation sprocket gear **2260** to rotate in the clockwise direction through an articulation actuation angle AAA. As the articulation sprocket gear **2260** rotates, the right distal articulation link **1710**R' is driven in the proximal direction PD and the left distal articulation link **1710**L' is driven in the distal direction DD which ultimately causes the surgical end effector to pivot about the articulation axis in the right direction RD. Once the surgical end effector **1100** has been articulated to the desired position, the user can lock the end effector **1100** in that articulated position by axially advancing the locking bar assembly **2240** in the proximal direction PD to cause the locking wedge **2244** to move proximally into driving contact with two actuation detents **2227**, **2229** formed on the right locking member **2224** and left locking member **2228**, respectively to laterally bias the right locking member **2224** and left locking member **2228** laterally outward into locking engagement with the right and left articu-

lation gear racks **1720**, **1723**, respectively. Such proximal movement of the locking bar assembly **2240** also serves to decouple the lock bar coupler **2246** from the shifter **2252** as shown in FIG. **89**.

[0466] As can be seen in FIG. **89**, when the shifter **2252** has been decoupled from the locking bar assembly **2240**, the shifter drive rack **2254** is no longer in meshing engagement with the firing rack **1624** on the distal firing bar **1620** and the shifter driven rack **2256** is no longer in meshing engagement with the articulation pinion gear **2262**. Thus, the distal firing bar **1620** can now be distally advanced to apply firing motions to the surgical end effector and then retracted in the proximal direction back to the starting position shown in FIG. **87**. Once the distal firing bar **1620** has returned to the starting position, the user may then distally advance the locking bar assembly **2240** so as to bring the lock bar coupler **2246** into operable engagement with the proximal end **2253** of the shifter **2252** and move the locking wedge **2244** back into its starting or unlocked position wherein the right locking member **2224** and the left locking member **2228** can spring back or otherwise return to their unlocked positions. The user may then apply axial motion to the distal firing bar **1620** in the appropriate axial direction to return the surgical end effector **1100** to its unarticulated position.

[0467] FIGS. **90-95** illustrate an alternative articulation lock arrangement **2310** for locking a surgical end effector **1100** in an articulated position about an articulation axis B-B relative to a shaft axis SA. In the illustrated example, the surgical end effector **1100** is pivotally coupled to a spine assembly **1500'**. The spine assembly **1500'** may be attached to the chassis **1800** (FIG. **4**) in the above-described manner. A distal end portion **1540** of an upper spine portion **1539** of the spine assembly **1500'** is formed with a downwardly protruding articulation pin **1542** that defines the articulation axis B-B. The articulation pin **1542** is configured to be rotatably or pivotally received within a spine attachment hole **1254** that is provided in a mounting base **1252** of an end effector mounting assembly **1250"**. The end effector mounting assembly **1250"** is attached to a proximal end **1103** of the elongate channel **1102** by a spring pin connector **1235** (FIG. **6**) that extends through a transverse mounting hole **1251** in the mounting assembly **1250"** to be received within the channel mounting holes **1106** (FIG. **6**) that are provided in the proximal end **1103** of the elongate channel **1102**.

[0468] Referring to FIG. **90**, the illustrated arrangement employs two articulation links **1710**R" and **1710**L" to apply right and left articulation motions to the surgical end effector **1100**. To articulate the surgical end effector **1100** to the right, the articulation link **1710**R" is axially retracted in the proximal direction PD and the articulation link **1710**L" is axially advanced in the distal direction DD. Conversely, to articulate the surgical end effector **1100** in the left direction, the articulation link **1710**L" is axially retracted in the proximal direction PD and the articulation link **1710**R" is axially advanced in the distal direction DD. The right distal articulation link **1710**R" has a slotted end portion **1711**R that is received on a right articulation pin **1266**R that is attached to the end effector mounting assembly **1250"**. Likewise, the left distal articulation link **1710**L" has a slotted end portion **1711**L that is received on a left articulation pin **1266**L that is attached to the end effector mounting assembly **1250"**.

[0469] Still referring to FIG. **90**, a right brake plate **2312** is formed on the right distal articulation link **1710**R" and a left brake plate **2320** is formed on the left distal articulation link **1710**L". As can also be seen in FIG. **90**, the right and left brake plates **2312**, **2320** are supported between a lower distal spine portion **1552'** and the upper spine portion **1539**. The lower distal spine portion **1552'** includes an upwardly extending distal support pin **1554** that is configured to be received in a distal boss (not shown) that is formed on the underside of the upper spine portion **1539**. In the illustrated arrangement, the articulation lock arrangement **2310** also includes an axially movable and lockable locking bar assembly **2340** that may operably interface with an articulation transmission of the type described herein or otherwise interface with a lock bar control arrangement (not shown) that is configured to apply axial control motions thereto in the distal direction DD and proximal direction PD. The locking bar assembly **2340** includes a locking clamp **2344** that is formed on a distal end **2342** thereof. The locking clamp **2344** extends through a right brake slot **2314** in the right brake plate **2312** and a left brake slot **2322** in the left brake plate **2320** as well as through an axial slot **2352** provided through a wedge plate **2350** to engage a clamp plate **2360**.

[0470] Operation of the articulation lock arrangement **2310** will be explained with reference to FIGS. **91-95**. FIG. **91** illustrates the surgical end effector **1100** in an unarticulated position. The locking bar assembly **2340** is in an unlocked position wherein the clamp portion **2344** is not applying any clamping force to the right and left brake plates **2312**, **2320**. Thus, the right distal articulation link **1710**R" and the left distal articulation link **1710**L" are free to move axially when articulation motions are applied thereto. Friction between the various components may keep the surgical end effector **1100** from flopping or rotating about the articulation axis B-B. FIG. **92** illustrates articulation of the surgical end effector **1100** in the left direction LD by axially moving the right distal articulation link **1710**R" in the distal direction DD and moving the left distal articulation link **1710**L" in the proximal direction PD. FIG. **93** illustrates the articulation lock arrangement **2310** in the unlocked configuration. FIGS. **94** and **95** illustrate the articulation lock arrangement **2310** in the locked configuration. The articulation lock arrangement **2310** is locked by applying an actuation motion to the locking bar assembly **2340** in the proximal direction. Such action causes the clamping portion thereof to clamp the right and left brake plates **2312**, **2320** to be retainingly clamped between the wedge plate **2350** and the lower distal spine portion **1552'**. Such arrangement serves to apply a clamping force CF between the clamping plate **2360** and the lower distal spine portion **1552'** to thereby prevent any further axial movement of the right distal articulation link **1710**R" and the left distal articulation link **1710**L".

[0471] FIGS. **96** and **97** illustrate an example of an articulation stroke multiplier transmission arrangement **2410** that may be employed with various articulation link arrangements disclosed herein. Turning first to FIG. **97**, a cross-sectional view is illustrated of a portion of a shaft assembly **1400"** that includes a proximal closure member **1410** as well as an upper intermediate spine segment **1510"** and a distal spine extension **1562"**. The intermediate spine segment **1510"** and a distal spine extension **1562"** serve to operably support a distal firing bar **1620** as well as the proximal firing shaft segment **1602** in the various manners disclosed herein. This embodiment includes an intermediate articulation link segment **1706** and a distal articulation link segment **1707**

that may interface with an end effector mounting assembly in any of the various ways disclosed herein. The intermediate articulation link **1706** may operably interface with an articulation lock **1210** in the various manners disclosed herein. As can be seen in FIG. **96**, the intermediate articulation link segment **1706** includes an intermediate or first gear rack **1708** formed thereon and the distal articulation link segment **1707** includes a second or distal gear rack **1709**. The gear racks **1708** and **1709** are in meshing engagement with at least one and preferably at least two multiplier pinion gear sets **2412** that are rotatably supported between an upper intermediate spine segment **1510"** and the distal spine extension **1562"**. See FIG. **97**. In the illustrated arrangement for example, each multiplier gear set **2412** comprises a smaller drive gear **2414** that is supported in meshing engagement with the first gear rack **1708** and a larger multiplier gear **2416** that is supported in meshing engagement with the distal gear rack **1709**.

[0472] FIGS. **98**A-**98**C illustrate operation of the articulation stroke multiplier transmission arrangement **2410**. FIG. **98**A illustrates the positions of the intermediate articulation link segment **1706** and a distal articulation link segment **1707** when in a neutral or unarticulated position. FIG. **98**B illustrates the positions of the intermediate articulation link segment **1706** and a distal articulation link segment **1707** after the intermediate articulation link segment **1706** has been axially advanced in the distal direction from the neutral position in FIG. **98**A a distance D_{1R}. As can also be seen in FIG. **98**B, the distal articulation link **1707** moved an axial distance D_{2R}. In the illustrated example, $D_{2R}>D_{1R}$. FIG. **98**C illustrates the positions of the intermediate articulation link segment **1706** and a distal articulation link segment **1707** after the intermediate articulation link segment **1706** has been axially advanced in the proximal direction PD from the neutral position illustrated in FIG. **98**A a distance D_{1L}. As can also be seen in FIG. **98**C, the distal articulation link **1707** moved an axial distance D_{2L}. In the illustrated example, $D_{2L}>D_{1L}$. Thus, such an arrangement enables additional axial articulation stroke to be gained and employed to articulate the end effector through greater ranges of articulation about the articulation axis.

[0473] FIGS. **99**A-**99**B illustrate an example of an articulation stroke multiplier transmission **2510** that may be employed with various articulation link arrangements disclosed herein. The articulation stroke multiplier **2510** operably interfaces with a proximal articulation driver **1700"** which may be identical to the proximal articulation driver **1700** except for the noted differences. In particular, the proximal articulation driver **1700"** includes a drive rack **1701** that is formed on the distal end thereof. The drive rack is configured to meshingly engage a gear segment **2522** that is formed on a swing gear **2520** that is pivotally pinned to a corresponding portion of the spine assembly. In the illustrated arrangement, the swing gear **2520** is pivotable about a swing gear axis that is transverse to the axial directions in which the proximal articulation driver **1700"** is configured to travel. The swing gear **2520** further includes a transfer slot **2524** that is configured to receive a transfer pin **1713** that is attached to a proximal end **1716** of an intermediate articulation link segment **1706"**. As can be seen in FIGS. **99**A-**99**B, the distal end of the intermediate articulation link segment **1706"** is configured to operably interface with an articulation lock **1210** in the various manners disclosed herein.

[0474] FIG. **99**A, illustrates the articulation stroke multiplier transmission **2510** in a neutral position wherein no articulation motion has been applied to the proximal articulation driver **1700"**. FIG. **99**B illustrates the position of the articulation stroke multiplier transmission **2510** after the proximal articulation driver **1700"** has been axially advanced in the distal direction DD a first axial distance D_1. Such movement of the proximal articulation driver **1700"** in the distal direction causes the swing gear **2520** to pivot in a clockwise direction CW about the swing gear axis. Such movement of the swing gear **2520** drives the intermediate articulation link segment **1706"** in the proximal direction a second axial distance D_2. In such example, $D_2>D_1$. FIGS. **99**C-**99**D illustrate a similar arrangement, except that the transfer slot **2524** is provided in the proximal end **1716** of the intermediate articulation link segment **1706"** and the transfer pin **1713** is provided in the swing gear **2520**.

EXAMPLES

Example 1

[0475] A surgical tool assembly comprising a surgical end effector movably coupled to a shaft assembly by an articulation joint. The articulation joint is configured to selectively facilitate selective articulation of the surgical end effector relative to the shaft assembly about an articulation axis. The articulation axis is transverse to a shaft axis that is defined by the shaft assembly. The shaft assembly comprises a proximal end, a distal end operably coupled to the articulation joint, and an elongate notch in the shaft assembly. The elongate notch is on one lateral side of the shaft axis and is located adjacent to the distal end.

Example 2

[0476] The surgical tool assembly of Example 1, wherein the articulation joint is configured to restrict articulation of the surgical end effector about the articulation axis to the one lateral side of the shaft axis.

Example 3

[0477] The surgical tool assembly of Examples 1 or 2, wherein the shaft assembly comprises a spine assembly and a proximal closure member. The spine assembly comprises a distal spine end operably coupled to the articulation joint. The proximal closure member is supported on the spine assembly for selective axial travel relative thereto. The elongate notch further comprises an elongate spine notch in the distal spine end on the one lateral side of the shaft axis and an elongate closure member notch in the proximal closure member on the one lateral side of the shaft axis and corresponding with the elongate spine notch.

Example 4

[0478] The surgical tool assembly of Example 3, wherein the surgical end effector comprises a first jaw operably coupled to the articulation joint and a second jaw supported for selective movable travel relative to the first jaw in response to closure motions applied thereto.

Example 5

[0479] The surgical tool assembly of Example 4, wherein the shaft assembly further comprises a distal closure mem-

ber movably coupled to the proximal closure member for selective axial travel therewith, the distal closure member operably interfacing with the second jaw to apply the closure motions thereto.

Example 6

[0480] The surgical tool assembly of Examples 1 or 2, wherein the surgical tool assembly further comprises means for preventing buckling of the distal end of the shaft assembly when an axial actuation motion is applied to the proximal end of the shaft assembly.

Example b **7**

[0481] The surgical tool assembly of Examples 3, 4, or 5, wherein the surgical tool assembly further comprises means for preventing buckling of the distal end of the shaft assembly when an axial actuation motion is applied to the proximal end of the shaft assembly.

Example 8

[0482] The surgical tool assembly of Example 7, wherein the means for preventing buckling comprises at least one alignment member protruding from the proximal closure member and extending into a corresponding axial slot in the spine assembly.

Example b **9**

[0483] The surgical tool assembly of Example 8, wherein the at least one alignment member comprises at least one first alignment member protruding from the proximal closure member at a first location and extending into a corresponding first axial slot in the spine assembly for axial travel therein and at least one second alignment member protruding from the proximal closure member at a second location that is diametrically opposed to the first location. The second alignment member extends into a corresponding second axial slot in the spine assembly.

Example 10

[0484] The surgical tool assembly of Examples 8 or 9, wherein at least one of the at least one alignment member has an L-shaped cross-sectional shape.

Example 11

[0485] A surgical tool assembly comprising a surgical end effector movably coupled to a shaft assembly by an articulation joint. The articulation joint is configured to facilitate selective articulation of the surgical end effector relative to the shaft assembly about an articulation axis. The articulation axis is transverse to a shaft axis that is defined by the shaft assembly. The shaft assembly comprises a proximal portion including an uninterrupted outer proximal perimeter and a distal portion extending from the proximal portion and operably coupled to the articulation joint. The distal portion includes a distal outer perimeter, which includes a discontinuous distal portion that is located on one lateral side of the shaft axis.

Example 12

[0486] The surgical tool assembly of Example 11, wherein the articulation joint is configured to restrict articulation of the surgical end effector about the articulation axis to the one lateral side of the shaft axis.

Example 13

[0487] The surgical tool assembly of Examples 11 or 12, wherein the shaft assembly comprises a spine assembly comprising a distal spine end operably coupled to the articulation joint and a proximal closure member supported on the spine assembly for selective axial travel relative thereto. The discontinuous distal portion comprises an elongate closure member notch in the proximal closure member on the one lateral side of the shaft axis.

Example 14

[0488] The surgical tool assembly of Example 13, wherein the surgical tool assembly further comprises an elongate closure member notch.

Example 15

[0489] The surgical tool assembly of Examples 13 or 14, wherein the surgical tool assembly further comprises means for preventing buckling of the distal end of the shaft assembly when an axial actuation motion is applied to the proximal portion of the shaft assembly.

Example 16

[0490] The surgical tool assembly of Example 15, wherein the means for preventing buckling comprises at least one alignment member protruding from the proximal closure member and extending into a corresponding axial slot in the spine assembly.

Example 17

[0491] The surgical tool assembly of Example 16, wherein the at least one alignment member comprises at least one first alignment member protruding from the proximal closure member at a first location and extending into a corresponding first axial slot in the spine assembly for axial travel therein and at least one second alignment member protruding from the proximal closure member at a second location that is diametrically opposed to the first location. The second alignment member extends into a corresponding second axial slot in the spine assembly.

Example 18

[0492] The surgical tool assembly of Examples 16 or 17, wherein at least one of the at least one alignment member has an L-shaped cross-sectional shape.

Example 19

[0493] The surgical tool assembly of Examples 11, 12, 13, 14, 15, 16, 17, or 18, wherein the distal portion includes a distal axial length. The proximal portion includes a proximal axial length, and the proximal axial length is greater than the distal axial length.

Example 20

[0494] A surgical tool assembly comprising a surgical end effector movably coupled to a shaft assembly by an articulation joint. The articulation joint is configured to facilitate selective articulation of the surgical end effector relative to the shaft assembly about an articulation axis. The articulation axis is transverse to a shaft axis that is defined by the shaft assembly. The shaft assembly comprises a proximal end, a distal end operably coupled to the articulation joint, an elongate notch, and an axially displaceable firing member axially aligned with the shaft axis. The elongate notch is in the shaft assembly on one lateral side of the shaft axis and located adjacent to the distal end.

Example 21

[0495] A surgical tool assembly comprising a shaft assembly, a surgical end effector, and a protective cap member. The shaft assembly comprises an axially movable closure member and an axially movable firing member selectively axially movable between an unfired position and a fired position. The surgical end effector comprises a first jaw and a second jaw comprising a mounting portion including a pair of mounting walls. The mounting walls are configured to movably engage a portion of the first jaw to movably support the second jaw on the first jaw. The mounting portion defines a cam area configured for engagement by the axially movable closure member to move the second jaw from an open position to a closed position relative to the first jaw. The mounting walls define an open topped parking area therebetween for accommodating the firing member therein when the firing member is in the unfired position. The protective cap member is attached to the mounting walls and covers at least a portion of the open topped parking area.

Example 22

[0496] The surgical tool assembly of Example 21, wherein each of the mounting walls are configured to pivotally engage corresponding portions of the first jaw to facilitate pivotal travel of the second jaw relative to the first jaw about a pivot axis.

Example 23

[0497] The surgical tool assembly of Example 22, wherein each of the mounting walls protrude proximally from the cam area. The protective cap comprises a transition portion configured to cover at least a portion of the open topped parking area proximal to the cam area and forming a pre-closure cam surface that is proximal to the cam area and at least one attachment portion extending from the transition portion to couple the protective cap to at least one of the mounting walls.

Example 24

[0498] The surgical tool assembly of Example 23, wherein the at least one attachment member comprises a first leg extending downward from the transition portion and being configured to retainingly engage a corresponding one of the mounting walls and a second leg extending downward from the transition portion and being configured to retainingly engage a corresponding another one of the mounting walls.

Example 25

[0499] The surgical tool assembly of Example 24, wherein the first and second legs are removably attachable to the mounting walls.

Example 26

[0500] The surgical tool assembly of Example 25, wherein the first leg comprises a first attachment opening configured to retainingly receive therein a first attachment lug formed on the corresponding one of the mounting walls. The second leg comprises a second attachment opening configured to retainingly receive therein a second attachment lug formed on the corresponding other one of the mounting walls.

Example 27

[0501] The surgical tool assembly of Examples 23, 24, 25, or 26, wherein the closure member comprises a distal camming surface configured to cammingly engage the pre-closure cam surface on the protective cap as well as the cam area on the mounting portion to move the second jaw from the open position to the closed position.

Example 28

[0502] The surgical tool assembly of Examples 22, 23, 24, 25, 26, or 27, wherein the surgical tool assembly further comprises means for biasing the second jaw to the open position.

Example 29

[0503] The surgical tool assembly of Example 28, wherein the surgical tool assembly further comprises means for preventing the second jaw from being opened beyond a maximum open position.

Example 30

[0504] The surgical tool assembly of Example 22, 23, 24, 25, 26, 27, 28, or 29, wherein the second jaw is configured to be selectively pivotal about a pivot axis relative to the first jaw, and wherein at least a portion of the open topped parking area is proximal to the pivot axis.

Example 31

[0505] The surgical tool assembly of Example 22, 23, 24, 25, 26, 27, 28, 29, or 30, wherein the second jaw comprises a pair of trunnions pivotally supported in the mounting walls.

Example 32

[0506] The surgical tool assembly of Example 31, wherein the pair of trunnions comprises a first trunnion configured to be pivotally supported in a first transverse pivot hole in a first one of the mounting walls and a second trunnion configured to be pivotally supported in a second transverse pivot hole in a second one of the mounting walls. The first and second trunnions define a pivot axis about which the second jaw is pivotable.

Example 33

[0507] The surgical tool assembly of Example 32, wherein the surgical tool assembly further comprises a first installa-

tion slot in the first one of the mounting walls and a second installation slot in the second one of the mounting walls. The first installation slot extends transversely to the first transverse pivot hole from a first top edge of the first one of the mounting walls to the first transverse pivot hole. The second installation slot extends transversely to second transverse pivot hole from a second top edge of said second one of said mounting walls to said second transverse pivot hole.

Example 34

[0508] A surgical tool assembly comprising a shaft assembly, a surgical end effector, and a protective cap member. The shaft assembly comprises an axially movable closure member and an axially movable firing member selectively axially movable between an unfired position and a fired position. The surgical end effector comprises an elongate channel configured to operably support a surgical staple cartridge therein and an anvil comprising an anvil mounting portion. The anvil mounting portion includes a pair of anvil mounting walls pivotally supported on the elongate channel for selective pivotal travel relative thereto about a pivot axis. The anvil mounting portion defines a cam area configured for engagement by the axially movable closure member to move the anvil from an open position to a closed position relative to the elongate channel. The anvil mounting walls define an open topped parking area therebetween for accommodating the firing member therein when the firing member is in the unfired position. The protective cap member is attached to the anvil mounting walls and covers at least a portion of the open topped parking area.

Example 35

[0509] The surgical tool assembly of Example 34, wherein at least a portion of the open topped parking area is proximal to the pivot axis.

Example 36

[0510] The surgical tool assembly of Example 34 or 35, wherein the firing member comprises a vertically extending firing body comprising a tissue cutting edge, top anvil engaging tabs, and bottom channel engaging tabs. The top anvil engaging tabs extend laterally from a top end of the firing body and are configured to engage the anvil as the firing member is axially advanced from the unfired position to the fired position. The bottom channel engaging tabs extend laterally from a bottom portion of the firing body and configured to engage the channel as the firing member is axially advanced from the unfired position to the fired position to retain an underside of the anvil a desired distance from a cartridge deck of a surgical staple cartridge supported in the elongate channel.

Example 37

[0511] The surgical tool assembly of Example 34, 35, or 36, wherein each of the mounting walls protrude proximally from the cam area. The protective cap comprises a transition portion configured to cover at least a portion of the open topped parking area proximal to the cam area and form a pre-closure cam surface that is proximal to the cam area and at least one attachment portion extending from the transition portion to couple the protective cap to at least one of the anvil mounting walls.

Example 38

[0512] The surgical tool assembly of Example 37, wherein the at least one attachment portion comprises a first leg extending downward from the transition portion and is configured to retainingly engage a corresponding one of the anvil mounting walls and a second leg extending downward from the transition portion and is configured to retainingly engage a corresponding another one of the anvil mounting walls.

Example 39

[0513] The surgical tool assembly of Example 34, 35, 36, 37, or 38, wherein the surgical tool assembly further comprises means for biasing the anvil to the open position when the closure member is in a starting position.

Example 40

[0514] A surgical tool assembly comprising a shaft assembly and a surgical end effector. The shaft assembly comprises an axially movable closure member and an axially movable firing member selectively axially movable between an unfired position and a fired position. The surgical end effector comprises a first jaw and a second jaw comprising a mounting portion. The mounting portion includes a pair of mounting walls configured to movably engage a portion of the first jaw to movably support the second jaw on the first jaw. The mounting portion defines a cam area configured for engagement by the axially movable closure member to move the second jaw from an open position to a closed position relative to the first jaw. The mounting walls define an open topped parking area therebetween for accommodating the firing member therein when the firing member is in the unfired position. The surgical tool assembly further comprises means for at least partially covering at least a portion of the open topped parking area and defining a pre-closure cam surface that is proximal to the cam area.

Example 41

[0515] A surgical tool assembly comprising a first jaw, a second jaw, and a shaft assembly. The second jaw is movably supported on the first jaw for selective movement relative to the first jaw between an open position and a closed position about a fixed pivot axis. The shaft assembly is configured to apply an initial closure motion to a cam surface on the second jaw in a first closure direction that is normal to the cam surface and an additional closure motion to the cam surface in a second closure direction that is parallel to the shaft axis as the closure member is axially advanced on the cam surface.

Example 42

[0516] The surgical tool assembly of Example 41, wherein the cam surface is formed on a second jaw mounting portion, and wherein the second jaw further comprises first and second mounting walls that are each pivotally attached to the first jaw for selective pivotal travel about the pivot axis.

Example 43

[0517] The surgical tool assembly of Example 41 or 42, wherein the axially movable closure member comprises a distal closure tube comprising a distal end surface and a

distal camming surface configured to cammingly engage the cam surface on the second jaw.

Example 44

[0518] The surgical tool assembly of Example 43, wherein the distal end surface is configured to apply the initial closure motion to the cam surface and the distal camming surface is configured to apply the additional closure motion to the cam surface.

Example 45

[0519] The surgical tool assembly of Example 44, wherein the distal end surface comprises a portion of a cross-sectional thickness of the closure tube and wherein the camming surface extends from the distal end surface and comprises another portion of the cross-sectional thickness of the closure tube.

Example 46

[0520] The surgical tool assembly of Example 45, wherein the closure tube comprises an outer surface, an inner surface, and a distal end defining the distal end surface. The distal camming surface extends from the distal end surface to the inner surface at an obtuse angle relative to the distal end surface.

Example 47

[0521] The surgical tool assembly of Example 42, wherein the shaft assembly further comprises an axially movable firing member selectively axially movable between the first and second mounting walls between a starting position and an ending position.

Example 48

[0522] The surgical tool assembly of Example 47, wherein at least a portion of the firing member is proximal to the cam surface when the firing member is in the starting position.

Example 49

[0523] A surgical tool assembly comprising an end effector and a shaft assembly. The end effector comprises an elongate channel configured to operably support a surgical staple cartridge therein and an anvil. The anvil comprises an anvil mounting portion movably supported on the elongate channel for selective movement relative to the elongate channel about a fixed pivot axis between an open position and closed positions. The shaft assembly defines a shaft axis and comprises an axially movable closure member that is configured to apply an initial closure motion to a cam surface on the anvil mounting portion in a first closure direction that is normal to the cam surface and an additional closure motion to the cam surface in a second closure direction that is parallel to the shaft axis as the closure member is axially advanced on the cam surface.

Example 50

[0524] The surgical tool assembly of Example 49, wherein the anvil further comprises first and second anvil mounting walls that are each pivotally attached to the elongate channel for selective pivotal travel about the pivot axis.

Example 51

[0525] The surgical tool assembly of Example 49 or 50, wherein the axially movable closure member comprises a distal closure tube comprising a distal end surface and a distal camming surface configured to cammingly engage the cam surface on the anvil mounting portion.

Example 52

[0526] The surgical tool assembly of Example 51, wherein the distal end surface is configured to apply the initial closure motion to the cam surface, and the distal camming surface is configured to apply the additional closure motion to the cam surface.

Example 53

[0527] The surgical tool assembly of Example 52, wherein the distal end surface comprises a portion of a cross-sectional thickness of the closure tube, and wherein the camming surface extends from the distal end surface and comprises another portion of the cross-sectional thickness of the closure tube.

Example 54

[0528] The surgical tool assembly of Example 50, wherein the shaft assembly further comprises an axially movable firing member that is selectively axially movable between the first and second anvil mounting walls between a starting position and an ending position.

Example 55

[0529] The surgical tool assembly of Example 54, wherein at least a portion of the firing member is proximal to the cam surface when the firing member is in the starting position.

Example 56

[0530] A surgical tool assembly comprising an end effector and a shaft assembly defining a shaft axis and comprising an axially movable closure member. The end effector comprises an elongate channel configured to operably support a surgical cartridge therein and an anvil movably comprising an anvil mounting portion supported on the elongate channel for selective movement relative to the elongate channel between an open position and a closed position. The surgical tool assembly further comprises first closure means on the closure member for applying an initial closure motion to a cam surface on the anvil mounting portion in a first closure direction that is normal to the cam surface and second closure means on the closure member for applying additional closure motion to the cam surface in a second closure direction that is parallel to the shaft axis as the closure member is axially advanced on the cam surface.

Example 57

[0531] The surgical tool assembly of Example 56, wherein the first closure means comprises a distal cam surface on a portion of a distal end of the closure member, and wherein the second closure means comprises a distal camming surface on another portion of the distal end and extending from the distal cam surface at an obtuse angle relative thereto.

Example 58

[0532] The surgical tool assembly of Example 56 or 57, wherein the cam surface is formed on an anvil mounting portion, and wherein the anvil further comprises first and second mounting walls that are each pivotally attached to the elongate channel for selective pivotal travel about the pivot axis.

Example 59

[0533] The surgical tool assembly of Example 58, wherein the shaft assembly further comprises an axially movable firing member selectively axially movable between the first and second mounting walls between a starting position and an ending position.

Example 60

[0534] The surgical tool assembly of Example 59, wherein at least a portion of the firing member is proximal to the cam surface when the firing member is in the starting position.

Example 61

[0535] A surgical tool assembly comprising a surgical end effector and a closure member axially movable in response to closing and opening motions applied thereto. The surgical end effector comprises a first jaw and a second jaw comprising a second jaw body portion and a second jaw mounting portion. The second jaw mounting portion is movably coupled to the first jaw for selective movement relative thereto between an open position and closed positions. The closure member comprises at least one opening cam formed thereon, and the at least one opening cam is configured to movably engage a corresponding cam surface formed on the second jaw body portion such that upon application of the opening motion to the closure member, the at least one opening cam movably engages the corresponding cam surface to move the second jaw to the open position. Upon application of the closure motion to the closure member, the closure member engages the second jaw to move the second jaw to one of the closed positions.

Example 62

[0536] The surgical tool assembly of Example 61, wherein the at least one opening cam comprises a first hook portion extending distally from a distal end of the closure member and being configured to cammingly engage a first one of the cam surfaces formed on the second jaw body portion and a second hook portion extending distally from the distal end of the closure member and being configured to cammingly engage a second one of the cam surfaces formed on the second jaw body portion.

Example 63

[0537] The surgical tool assembly of Example 61 or 62, wherein the cam surface comprises a downwardly extending ramp surface formed on the second jaw body portion.

Example 64

[0538] The surgical tool assembly of Example 63, wherein each of the at least one opening cam comprises a camming end formed thereon configured to cammingly engage the corresponding ramp surface upon application of the opening motion to the closure member.

Example 65

[0539] The surgical tool assembly of Example 64, wherein each ramp surface comprises a ramp surface end, and wherein each camming end is configured to engage the ramp surface end of the corresponding ramp surface to retain the second jaw in a fully open position relative to the first jaw.

Example 66

[0540] The surgical tool assembly of Example 61, 62, 63, 64, or 65, wherein the surgical tool assembly further comprises secondary jaw opening means for applying additional opening motion to the second jaw.

Example 67

[0541] The surgical tool assembly of Example 66, wherein the secondary jaw opening means comprises at least one secondary jaw opening member on the closure member configured to engage a corresponding jaw opening feature on the second jaw to apply the additional opening motion to the second jaw as the opening motion is applied to the closure member.

Example 68

[0542] The surgical tool assembly of Example 67, wherein the secondary jaw opening feature comprises at least one first jaw opening tab integrally formed in the closure member and configured to contact a corresponding one of the corresponding jaw opening feature and at least one second jaw opening tab integrally formed in the closure member and configured to contact another corresponding one of the corresponding jaw opening feature.

Example 69

[0543] The surgical tool assembly of Example 66, 67, or 68, wherein the secondary jaw opening means comprises at least one biasing member configured to apply additional opening motion to the second jaw.

Example 70

[0544] The surgical tool assembly of Example 62, 63, 64, 65, 66, 67, 68, or 69, wherein the first and second hook portions each comprise a compliant portion thereon.

Example 71

[0545] The surgical tool assembly of Example 70, wherein the compliant portion comprises a compliant material attached to each of the first and second hook portions.

Example 72

[0546] The surgical tool assembly of Example 70 or 71, wherein the at least one biasing member comprises a spring corresponding to each of the first and second hook portions and being attached thereto.

Example 73

[0547] A surgical tool assembly comprising a surgical end effector and a closure member axially movable in response to closing and opening motions applied thereto. The surgical

end effector comprises an elongate channel configured to operably support a surgical staple cartridge therein and an anvil comprising an anvil body and an anvil mounting portion, the anvil mounting portion pivotally supported on the elongate channel for selective movement relative thereto between an open position and closed positions. The closure member comprises at least one opening cam formed thereon, wherein the at least one opening cam is configured to movably engage a corresponding cam surface formed on the anvil body portion such that upon application of the opening motion to the closure member. The at least one opening cam movably engages the corresponding cam surface to move the anvil to the open position and upon application of the closure motion to the closure member, the closure member engages the anvil to move the anvil to one of the closed positions.

Example 74

[0548] The surgical tool assembly of Example 73, wherein the surgical tool assembly further comprises at least one tissue stop formed on the anvil body and wherein the at least one cam surface is located proximal to the at least one tissue stop.

Example 75

[0549] The surgical tool assembly of Example 73 or 74, wherein the at least one opening cam comprises a first hook portion extending distally from a distal end of the closure member and being configured to cammingly engage a first one of the cam surfaces formed on the anvil body and a second hook portion extending distally from the distal end of the closure member and being configured to cammingly engage a second one of the cam surfaces formed on the anvil body.

Example 76

[0550] The surgical tool assembly of Example 75, wherein the first and second hook portions each comprise a compliant portion thereon.

Example 77

[0551] The surgical tool assembly of Example 73 or 74, wherein the first and second hook portions each comprise a compliant portion thereon.

Example 78

[0552] The surgical tool assembly of Example 73, 74, 75, 76, or 77, wherein the surgical tool assembly further comprises secondary anvil opening means for applying additional opening motion to the second jaw.

Example 79

[0553] The surgical tool assembly of Example 78, wherein the anvil is pivotally coupled to the elongate channel for selective pivotal travel between the open and closed positions about a pivot axis. The secondary anvil opening means is located proximal to the pivot axis.

Example 80

[0554] A surgical tool assembly comprising a surgical end effector and a closure member. The surgical end effector comprises an elongate channel configured to operably support a surgical staple cartridge therein and an anvil comprising an anvil body and an anvil mounting portion. The anvil mounting portion is pivotally supported on the elongate channel for selective movement relative thereto between an open position and closed positions. The closure member is axially movable between a fully actuated position corresponding to a fully closed one of the closed positions and an unactuated position corresponding to the open position. The closure member comprises a closure system configured to sequentially apply initial opening motions to the anvil and additional secondary motions to the anvil as the closure member is moved from the fully actuated position to the unactuated position.

Example 81

[0555] A surgical end effector comprising a first jaw configured to operably support a surgical staple cartridge therein, a second jaw movably supported relative to the first jaw for selective movement between open and closed positions, a firing member, and a firing member lockout system. The firing member is supported for axial movement within the first jaw along a shaft axis between a starting position and an ending position upon applications of firing and retraction motions thereto. The firing member lockout system is movable by second jaw between an unactuated position and a locking position wherein when the firing member is initially distally advanced from the starting position, the firing member lockingly engages the firing member lockout system to prevent further distal advancement of the firing member unless an unfired surgical staple cartridge comprising a cam assembly that is located in an unfired position is supported within the first jaw.

Example 82

[0556] The surgical end effector of Example 81, wherein the firing member lockout system comprises a lock member mounted to the first jaw.

Example 83

[0557] The surgical end effector of Example 82, wherein the lock member further comprises a spring tab configured to support the lock member on the first jaw and bias the lock member into the unlocked position.

Example 84

[0558] The surgical end effector of Example 82 or 83, wherein the lock member comprises at least one laterally movable locking portion configured to lockingly engage a portion of the firing member upon the initial distal advancement of the firing member when the second jaw is in the closed position unless the unfired surgical staple cartridge is supported within the first jaw.

Example 85

[0559] The surgical end effector of Example 84, wherein the firing member comprises a firing member body comprising a lock protrusion that corresponds to each of the laterally movable locking portions, each lock protrusion oriented for locking engagement with the corresponding laterally movable locking portion upon the initial distal advancement of the firing member when the second jaw is

in the closed position unless the unfired surgical staple cartridge is supported within the first jaw.

Example 86

[0560] The surgical end effector of Example 85, wherein the cam assembly comprises an unlocking feature corresponding to each laterally movable locking portion to laterally bias each of the corresponding laterally movable locking portions out of locking engagement with the corresponding lock protrusion when the unfired surgical staple cartridge is supported in the first jaw and the cam assembly thereof is in the unfired position.

Example 87

[0561] The surgical end effector of Example 85 or 86, wherein each of the laterally movable locking portions comprises a locking window configured to lockingly receive a portion of the corresponding lock protrusion when the laterally movable locking portion is in the locking engagement with the corresponding lock protrusion.

Example 88

[0562] The surgical end effector of Example 81, 82, 83, 84, 85, 86, or 87, wherein the firing member lockout system comprises at least one lock member movably coupled to said second jaw for travel along a corresponding lock axis that is transverse to said shaft axis when said anvil is in said closed position.

Example 89

[0563] The surgical end effector of Example 81, 82, 83, 84, 85, 86, 87, or 88, wherein the firing member lockout system comprises a locking member movably supported for travel between the unlocked position and the locking position wherein upon the initial distal advancement of the firing member, at least a portion of the locking member is configured to hookingly engage a corresponding portion of the firing member to prevent the firing member from being advanced from the starting position to the ending position.

Example 90

[0564] A surgical end effector comprising an elongate channel configured to operably support a surgical staple cartridge therein, an anvil supported relative to the elongate channel such that the anvil is selectively movable relative to the elongate channel between open and closed positions, a firing member, and a firing member lockout system. The firing member is supported for axial movement within the elongate channel along a shaft axis between a starting position and an ending position upon applications of firing and retraction motions thereto. The firing member lockout system is movably by the anvil between an unactuated position and a locking position, wherein when the firing member is initially distally advanced from the starting position, the firing member lockingly engages the firing member lockout system to prevent further distal advancement of the firing member unless an unfired surgical staple cartridge comprising a cam assembly that is located in an unfired position is supported within the elongate channel. The firing member lockout system is configured to be moved from the unactuated position to the locking position when the anvil is moved to the closed position.

Example 91

[0565] The surgical end effector of Example 90, wherein the firing member lockout system comprises a lock member. The lock member comprises a pair of laterally movable locking portions, a mounting portion configured to support the lock member on the surgical end effector and bias the lock member into the unactuated position, and at least one anvil tab on the lock member for contact by a corresponding portion of the anvil as the anvil is moved to the closed position.

Example 92

[0566] The surgical end effector of Example 91, wherein each laterally movable locking portion comprises a locking window configured to retainingly engage a corresponding portion of the firing member when the lock member is in the locking position unless an unfired surgical staple cartridge is supported within the elongate channel.

Example 93

[0567] The surgical end effector of Example 92, wherein each corresponding portion of the firing member comprises a laterally protruding lock lug corresponding to each of the lock windows of the corresponding laterally movable locking portions and sized to be retainingly received therein in locking engagement therewith when the lock member is in the locking position unless an unfired surgical staple cartridge comprising a cam assembly that is located in an unfired position is supported within the elongate channel.

Example 94

[0568] The surgical end effector of Example 93, wherein the cam assembly comprises an unlocking feature corresponding to each laterally movable locking portion to laterally bias each of the corresponding laterally movable locking portions out of locking engagement with the corresponding lock lug when the unfired surgical staple cartridge is supported in the elongate channel and the cam assembly thereof is in the unfired position.

Example 95

[0569] The surgical end effector of Example 90, 91, 92, 93, or 94, wherein the firing member lockout system comprises at least one lock member and wherein the anvil comprises an anvil body and an anvil mounting portion comprising a pair of spaced anvil mounting walls, each anvil mounting wall being pivotally supported on the elongate channel, and wherein each anvil mounting wall movably supports a corresponding one of the lock members therein.

Example 96

[0570] The surgical end effector of Example 90, 91, 92, 93, 94, or 95, wherein the firing member lockout system comprises at least one lock member movably coupled to the anvil for travel along a corresponding lock axis that is transverse to the shaft axis when the anvil is in the closed position.

Example 97

[0571] The surgical end effector of Example 90, 91, 92, 93, 94, 95, or 96, wherein the surgical end effector further comprises a tissue cutting surface on the firing member.

Example 98

[0572] A surgical instrument comprising an elongate shaft defining a shaft axis, an elongate channel operably coupled to the elongate shaft and being configured to operably support a surgical staple cartridge therein, and an anvil supported relative to the elongate channel such that the anvil is selectively movable relative to the elongate channel between open and closed positions. The surgical instrument further comprises a firing member supported for axial travel within the elongate channel between a starting position and an ending position upon applications of firing and retraction motions thereto and means for preventing the firing member from moving from the starting to the ending position unless the anvil is in the closed position and an unfired surgical staple cartridge comprising a cam assembly that is located in an unfired position is supported within the elongate channel.

Example 99

[0573] The surgical instrument of Example 98, wherein the anvil comprises an anvil body and a pair of anvil mounting walls extending from the anvil body portion. Each anvil mounting wall is pivotally coupled to the elongate channel such that the anvil is selectively movable relative to the elongate channel between the open and closed positions upon application of closing and opening motions to the anvil by a closure portion of the elongate shaft assembly.

Example 100

[0574] The surgical instrument of Example 98 or 99, wherein the means for preventing comprises a locking member movably supported for travel between the unlocked position and the locked position, wherein at least a portion is configured to hookingly engage a corresponding portion of the firing member to prevent the firing member from being advanced from the starting position to the ending position and means for biasing the firing member to the unlocked position.

Example 101

[0575] A surgical instrument comprising a surgical end effector, an elongate shaft defining a shaft axis, a closure member, and an articulation joint. The surgical end effector comprises a first jaw and a second just movably supported on the first jaw for selective travel between open and closed positions relative to the first jaw. The closure member is movably supported on the elongate shaft and is configured to selectively move in a closing direction from an open position to closed positions and in an opening direction from the closed positions to the open position. The articulation joint couples the surgical end effector to the elongate shaft such that the surgical end effector is selectively articulatable relative thereto about an articulation axis that is transverse to the shaft axis. The articulation joint comprises an articulation lock arrangement configured to move from a locked configuration, wherein the surgical end effector is prevented from articulating about the articulation axis and an unlocked configuration wherein the surgical end effector is articulatable about the articulation axis. The articulation lock arrangement moves from the locked configuration to the unlocked configuration when the closure member is moved from the open position in the closing direction. The surgical instrument further comprises means for applying an articulation motion to the surgical end effector when the articulation lock arrangement is in the unlocked configuration.

Example 102

[0576] The surgical instrument of Example 101, wherein the articulation lock arrangement comprises at least one locking member movable between a first position corresponding to the unlocked configuration and a second position wherein the at least one locking member is in frictional engagement with a mounting portion of the surgical end effector and a distal end portion of the elongate shaft. The at least one locking member operably interfaces with the closure member such that the initial movement of the closure member in the closing direction causes the at least one locking member to move from the first position to the second position.

Example 103

[0577] The surgical instrument of Example 102, wherein the mounting portion of the surgical end effector comprises an upstanding mounting column including a plurality of column sides, and wherein the at least one locking member comprises a locking member corresponding to each of the column sides.

Example 104

[0578] The surgical instrument of Example 103, wherein the distal end portion of the elongate shaft comprises a pivot hole that defines the articulation axis, and wherein the upstanding mounting column extends into the pivot hole such that each of the locking members is movably supported within the pivot hole between the corresponding column side and an internal wall of the pivot hole.

Example 105

[0579] The surgical instrument of Example 104, wherein the upstanding mounting column is configured to move the plurality of locking members into frictional engagement with the internal wall of the pivot hole and the corresponding column side when the closure member is moved in the closing direction.

Example 106

[0580] The surgical instrument of Example 105, wherein the closure member comprises a proximal closure member interfacing with a source of closing and opening motions to move the proximal closure member in the closing and opening directions and a distal closure member pivotally coupled to the proximal closure member by a linkage arrangement, wherein a portion of the linkage arrangement is configured to interface with the upstanding mounting column so as to cause the upstanding mounting column to move the plurality of locking members into frictional engagement with the internal wall of the pivot hole and the corresponding column sidewalls when the closure member is initially moved in the closing direction.

Example 107

[0581] The surgical instrument of Example 106, wherein the linkage arrangement comprises an upper double pivot link pivotally coupled to the proximal closure member and the distal closure member and extending therebetween and a lower double pivot link pivotally coupled to the proximal closure member and the distal closure member and extending therebetween. The lower double pivot link is configured to operably interface with the upstanding mounting column to apply a locking motion thereto when the lower double pivot link is initially moved in the closing direction.

Example 108

[0582] The surgical instrument of Example 107, wherein the upstanding mounting column comprises a first end portion attached to a mounting based adjacent the lower double pivot link, the upstanding column tapering to a free end, wherein a cross-sectional area of the free end is smaller than another cross-sectional area of the first end portion of the column.

Example 109

[0583] The surgical instrument of Example 101, 102, 103, 104, 105, 106, 107, or 108, wherein the first jaw comprises an elongate channel configured to operably support a surgical staple cartridge therein and wherein the second jaw comprises an anvil.

Example 110

[0584] The surgical instrument of Example 101, 102, 103, 104, 105, 106, 107, 108, or 109, wherein the means for applying an articulation motion to the surgical end effector comprises means for applying a first articulation motion to the surgical end effector to cause the surgical end effector to articulate about the articulation axis in a first articulation direction and means for applying a second articulation motion to the surgical end effector to cause the surgical end effector to articulate about the articulation axis in a second articulation direction.

Example 111

[0585] A surgical instrument comprising an elongate shaft comprising a distal end portion and defining a shaft axis, a surgical end effector, an articulation lock arrangement, and an articulation member. The surgical end effector comprises an end effector mounting portion, wherein one of the distal end portion of the elongate shaft and the end effector mounting portion comprises a pivot hole and the other of the distal end portion of the elongate shaft and the end effector mounting portion defines an articulation pin pivotally received within the pivot hole and defining an articulation axis that is transverse to the shaft axis about which the surgical end effector is articulatable relative to the elongate shaft upon application of articulation motions to the surgical end effector. The articulation lock arrangement is supported within the pivot hole between the articulation pin and an inner wall of the pivot hole. The articulation lock arrangement is movable from a first locked configuration wherein the articulation lock arrangement frictionally engages the articulation pin and the inner wall of the pivot hole to prevent relative pivotal travel of the articulation pin and the distal end portion of the elongate shaft and an unlocked configuration wherein the articulation pin and the distal end portion are pivotable relative to each other. The articulation member interfaces with the surgical end effector such that actuation of the articulation member causes the articulation member to apply the articulation motions to the surgical end effector. The articulation member interfaces with the articulation lock arrangement such that an initial actuation of the articulation member causes the articulation lock arrangement to move from the locked configuration to the unlocked configuration and upon deactivation of the articulation member, the articulation lock arrangement moves from the unlocked configuration to the locked configuration.

Example 112

[0586] The surgical instrument of Example 111, wherein the articulation lock arrangement comprises a torsion spring supported between the articulation pin and the inner wall of the pivot hole.

Example 113

[0587] The surgical instrument of Example 112, wherein the torsion spring is rotatable from a first position wherein the torsion spring frictionally engages the articulation pin and the inner wall of the pivot hole to prevent relative pivotal travel of the distal end portion of the elongate shaft and the surgical end effector and positions wherein the torsion spring does not prevent the relative pivotal travel.

Example 114

[0588] The surgical instrument of Example 111, 112, or 113, wherein the articulation lock arrangement comprises at least one locking ball movably supported between the articulation pin and the inner wall of the pivot hole between a first position, wherein each locking ball frictionally engages the articulation pin and the inner wall of the pivot hole to prevent relative pivotal travel of the distal end portion of the elongate shaft and the surgical end effector and positions wherein each said locking ball does not prevent said relative pivotal travel.

Example 115

[0589] The surgical instrument of Example 111, 112, 113, or 114, wherein the surgical end effector comprises a first jaw and a second jaw supported for movable travel relative to the first jaw.

Example 116

[0590] The surgical instrument of Example 115, wherein the first jaw comprises an elongate channel configured to operably support a surgical staple cartridge therein and wherein the second jaw comprises an anvil.

Example 117

[0591] The surgical instrument of Example 111, 112, 113, 114, 115, or 116, wherein the articulation member comprises an axially movable articulation member that is pivotally linked to the surgical end effector such that axial movement thereof in a first axial direction causes the surgical end effector to articulate in a first articulation direction about the articulation axis and movement of the axially movable articulation member in a second axial direction causes the

surgical end effector to articulate in a second articulation direction about the articulation axis.

Example 118

[0592] A surgical instrument comprising a surgical end effector, an elongate shaft defining a shaft axis, closure means, and an articulation joint. The surgical end effector comprises a first jaw movably coupled to the elongate shaft for selective articulation relative thereto about an articulation axis that is transverse to the shaft axis and a second jaw movably supported on the first jaw for selective travel between open and closed positions relative to the first jaw. The closure means selectively moves the second jaw from the open position to the closed positions, the closure means being further configured to selectively move the second jaw from the closed positions to the open position. The articulation joint couples the surgical end effector to the elongate shaft such that the surgical end effector is selectively articulatable relative thereto about an articulation axis that is transverse to the shaft axis. The articulation joint comprises an articulation lock arrangement configured to move from a locked configuration, wherein the surgical end effector is prevented from articulating about the articulation axis and an unlocked configuration wherein the surgical end effector is articulatable about the articulation axis. The articulation lock arrangement moves from the locked configuration to the unlocked configuration when the closure means moves the second jaw from the open position towards the closed positions. The surgical instrument further comprises means for applying an articulation motion to the surgical end effector when the articulation lock arrangement is in the unlocked configuration.

Example 119

[0593] The surgical instrument of Example 118, wherein the first jaw comprises an elongate channel configured to operably support a surgical staple cartridge therein and wherein the second jaw comprises an anvil.

Example 120

[0594] The surgical instrument of Example 119 or 120, wherein the articulation lock arrangement comprises at least one locking member movable between a first position corresponding to the unlocked configuration and a second position wherein the at least one locking member is in frictional engagement with a mounting portion of the first jaw and a distal end portion of the elongate shaft. The at least one locking member operably interfaces with the closure member such that the initial movement of the closure member in the closing direction causes the at least one locking member to move from the first position to the second position.

Example 121

[0595] A surgical instrument comprising an elongate shaft defining a shaft axis, a surgical end effector, at least one articulation link, and an articulation lock arrangement. The surgical end effector is coupled to the elongate shaft for selective articulation relative to the elongate shaft about an articulation axis that is transverse to the shaft axis. The at least one articulation link operably interfaces with a source of articulation motions and is coupled to the surgical end effector for applying the articulation motions thereto. The articulation lock arrangement comprises an articulation lock member corresponding to each articulation link, each articulation lock member is configured to laterally move into locking engagement with the corresponding articulation link from an unlocked position that is laterally adjacent to the corresponding articulation link. The surgical instrument further comprises actuation means operably interfacing with each of the articulation lock members to selectively laterally move each articulation lock member from the unlocked position into locking engagement with the corresponding articulation link.

Example 122

[0596] The surgical instrument of Example 121, wherein each at least one articulation link comprises an articulation gear rack, and wherein the articulation lock member corresponding thereto comprises a locking gear rack corresponding to each articulation gear rack and is oriented relative thereto in a lateral confronting relationship for the meshing engagement therewith when the corresponding articulation lock member is laterally advanced toward the articulation link.

Example 123

[0597] The surgical instrument of Example 121 or 122, wherein the at least one articulation link comprises an axially movable right articulation link including a right articulation gear rack thereon and an axially movable left articulation link including a left articulation gear rack thereon. The articulation lock member comprises a right articulation lock member including a right locking gear rack that is in lateral confronting relationship with the right articulation gear rack for meshing engagement therewith when the right articulation lock member is laterally advanced toward the right articulation link and a left articulation lock member including a left locking gear rack that is in lateral confronting relationship with the left articulation gear rack for meshing engagement therewith when the left articulation lock member is laterally advanced toward the left articulation link.

Example 124

[0598] The surgical instrument of Example 123, wherein the actuation means comprises a locking actuator movably positioned relative to the right articulation lock member and the left articulation lock member such that axial movement of the locking actuator in a first axial direction causes the right articulation lock member to move laterally toward the right articulation link so as to bring the right locking gear rack into locking engagement with the right articulation gear rack and the left articulation lock member to move laterally toward the left articulation link so as to bring the left locking gear rack into locking engagement with the left articulation gear rack.

Example 125

[0599] The surgical instrument of Example 121, 122, 123, or 124, wherein the source of articulations motions comprises an axially movable firing actuator configured to selectively apply firing motions to a corresponding portion of the surgical end effector and an articulation transmission operably interfacing with the axially movable firing actuator and the at least one articulation link such that actuation of

the axially movable firing actuator in a first axial firing direction moves the at least one articulation link in a first axial articulation direction and movement of the axially movable firing actuator in a second axial retraction direction moves the at least one articulation link in a second axial articulation direction.

Example 126

[0600] The surgical instrument of Example 123 or 124, wherein the source of articulation motions comprises an axially movable firing actuator configured to selectively apply firing motions to a corresponding portion of the surgical end effector and an articulation transmission operably interfacing with the right and left articulation links and the axially movable firing member such that actuation of the axially movable firing actuator in a first axial firing direction moves the right articulation link in the first axial direction and the left articulation link in a second axial direction and movement of the axially movable firing actuator in the second axial direction moves the right articulation link in the second axial direction and the left articulation link in the first axial direction.

Example 127

[0601] The surgical instrument of Example 126, wherein the articulation lock arrangement further comprises a locking actuator movably positioned relative to the right articulation lock member and the left articulation lock member such that axial movement of the locking actuator in the first axial direction causes the right articulation lock member to move laterally toward the right articulation link so as to bring the right locking gear rack into locking engagement with the right articulation gear rack and the left articulation lock member to move laterally toward the left articulation link so as to bring the left locking gear into locking engagement with the left articulation gear rack.

Example 128

[0602] The surgical instrument of Example 127, wherein the articulation transmission comprises a gear assembly in meshing engagement with the right and left articulation links and a shifter configured for selective meshing engagement with the gear assembly and the axially movable firing actuator. The shifter is configured for selective operable engagement with the locking actuator such that when the shifter is in operable engagement with the locking actuator, the shifter is moved into meshing engagement with the axially movable firing actuator and the gear assembly and movement of the shifter out of operable engagement with the locking actuator also moves the shifter out of meshing engagement with the gear assembly and the axially movable firing actuator.

Example 129

[0603] The surgical instrument of Example 125, wherein the corresponding portion of the surgical end effector comprises a firing member attached to the axially movable firing actuator. The firing member is supported for axial travel through the surgical end effector between a starting and ending position therein.

Example 130

[0604] A surgical instrument comprising an elongate shaft defining a shaft axis, a surgical end effector, a firing actuator, at least one articulation link configured for selective operable engagement with the firing actuator, and an articulation lock arrangement. The surgical end effector is coupled to the elongate shaft for selective articulation relative to the elongate shaft about an articulation axis that is transverse to the shaft axis. The firing actuator is selectively axially movable in first and second axial directions to apply firing motions to a firing member operably supported in the surgical end effector. Axial movement of the firing actuator is transmitted to each of the at least one articulation links. The articulation lock arrangement is configured to laterally move between a locked configuration, wherein each of the at least one articulation links are non-movably locked in position and an unlocked configuration, and wherein each of the at least one articulation links are movable in response to movement of the firing actuator. The articulation lock arrangement interfaces with the firing actuator such that when the articulation lock arrangement is in the unlocked configuration, the firing actuator is in operable engagement with each of the at least one articulation links and when the articulation lock arrangement is in the locked configuration, each of the at least one articulation links is prevented from operable engagement with the firing actuator.

Example 131

[0605] The surgical instrument of Example 130, wherein the articulation lock arrangement comprises an articulation lock member corresponding to each articulation link. Each articulation lock member is configured to laterally move into locking engagement with the corresponding articulation link from an unlocked position that is laterally adjacent to the corresponding articulation link.

Example 132

[0606] The surgical instrument of Example 131, wherein each of the at least one articulation link comprises an articulation gear rack and wherein each corresponding articulation lock member comprises a locking gear rack oriented relative to the articulation gear rack of the corresponding articulation link in lateral confronting relationship relative thereto for meshing engagement therewith when the articulation lock member is laterally advanced toward the corresponding articulation link.

Example 133

[0607] The surgical instrument of Example 132, wherein the at least one articulation link comprises an axially movable right articulation link including a right articulation gear rack thereon and an axially movable left articulation link including a left articulation gear rack thereon. The articulation lock member comprises a right articulation lock member including a right locking gear rack that is in lateral confronting relationship with the right articulation gear rack for meshing engagement therewith when the right articulation lock member is laterally advanced toward the right articulation link and a left articulation lock member including a left locking gear rack that is in lateral confronting relationship with the left articulation gear rack for meshing

engagement therewith when the left articulation lock member is laterally advanced toward the left articulation link.

Example 134

[0608] The surgical instrument of Example 130, 131, 132, or 133, wherein the surgical end effector comprises a firing member coupled to the firing actuator and supported for axial travel through the surgical end effector.

Example 135

[0609] The surgical instrument of Example 134, wherein the surgical end effector comprises an elongate channel configured to operably support a surgical staple cartridge therein and an anvil movably supported on the elongate channel for selective movement between open and closed positions. The elongate channel is coupled to the elongate shaft for selective articulation relative thereto about the articulation axis. The firing member comprises a tissue cutting feature.

Example 136

[0610] The surgical instrument of Example 133, wherein the surgical instrument further comprises an articulation transmission operably interfacing with the right and left articulation links and the axially movable firing actuator such that actuation of the axially movable firing actuator in a first axial firing direction moves the right articulation link in the first axial direction and the left articulation link in a second axial direction and movement of the axially movable firing actuator in the second axial direction moves the right articulation link in the second axial direction and the left articulation link in the first axial direction.

Example 137

[0611] The surgical instrument of Example 133 or 136, wherein the articulation lock arrangement further comprises a locking actuator movably positioned relative to the right articulation lock member and the left articulation lock member such that axial movement of the locking actuator in a first axial direction causes the right articulation lock member to move laterally toward the right articulation link so as to bring the right locking gear rack into locking engagement with the right articulation gear rack and the left articulation lock member to move laterally toward the left articulation link so as to bring the left locking gear into locking engagement with the left articulation gear rack.

Example 138

[0612] The surgical instrument of Example 136, wherein the articulation transmission comprises a gear assembly in meshing engagement with the right and left articulation links and a shifter configured for selective meshing engagement with the gear assembly and the axially movable firing actuator. The shifter is configured for selective operable engagement with the locking actuator such that when the shifter is in operable engagement with the locking actuator, the shifter is moved into meshing engagement with the axially movable firing actuator and the gear assembly. When the shifter is out of operable engagement with the locking actuator, the shifter is moved out of meshing engagement with the gear assembly and the axially movable firing actuator.

Example 139

[0613] A surgical instrument comprising an elongate shaft defining a shaft axis, a surgical end effector coupled to the elongate shaft for selective articulation relative to the elongate shaft about an articulation axis that is transverse to the shaft axis, means for generating axial firing motions, and articulation means. The articulation means interface with the means for generating and the articulation means are configured to apply articulation motions to the surgical end effector in response to the axial firing motions generated by the means for generating. The surgical instrument further comprises means for selectively locking the articulation means in a non-movable configuration and unlocking the articulation means and operably coupling the articulation means with the means for generating such that the means for generating may apply the axial firing motions to the articulation means.

Example 140

[0614] The surgical instrument of Example 139, wherein the surgical end effector comprises an elongate channel configured to operably support a surgical staple cartridge therein and an anvil movably supported on the elongate channel for selective movement between open and closed positions. The elongate channel is coupled to the elongate shaft for selective articulation relative thereto about the articulation axis. The firing member comprises a tissue cutting feature.

Example 141

[0615] A surgical tool assembly comprising an elongate shaft defining a shaft axis, a surgical end effector coupled to the elongate shaft for selective articulation relative to the elongate shaft about an articulation axis that is transverse to the shaft axis, a first articulation link, a second articulation link, and an articulation stroke multiplier. The first articulation link operably interfaces with a source of articulation motions to selectively axially move the first articulation link a first axial distance in a first articulation direction. The second articulation link operably interfaces with the surgical end effector to apply articulation motions thereto. The articulation stroke multiplier operably interfaces with the first articulation link and the second articulation link such that when the first articulation link is axially moved the first axial distance in the first axial direction, the articulation stroke multiplier moves the second articulation link another first axial distance in the first axial direction that is greater than the first axial distance.

Example 142

[0616] The surgical tool assembly of Example 141, wherein the source of articulation motions is configured to additionally axially move the first articulation link a second axial distance in a second axial direction and wherein when the first articulation link is moved the second axial distance in the second axial direction, the articulation stroke multiplier moves the second articulation link another second axial distance in the second axial direction that is greater than the second axial distance.

Example 143

[0617] The surgical tool assembly of Example 141 or 142, wherein the first articulation link comprises a first articula-

tion gear rack, wherein the second articulation link comprises a second articulation gear rack, and wherein the articulation stroke multiplier comprises at least one gear set in meshing engagement with the first and second articulation gear racks.

Example 144

[0618] The surgical tool assembly of Example 143, wherein each of the at least one gear set comprises a first gear rotatably supported in meshing engagement with the first articulation gear rack and a first gear rotatably supported in meshing engagement with the first articulation gear rack.

Example 145

[0619] The surgical tool assembly of Example 141, 142, 143, or 144, wherein the second articulation link operably interfaces with an articulation lock assembly that is operably coupled to the surgical end effector.

Example 146

[0620] The surgical tool assembly of Example 141, 142, 143, 144, or 145, wherein the first articulation link comprises a first articulation gear rack and wherein the articulation stroke multiplier comprises a swing gear in meshing engagement with the first articulation gear rack and slidably coupled to the second articulation link.

Example 147

[0621] The surgical tool assembly of Example 141, 142, 143, 144, 145, or 146, wherein the swing gear is supported for rotational travel about a swing gear mounting axis that is transverse to the first and second articulation links.

Example 148

[0622] The surgical tool assembly of Example 146 or 147, wherein the second articulation link comprises a slotted distal end slidably engaging a portion of the swing gear therein.

Example 149

[0623] The surgical tool assembly of Example 146, 147, or 148, wherein the swing gear has a slot therein configured to slidably engage a distal end portion of the second articulation link.

Example 150

[0624] A surgical tool assembly comprising an elongate shaft defining a shaft axis, a surgical end effector, a first articulation link, a second articulation link, and an articulation stroke multiplier. The surgical end effector comprises an elongate channel configured to operably support a surgical staple cartridge therein and coupled to the elongate shaft for selective articulation relative to the elongate shaft about an articulation axis that is transverse to the shaft axis and an anvil movably supported on the elongate channel. The first articulation link operably interfaces with a source of articulation motions to selectively axially move the first articulation link a first axial distance in a first articulation direction. The second articulation link operably interfaces with the surgical end effector to apply articulation motions thereto. The articulation stroke multiplier operably interfaces with the first articulation link and the second articulation link such that when the first articulation link is axially moved the first axial distance in the first axial direction. The articulation stroke multiplier moves the second articulation link another first axial distance in the first axial direction that is greater than the first axial distance.

Example 151

[0625] The surgical tool assembly of Example 150, wherein the source of articulation motions comprises a firing member assembly operably interfacing with a firing member that is supported for axial travel within the elongate channel and a clutch assembly operably interfacing with the first articulation link and the firing member assembly and being selectively configurable between a firing mode, wherein axial movement of the firing member assembly is applied to the firing member and an articulation mode, and wherein the axial movement of the firing member assembly is applied to the first articulation link.

Example 152

[0626] The surgical tool assembly of Example 151, wherein when the clutch assembly is in the articulation mode, the firing member assembly is configured to additionally axially move the first articulation link a second axial distance in a second axial direction and wherein when the first articulation link is moved the second axial distance in the second axial direction, the articulation stroke multiplier moves the second articulation link another second axial distance in the second axial direction that is greater than the secondary axial distance.

Example 153

[0627] The surgical tool assembly of Example 151 or 152, wherein the first articulation link comprises a first articulation gear rack, wherein the second articulation link comprises a second articulation gear rack, and wherein the articulation stroke multiplier comprises at least one gear set in meshing engagement with the first and second articulation gear racks.

Example 154

[0628] The surgical tool assembly of Example 153, wherein each of the at least one gear set comprises a first gear rotatably supported in meshing engagement with the first articulation gear rack and a second gear attached to the first gear for rotation therewith. The second gear has a larger diameter than a diameter of the first gear, and the second gear is in meshing engagement with the second articulation gear rack.

Example 155

[0629] The surgical tool assembly of Example 151, 152, 153, or 154, wherein the second articulation link operably interfaces with an articulation lock assembly that is operably coupled to the surgical end effector.

Example 156

[0630] The surgical tool assembly of Example 151, 152, 153, 154, or 155, wherein the first articulation link comprises a first articulation gear rack and wherein the articu-

lation stroke multiplier comprises a swing gear in meshing engagement with the first articulation gear rack and slidably coupled to the second articulation link.

Example 157

[0631] The surgical tool assembly of Example 156, wherein the swing gear is supported for rotational travel about a swing gear mounting axis that is transverse to the first and second articulation links.

Example 158

[0632] The surgical tool assembly of Example 156 or 157, wherein the second articulation link comprises a slotted distal end slidably engaging a portion of the swing gear therein.

Example 159

[0633] The surgical tool assembly of Example 156, 157, or 158, wherein the swing gear has a slot therein configured to slidably engage a distal end portion of the second articulation link.

Example 160

[0634] A surgical tool assembly comprising an elongate shaft defining a shaft axis, a surgical end effector, a first articulation link, a second articulation link, and an articulation stroke multiplying means. The surgical end effector is coupled to the elongate shaft for selective articulation relative to the elongate shaft about an articulation axis that is transverse to the shaft axis. A first articulation link operably interfaces with a source of articulation motions to selectively axially move the first articulation link a first axial distance in a first articulation direction. A second articulation link operably interfaces with the surgical end effector to apply articulation motions thereto. The articulation stroke multiplying means operably interfaces with the first articulation link and the second articulation link to move the second articulation a second axial distance in response to movement of the first articulation link a first axial distance that is less than the second axial distance.

Example 161

[0635] A surgical tool assembly comprising an elongate shaft assembly defining a shaft axis, a surgical end effector, and a distal articulation member. The surgical end effector is movably coupled to the elongate shaft assembly by a distal support link that is pivotally coupled to the surgical end effector to define an articulation axis that is transverse to the shaft axis. The distal support link is pivotally and axially movably coupled to the elongate shaft assembly to facilitate selective articulation of the surgical end effector relative to the elongate shaft assembly about the articulation axis between a first unarticulated position, wherein the surgical end effector is aligned with the elongate shaft assembly along the shaft axis and articulation positions located on one side of the shaft axis. The distal articulation member operably interfaces with a source of articulation motions and is pivotally coupled to the surgical end effector to apply the articulation motions thereto.

Example 162

[0636] The surgical tool assembly of Example 161, wherein the distal articulation member is configured to axially move on the one side of the shaft axis in response to the articulation motions applied thereto and wherein the distal support link is configured to axially move relative to the elongate shaft assembly along the shaft axis.

Example 163

[0637] The surgical tool assembly of Example 161 or 162, wherein the distal support link comprises a distal end pivotally coupled to the surgical end effector for pivotal travel about the articulation axis and a proximal end comprising a proximal axial slot configured to receive a corresponding articulation pin therein that is attached to a distal end of elongate shaft assembly.

Example 164

[0638] The surgical tool assembly of Example 161, 162, or 163, wherein the surgical tool assembly further comprises a proximal articulation member operably interfacing with the source of articulation motions and an articulation lock assembly operably coupled to the proximal articulation member and a proximal end of the distal articulation member to selectively lock the distal articulation member in an axial position.

Example 165

[0639] The surgical tool assembly of Example 164, wherein the proximal end of the distal articulation member is pivotally coupled to the articulation lock assembly.

Example 166

[0640] The surgical tool assembly of Example 161, 162, 163, 164, or 165, wherein the distal support link is pivotally and axially movably coupled to a distal spine member of the elongate shaft assembly.

Example 167

[0641] The surgical tool assembly of Example 161, 162, 163, 164, 165, or 166, wherein the surgical end effector comprises an elongate channel configured to operably support a surgical staple cartridge therein and an anvil movably supported on the elongate channel for selective movement relative thereto between an open position and closed positions.

Example 168

[0642] The surgical tool assembly of Example 167 wherein the elongate channel is pivotally coupled to the distal support link by an end effector mounting assembly coupled to the elongate channel.

Example 169

[0643] The surgical tool assembly of Example 161, 162, 163, 164, 165, 166, 167, or 168, wherein the distal articulation member is configured to axially move in first and second axial directions such that when the distal articulation member is moved in the first axial direction, the surgical end effector is articulated in a first articulation direction from the first unarticulated position to any one of the articulation

positions, and when the distal articulation member is axially moved in the second axial direction, the surgical end effector is moved in a second articulation direction from any one of the articulation positions to the first unarticulated position.

Example 170

[0644] The surgical tool assembly of Example 169, wherein the surgical tool assembly further comprises means for preventing movement of the surgical end effector in the second articulation direction beyond the first unarticulated position when the distal articulation member is moved in the second axial direction.

Example 171

[0645] A surgical tool assembly comprising an elongate shaft assembly defining a shaft axis, a surgical end effector, a distal support link, and a distal articulation member. The surgical end effector comprises an elongate channel configured to operably support a surgical staple cartridge therein and an anvil supported for movable travel relative to the surgical staple cartridge. The distal support link is pivotally coupled to the elongate channel to define an articulation axis that is transverse to the shaft axis and about which the elongate channel may articulate relative to the elongate shaft assembly. The distal support link is attached to a distal end of the elongate shaft assembly for axial and pivotal travel relative thereto along the shaft axis. The distal articulation member is supported for axial travel on one side of the shaft axis, the distal articulation member being pivotally coupled to the elongate channel and operably interfacing with a source of articulation motions.

Example 172

[0646] The surgical tool assembly of Example 171, wherein a proximal end of the distal support link comprises a proximal axial slot that is configured to receive a corresponding articulation pin therein that is attached to the distal end of said elongate shaft assembly.

Example 173

[0647] The surgical tool assembly of Example 171 or 172, wherein the surgical tool assembly further comprises a proximal articulation member operably interfacing with the source of articulation motions and an articulation lock assembly operably coupled to the proximal articulation member and a proximal end of the distal articulation member to selectively lock the distal articulation member in an axial position.

Example 174

[0648] The surgical tool assembly of Example 173, wherein the proximal end of the distal articulation member is pivotally coupled to the articulation lock assembly.

Example 175

[0649] The surgical tool assembly of Example 171, 172, 173, or 174, wherein the distal support link is pivotally and axially movably coupled to a distal spine member of the elongate shaft assembly.

Example 176

[0650] The surgical tool assembly of Example 171, 172, 173, 174, or 175, wherein the distal articulation member is configured to move in first and second axial directions such that when the distal articulation member is moved in the first axial direction, the surgical end effector is articulated in a first articulation direction from the first unarticulated position to any one of the articulation positions and when the distal articulation member is moved in the second axial direction, the surgical end effector is moved in a second articulation direction from any one of the articulation positions to the first unarticulated position.

Example 177

[0651] The surgical tool assembly of Example 176, wherein the surgical tool assembly further comprises means for preventing movement of the surgical end effector in the second articulation direction beyond the first unarticulated position when the distal articulation member is moved in the second axial direction.

Example 178

[0652] A surgical tool assembly comprising an elongate shaft assembly defining a shaft axis, means for coupling a surgical end effector to a distal end of the elongate shaft assembly such that the surgical end effector may be selectively articulated about an articulation axis that is transverse to the shaft axis between an unarticulated position wherein the surgical end effector is aligned with the elongate shaft along the shaft axis and articulation positions located on one side of the shaft axis, and means for applying articulation motions to the surgical end effector. The means for coupling are coupled to the elongate shaft assembly for axial and pivotal travel relative thereto.

Example 179

[0653] The surgical tool assembly of Example 178, wherein the means for applying is pivotally coupled to the surgical end effector at a location that is laterally offset from the shaft axis.

Example 180

[0654] The surgical tool assembly of Example 178 or 179, wherein the means for applying further comprises means for selectively locking the surgical end effector in any one of the articulation positions.

Example 181

[0655] A surgical staple cartridge is configured to be supported within a jaw of a surgical end effector wherein at least one jaw of the surgical end effector is movable relative to a second jaw of the surgical end effector between open and closed positions. The surgical end effector includes a lock member that is moved from an unlocked configuration to a locked configuration when the at least one jaw is moved to the closed position to prevent axial travel of a firing member through the surgical end effector. The surgical end effector comprises a cartridge body sized to be seated within the surgical end effector, the cartridge body operably supporting a plurality of surgical staples arranged in staple lines therein and a cam assembly. The cam assembly is movable between a starting position and an ending position within the

cartridge body, the cam assembly defining a central axis and a plurality of cam features thereon wherein each cam feature corresponds to at least one of the staple lines. The cam assembly further comprises at least one unlocking feature thereon that is laterally offset from the central axis and is configured to unlockingly engage a corresponding portion of the lock member when the cartridge body is seated within the surgical end effector and the cam assembly is in the starting position to thereby prevent the locking member from attaining the locked configuration when the at least one jaw is moved to the closed position.

Example 182

[0656] The surgical staple cartridge of Example 181, wherein the at least one unlocking feature comprises a first unlocking ramp formed on a proximal end of the cam assembly in a position that is laterally offset to one side of the central axis and a second unlocking ramp formed on the proximal end of the cam assembly in another position that is laterally offset on an opposite side of the central axis.

Example 183

[0657] The surgical staple cartridge of Example 181 or 182, wherein each unlocking feature is configured to bias the lock member into the unlocked configuration.

Example 184

[0658] The surgical staple cartridge of Example 182, wherein the proximal end of the cam assembly defines a central contact area located between the first and second unlocking ramps that is configured for engagement by the firing member as the firing member is axially advanced through the surgical end effector.

Example 185

[0659] A surgical end effector comprising a first jaw, an anvil, a firing member, a lock member, and a surgical staple cartridge. The anvil is supported relative to the first jaw for selective movement relative to the first jaw between an open position and a closed position relative to each other. The firing member is supported for axial movement within the end effector between a beginning position and an ending position upon applications of firing and retraction motions thereto. The lock member is movable between a locked configuration wherein the firing member is prevented from axial travel through the surgical end effector and an unlocked configuration wherein the firing member is axially advanceable through the surgical end effector. The surgical staple cartridge comprises a cartridge body and a cam assembly. The cartridge body is sized to be seated within the first jaw, the cartridge body operably supporting a plurality of surgical staples arranged in staple lines therein. The cam assembly is movable between a starting position and an end position within the cartridge body, the cam assembly defining a central axis and comprising a plurality of cam features thereon wherein each cam feature corresponds to at least one of the staple lines. The cam assembly further comprises at least one unlocking feature thereon laterally offset from the central axis and being configured to unlockingly engage a corresponding portion of the lock member when the cartridge body is seated within the first jaw and the cam assembly is in the starting position to thereby prevent the lock member from attaining the locked configuration when the anvil is moved to the closed position.

Example 186

[0660] The surgical end effector of Example 185, wherein the at least one unlocking feature comprises a first unlocking ramp formed on a proximal end of the cam assembly in a position that is laterally offset to one side of the central axis and a second unlocking ramp formed on the proximal end of the cam assembly in another position that is laterally offset on an opposite side of the central axis.

Example 187

[0661] The surgical end effector of Example 185 or 186, wherein the anvil is configured to move the lock member in a first direction into locking engagement with the firing member when the anvil is moved to the closed position and wherein each unlocking feature is configured to bias the corresponding portion of the lock member in a second direction that is opposite to the first direction.

Example 188

[0662] The surgical end effector of Example 186, wherein the proximal end of the cam assembly defines a central contact area located between the first and second unlocking ramps that is configured for engagement by the firing member as the firing member is axially advanced through the surgical end effector.

Example 189

[0663] The surgical end effector of Example 181, 182, 183, or 184, wherein the surgical staple cartridge comprises an elongate slot configured to slidably receive the firing member therein as the firing member is moved between the beginning and ending positions and wherein the lock member is configured to axially align the firing member with the elongate slot.

Example 190

[0664] The surgical end effector of Example 185, 186, 187, or 188, wherein the firing member comprises two lateral sides and wherein the lock member is configured to retainingly engage each lateral side of the firing member when the lock member is in the locked configuration.

Example 191

[0665] The surgical end effector of Example 190, wherein the lock member comprises a spring arm corresponding to each lateral side of the firing member and a lock notch in each spring arm configured to releasably engage a corresponding lock lug on each lateral side of the firing member.

Example 192

[0666] The surgical end effector of Example 185, 186, 187, 188, 190, or 191, wherein the surgical end effector further comprises a tissue cutting surface on the firing member.

Example 193

[0667] The surgical end effector of Example 185, 186, 187, 188, 190, 191, or 192, wherein the anvil comprises an

anvil body, an axial slot in the anvil body to permit a portion of the firing member to axially pass therethrough, and an axial passage within the anvil body on each side of the axial slot.

Example 194

[0668] The surgical end effector of Example 193, wherein the firing member comprises a foot configured to slidably pass within a corresponding passage within the first jaw and laterally extending anvil engagement features extending laterally from a top portion of the firing member body and configured to pass through a corresponding one of the axial passages within the anvil body and wherein the first and second engagement features are located between the foot and the anvil engagement features.

Example 195

[0669] A surgical staple cartridge is configured to be supported within a jaw of a surgical end effector that defines a shaft axis and wherein at least one jaw of the surgical end effector is movable relative to a second jaw of the surgical end effector between open and closed positions. The surgical end effector includes a lock member that is movable between a locked configuration wherein a firing member is prevented from axial travel through the surgical end effector and an unlocked configuration wherein the firing member is axially advanceable through the surgical end effector. The surgical staple cartridge comprises a cartridge body sized to be seated within the one jaw of the surgical end effector, the cartridge body operably supporting a plurality of surgical staples arranged in staple rows therein and staple camming means for camming the staples out of the cartridge body as the camming means is axially moved within the cartridge body from a starting position to an ending position. The staple camming means is configured to unlockingly engage at least one corresponding portion of the lock member that is laterally offset from the shaft axis when the cartridge body is seated within the jaw of the surgical end effector and the staple camming means is in the starting position to thereby prevent the locking member from attaining the locked configuration when the at least one jaw is moved to the closed position.

Example 196

[0670] A method comprises obtaining a first staple cartridge having a first row of staples and obtaining a second staple cartridge having a second row of staples, wherein the first row of staples and the second row of staples comprise the same length. The method further comprises inserting the first staple cartridge into a channel comprising a keyed profile, wherein complete insertion of the first staple cartridge into the channel is prevented by an interference between the keyed profile and the channel and inserting the second staple cartridge into the channel, wherein complete insertion of the second staple cartridge into the channel is permitted by the keyed profile.

Example 197

[0671] The method of Example 196, wherein inserting the second staple cartridge into the channel further comprises aligning key features on the second staple cartridge with the keyed profile on the channel.

Example 198

[0672] The method of Example 196 or 197, wherein the method further comprises a bottom surface of the first staple cartridge being spaced apart from the channel when the first staple cartridge is inserted into the channel.

Example 199

[0673] The method of Example 198, wherein the method further comprises a bottom surface of the second staple cartridge being positioned against the channel when the second staple cartridge is inserted into the channel.

Example 200

[0674] The method of Example 196, 197, 198, or 199, wherein the method further comprises a proximal portion of the first staple cartridge obstructing clamping of an anvil against a distal portion of the first staple cartridge when the first staple cartridge is inserted into the channel.

Example 201

[0675] The method of Example 196, 197, 198, 199, or 200, wherein the method further comprises a firing lockout of the first staple cartridge preventing a firing stroke when the first staple cartridge is inserted into the channel.

Example 202

[0676] A method comprising obtaining a first staple cartridge comprising a first quantity of staples and obtaining a second staple cartridge comprising the first quantity of staples. The method further comprises inserting the first staple cartridge into a channel comprising a keyed profile, wherein the complete insertion of the first staple cartridge into the channel is prevented by the keyed profile and inserting the first staple cartridge into a channel comprising a keyed profile, wherein the complete insertion of the first staple cartridge into the channel is prevented by the keyed profile.

Example 203

[0677] The method of Example 202, wherein inserting the second staple cartridge into the channel further comprises aligning key features on the second staple cartridge with the keyed profile on the channel.

Example 204

[0678] The method of Example 202 or 203, wherein the method further comprises a bottom surface of the first staple cartridge being spaced apart from the channel when the first staple cartridge is inserted into the channel.

Example 205

[0679] The method of Example 204, wherein the method further comprises a bottom surface of the first staple cartridge being spaced apart from the channel when the first staple cartridge is inserted into the channel.

Example 206

[0680] The method of Example 202, 203, 204, or 205, wherein the method further comprises the first staple car-

tridge obstructing clamping of an anvil against the first staple cartridge when the first staple cartridge is inserted into the channel.

Example 207

[0681] The method of Example 202, 203, 204, 205, or 206, wherein the method further comprises a firing lockout of the first staple cartridge preventing a firing stroke when the first staple cartridge is inserted into the channel.

Example 208

[0682] A method comprises obtaining a channel, obtaining a compatible staple cartridge comprising a proximal alignment protrusion and a distal alignment protrusion, and aligning the proximal alignment protrusion with a corresponding proximal alignment feature in a channel. The method further comprises aligning the distal alignment protrusion with a corresponding distal alignment feature in the channel and inserting the compatible staple cartridge into the channel such that the proximal alignment protrusion interlocks with the corresponding proximal alignment feature and the distal alignment protrusion interlocks with the corresponding distal alignment feature.

Example 209

[0683] The method of Example 208, wherein the method further comprises a bottom surface of the compatible staple cartridge being positioned against the channel when the compatible staple cartridge is inserted into the channel.

Example 210

[0684] The method of Example 208 or 209, wherein the method further comprises a firing lockout of the compatible staple cartridge preventing a firing stroke until the compatible staple cartridge is inserted into the channel.

Example 211

[0685] The method of Example 208, 209, or 210, wherein the method further comprises attempting to insert an incompatible staple cartridge into the channel, wherein the incompatible staple cartridge further comprises an interference feature relative to the corresponding proximal alignment feature on the channel.

Example 212

[0686] The method of Example 211, wherein the method further comprises a bottom surface of the incompatible staple cartridge being spaced apart from the channel when the incompatible staple cartridge is inserted into the channel.

Example 213

[0687] The method of Example 212, wherein the method further comprises a proximal portion of the incompatible staple cartridge obstructing clamping of an anvil against a distal portion of the incompatible staple cartridge when the incompatible staple cartridge is inserted into the channel.

Example 214

[0688] The method of Example 211, 212, or 213, wherein the method further comprises a lockout preventing at least one surgical function when the incompatible staple cartridge is positioned in the channel.

Example 215

[0689] The method of Example 208, 209, 210, 211, 212, 213, or 214, wherein the channel comprises a jaw of an end effector, and the method further comprises matching a classifying indication on the end effector with a classifying indication on the compatible staple cartridge.

Example 216

[0690] A system comprising a replaceable staple cartridge and a channel configured to receive the replaceable staple cartridge. The replaceable staple cartridge comprises a plurality of staples, a first downwardly-protruding tab, and a second downwardly-protruding tab. The channel comprises a first receptacle positioned and dimensioned to receive the first downwardly-protruding tab and a second receptacle positioned and dimensioned to receive the second downwardly-protruding tab.

Example 217

[0691] The system of Example 216, wherein the replaceable staple cartridge further comprises a cartridge body and a pan positioned around a portion of the cartridge body, wherein the pan further comprises a base, and wherein the first downwardly-protruding tab and the second downwardly-protruding tab protrude from the base.

Example 218

[0692] The system of Example 217, wherein the first downwardly-protruding tab and the second downwardly-protruding tab are comprised of metal.

Example 219

[0693] The system of Example 216, 217, or 218, wherein the replaceable staple cartridge further comprises a first laterally-extending lug and a second laterally-extending lug.

Example 220

[0694] The system of Example 219, wherein the replaceable staple cartridge further comprises a first sidewall comprising a first cutout, wherein the first cutout is positioned and dimensioned to receive the first laterally-extending lug and a second sidewall comprising a second cutout, wherein the second cutout is positioned and dimensioned to receive the second laterally-extending lug.

Example 221

[0695] The system of Example 220, wherein the replaceable staple cartridge further comprises a molded cartridge body, and wherein the first laterally-extending lug and the second laterally-extending lug are molded features of the molded cartridge body.

Example 222

[0696] The system of Example 221, wherein the cartridge body is comprised of a plastic material.

Example 223

[0697] The system of Example 219, 220, 221, or 222, wherein the first laterally-extending lug and the second laterally-extending lug are located distal to the first downwardly-protruding tab and second downwardly-protruding tab.

Example 224

[0698] A system comprising a replaceable staple cartridge and a channel configured to receive the replaceable staple cartridge. The replaceable staple cartridge comprises a plurality of staples and an outer surface comprising a plurality of ribs. The channel comprises a plurality of slots, wherein each of the slots is configured to receive one of the ribs.

Example 225

[0699] The system of Example 224, wherein the plurality of ribs comprises a first rib and a second rib.

Example 226

[0700] The system of Example 225, wherein the plurality of slots comprises a first slot and a second slot, and wherein the channel further comprises a first sidewall comprising the first slot and a second sidewall comprising the second slot.

Example 227

[0701] The system of Example 224, 225, or 226, wherein the replaceable staple cartridge further comprises a molded cartridge body, and wherein the ribs are molded features of the molded cartridge body.

Example 228

[0702] The system of Example 224, 225, 226, or 227, wherein the replaceable staple cartridge further comprises a first laterally-extending lug and a second laterally-extending lug.

Example 229

[0703] The system of Example 224, 225, 226, 227, or 228, wherein the channel further comprises a first sidewall comprising a first cutout, wherein the first cutout is positioned and dimensioned to receive the first laterally-extending lug and a second sidewall comprising a second cutout, wherein the second cutout is positioned and dimensioned to receive the second laterally-extending lug.

Example 230

[0704] The system of Example 229, wherein the replaceable staple cartridge further comprises a molded cartridge body, and wherein the first laterally-extending lug and the second laterally-extending lug are molded in the molded cartridge body.

Example 231

[0705] The system of Example 230, wherein the molded cartridge body is comprised of a plastic material.

Example 232

[0706] The system of Example 231, wherein the first laterally-extending lug and the second laterally-extending lug are located distal to the rubs.

Example 233

[0707] A system comprising a compatible staple cartridge comprising a plurality of staples and a channel. The system further comprises means for permitting complete insertion of the compatible staple cartridge and for preventing an incompatible staple cartridge from being completely inserted in the channel, wherein the incompatible staple cartridge and the compatible staple cartridge comprise the same length and the same width.

Example 234

[0708] The system of Example 233, wherein the means comprises proximal and distal alignment keys.

Example 235

[0709] The system of Example 233 or 234, wherein the system further comprises a second channel, and wherein the incompatible staple cartridge is compatible with the second channel.

Example 236

[0710] A system comprising a replaceable staple cartridge and a channel configured to receive the replaceable staple cartridge. The replaceable staple cartridge comprises a plurality of staples, a proximal laterally-protruding lug, and a distal laterally-protruding lug. The channel comprises a sidewall comprising a proximal receptacle positioned and dimensioned to receive the proximal laterally-protruding lug and a distal receptacle positioned and dimensioned to receive the distal laterally-protruding lug.

Example 237

[0711] The system of Example 236, wherein the channel further comprises an obstruction, and wherein the replaceable staple cartridge further comprises a complementary anti-obstruction positioned and dimensioned to overcome the obstruction.

Example 238

[0712] The system of Example 237, wherein the system further comprises a second replaceable staple cartridge comprising a non-complementary anti-obstruction positioned and dimensioned to interfere with the obstruction.

Example 239

[0713] The system of Example 236, 237, or 238, wherein the proximal receptacle defines a cutout in the sidewall, and wherein the cutout comprises a depression and a projection.

Example 240

[0714] The system of Example 239, wherein the projection is positioned within the depression.

Example 241

[0715] The system of Example 236, 237, 238, 239, or 240, wherein the system further comprises a second replaceable staple cartridge comprising a second plurality of staples, a second proximal laterally-protruding lug, and a second distal laterally-protruding lug.

Example 242

[0716] The system of Example 241, wherein the second distal laterally-protruding lug is spaced apart from the second proximal laterally-protruding lug by a distance, and wherein the distance is different than a first distance between the proximal laterally-protruding lug and the distal laterally-protruding lug of the replaceable staple cartridge.

Example 243

[0717] The system of Example 241 or 242, wherein the second distal laterally-protruding lug matches the distal laterally-protruding lug, and wherein the second proximal laterally-protruding lug is different than the proximal laterally protruding-lug.

Example 244

[0718] The system of Example 241, 242, or 243, wherein the second replaceable staple cartridge further comprises a deck, wherein the channel further comprises a bottom surface, and wherein the deck is obliquely oriented relative to the bottom surface when the second replaceable staple cartridge is positioned in the channel.

Example 245

[0719] The system of Example 241, 242, 243, or 244, wherein the replaceable staple cartridge and the second replaceable staple cartridge comprise the same width and the same length.

Example 246

[0720] The system of Example 241, 242, 243, 244, or 245, wherein the plurality of staples and the second plurality of staples comprise the same quantity of staples.

Example 247

[0721] The system of Example 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, or 246, wherein the distal laterally-protruding lug comprises a different geometry than the proximal laterally-protruding lug.

Example 248

[0722] The system of Example 247, wherein the proximal laterally-protruding lug comprises a wedge.

Example 249

[0723] The system of Example 247 or 248, wherein the proximal laterally-protruding lug comprises a cutout that matches a projection in the proximal receptacle.

Example 250

[0724] The system of Example 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, or 249, wherein the proximal laterally-protruding lug protrudes from a first side of the replaceable staple cartridge, and wherein the distal laterally-protruding lug protrudes from a second side of the replaceable staple cartridge.

Example 251

[0725] The system of Example 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, or 250, wherein the replaceable staple cartridge further comprises a deck, wherein the channel further comprises a bottom surface, and wherein the deck is parallel to the bottom surface when the replaceable staple cartridge is positioned in the channel.

Example 252

[0726] A system comprising a channel comprising an obstruction, a compatible staple cartridge comprising a complementary anti-obstruction positioned and dimensioned to complement the obstruction when the compatible staple cartridge is received in said channel, and an incompatible staple cartridge comprising a non-complementary anti-obstruction positioned and dimensioned to interfere with the obstruction when the incompatible staple cartridge is received in the channel.

Example 253

[0727] The system of Example 252, wherein the compatible staple cartridge and the incompatible staple cartridge comprise rows of staples of the same length.

Example 254

[0728] The system of Example 252 or 253, wherein the compatible staple cartridge and the incompatible staple cartridge comprise the same quantity of staples.

Example 255

[0729] The system of Example 252, 253, or 254, wherein the obstruction further comprises a cutout comprising a depression and a projection.

Example 256

[0730] A system comprising a compatible staple cartridge comprising a first quantity of staples, an incompatible staple cartridge comprising the first quantity of staples, and a channel comprising means for permitting complete insertion of the compatible staple cartridge and for preventing the incompatible staple cartridge from being completely inserted into the channel.

Example 257

[0731] A system comprising an end effector configured to receive a compatible replaceable staple cartridge, wherein the end effector comprises a first outer surface, and wherein a classifying identification of the end effector is inscribed on the first outer surface, and the compatible replaceable staple cartridge comprising a second outer surface, wherein a classifying identification of the compatible replaceable staple cartridge is inscribed on the second outer surface, and wherein the classifying identification of the compatible replaceable staple cartridge corresponds to the classifying identification of the end effector.

Example 258

[0732] The system of Example 257, wherein the system further comprises an incompatible replaceable staple cartridge, wherein the incompatible replaceable staple cartridge comprises a third outer surface, wherein a classifying identification of the incompatible replaceable staple cartridge is positioned on the third outer surface, and wherein the classifying identification of the compatible replaceable staple cartridge is different than the classifying identification of the end effector.

Example 259

[0733] The system of Example 257 or 258, wherein the end effector further comprises a distal portion, and wherein the classifying identification of the end effector is positioned on the distal portion.

Example 260

[0734] The system of Example 259, wherein the end effector further comprises an anvil, and wherein the classifying identification of the end effector is positioned at a distal end of the anvil.

Example 261

[0735] The system of Example 257, 258, 259, or 260, wherein the end effector further comprises an anvil comprising a pair of tissue stops, and wherein a secondary classifying identification of the end effector is positioned on each of the tissue stops.

Example 262

[0736] The system of Example 257, 258, 259, 260, or 261, wherein the compatible replaceable staple cartridge further comprises a wedge-shaped distal nose, and wherein the classifying identification of the compatible replaceable staple cartridge is positioned on the wedge-shaped distal nose.

Example 263

[0737] The system of Example 257, 258, 259, 260, 261, or 262, wherein the classifying identification of the end effector and the classifying identification of the compatible replaceable staple cartridge comprise the same alphanumeric characters.

Example 264

[0738] The system of Example 263, wherein the same alphanumeric characters indicates a length of a resultant staple line fired from the compatible replaceable staple cartridge.

Example 265

[0739] The system of Example 264, wherein the same alphanumeric character indicates a type of end effector.

Example 266

[0740] The system of Example 257, 258, 259, 260, 261, 262, 263, 264, or 265, wherein the classifying identification of the end effector and the classifying identification of the compatible replaceable staple cartridge comprise the same shape.

Example 267

[0741] The system of Example 257, 258, 259, 260, 261, 262, 263, 264, 265, or 266, wherein the classifying identification of the end effector and the classifying identification of the compatible replaceable staple cartridge comprise the same color.

Example 268

[0742] The system of Example 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, or 267, wherein the system further comprises a lockout configured to prevent at least one surgical function unless the compatible replaceable staple cartridge is positioned in the end effector.

Example 269

[0743] A system comprising an end effector configured to receive a compatible replaceable staple cartridge, wherein the end effector comprises a first distal end comprising a cartridge compatibility indicator and the compatible replaceable staple cartridge comprising a plurality of staples, wherein the compatible replaceable staple cartridge comprises a second distal end comprising an end effector compatibility indicator.

Example 270

[0744] The system of Example 269, wherein the cartridge compatibility indicator is embossed on an outer surface of the end effector.

Example 271

[0745] The system of Example 270, wherein the end effector compatibility indicator is embossed on an outer surface of the compatible replaceable staple cartridge.

Example 272

[0746] The system of Example 269, 270, or 271, wherein the cartridge compatibility indicator longitudinally overlaps the end effector compatibility indicator when the compatible replaceable staple cartridge is positioned in the end effector.

Example 273

[0747] A system comprising an end effector configured to receive a compatible replaceable staple cartridge, wherein the end effector comprises a first outer surface comprising a first code and the compatible replaceable staple cartridge comprising a plurality of staples and a second outer surface, wherein the second outer surface comprises a second code, and wherein the second code matches the first code.

Example 274

[0748] The system of Example 273, wherein the first code is embossed on the first outer surface, and wherein the second code is embossed on the second outer surface.

Example 275

[0749] The system of Example 273 or 274, wherein the first code and the second code indicate a length of the compatible replaceable staple cartridge.

Example 276

[0750] The system of Example 273, 274, or 275, wherein the first code and the second code include at least one number and at least one letter.

[0751] Many of the surgical instrument systems described herein are motivated by an electric motor; however, the surgical instrument systems described herein can be motivated in any suitable manner. In various instances, the surgical instrument systems described herein can be motivated by a manually-operated trigger, for example. In certain instances, the motors disclosed herein may comprise a portion or portions of a robotically controlled system. Moreover, any of the end effectors and/or tool assemblies disclosed herein can be utilized with a robotic surgical instrument system. U.S. patent application Ser. No. 13/118,241, entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, now U.S. Patent Application Publication No. 2012/0298719, for example, discloses several examples of a robotic surgical instrument system in greater detail.

[0752] The surgical instrument systems described herein have been described in connection with the deployment and deformation of staples; however, the embodiments described herein are not so limited. Various embodiments are envisioned which deploy fasteners other than staples, such as clamps or tacks, for example. Moreover, various embodiments are envisioned which utilize any suitable means for sealing tissue. For instance, an end effector in accordance with various embodiments can comprise electrodes configured to heat and seal the tissue. Also, for instance, an end effector in accordance with certain embodiments can apply vibrational energy to seal the tissue.

[0753] The entire disclosures of:

[0754] U.S. Pat. No. 5,403,312, entitled ELECTROSURGICAL HEMOSTATIC DEVICE, which issued on Apr. 4, 1995;

[0755] U.S. Pat. No. 7,000,818, entitled SURGICAL STAPLING INSTRUMENT HAVING SEPARATE DISTINCT CLOSING AND FIRING SYSTEMS, which issued on Feb. 21, 2006;

[0756] U.S. Pat. No. 7,422,139, entitled MOTOR-DRIVEN SURGICAL CUTTING AND FASTENING INSTRUMENT WITH TACTILE POSITION FEEDBACK, which issued on Sep. 9, 2008;

[0757] U.S. Pat. No. 7,464,849, entitled ELECTRO-MECHANICAL SURGICAL INSTRUMENT WITH CLOSURE SYSTEM AND ANVIL ALIGNMENT COMPONENTS, which issued on Dec. 16, 2008;

[0758] U.S. Pat. No. 7,670,334, entitled SURGICAL INSTRUMENT HAVING AN ARTICULATING END EFFECTOR, which issued on Mar. 2, 2010;

[0759] U.S. Pat. No. 7,753,245, entitled SURGICAL STAPLING INSTRUMENTS, which issued on Jul. 13, 2010;

[0760] U.S. Pat. No. 8,393,514, entitled SELECTIVELY ORIENTABLE IMPLANTABLE FASTENER CARTRIDGE, which issued on Mar. 12, 2013;

[0761] U.S. patent application Ser. No. 11/343,803, entitled SURGICAL INSTRUMENT HAVING RECORDING CAPABILITIES; now U.S. Pat. No. 7,845,537;

[0762] U.S. patent application Ser. No. 12/031,573, entitled SURGICAL CUTTING AND FASTENING INSTRUMENT HAVING RF ELECTRODES, filed Feb. 14, 2008;

[0763] U.S. patent application Ser. No. 12/031,873, entitled END EFFECTORS FOR A SURGICAL CUTTING AND STAPLING INSTRUMENT, filed Feb. 15, 2008, now U.S. Pat. No. 7,980,443;

[0764] U.S. patent application Ser. No. 12/235,782, entitled MOTOR-DRIVEN SURGICAL CUTTING INSTRUMENT, now U.S. Pat. No. 8,210,411;

[0765] U.S. patent application Ser. No. 12/249,117, entitled POWERED SURGICAL CUTTING AND STAPLING APPARATUS WITH MANUALLY RETRACTABLE FIRING SYSTEM, now U.S. Pat. No. 8,608,045;

[0766] U.S. patent application Ser. No. 12/647,100, entitled MOTOR-DRIVEN SURGICAL CUTTING INSTRUMENT WITH ELECTRIC ACTUATOR DIRECTIONAL CONTROL ASSEMBLY, filed Dec. 24, 2009; now U.S. Pat. No. 8,220,688;

[0767] U.S. patent application Ser. No. 12/893,461, entitled STAPLE CARTRIDGE, filed Sep. 29, 2012, now U.S. Pat. No. 8,733,613;

[0768] U.S. patent application Ser. No. 13/036,647, entitled SURGICAL STAPLING INSTRUMENT, filed Feb. 28, 2011, now U.S. Pat. No. 8,561,870;

[0769] U.S. patent application Ser. No. 13/118,241, entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, now U.S. Pat. No. 9,072,535;

[0770] U.S. patent application Ser. No. 13/524,049, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING A FIRING DRIVE, filed on Jun. 15, 2012; now U.S. Pat. No. 9,101,358;

[0771] U.S. patent application Ser. No. 13/800,025, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, filed on Mar. 13, 2013, now U.S. Patent Application Publication No. 2014/0263551;

[0772] U.S. patent application Ser. No. 13/800,067, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, filed on Mar. 13, 2013, now U.S. Patent Application Publication No. 2014/0263552;

[0773] U.S. Patent Application Publication No. 2007/0175955, entitled SURGICAL CUTTING AND FASTENING INSTRUMENT WITH CLOSURE TRIGGER LOCKING MECHANISM, filed Jan. 31, 2006; and

[0774] U.S. Patent Application Publication No. 2010/0264194, entitled SURGICAL STAPLING INSTRUMENT WITH AN ARTICULATABLE END EFFECTOR, filed Apr. 22, 2010, now U.S. Pat. No. 8,308,040, are hereby incorporated by reference herein.

[0775] Although various devices have been described herein in connection with certain embodiments, modifications and variations to those embodiments may be implemented. Particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments. Thus, the particular features, structures, or characteristics illustrated or described in connection with one embodiment may be combined in whole or in part, with the features, structures or characteristics of one ore more other embodiments without limitation. Also, where materi-

als are disclosed for certain components, other materials may be used. Furthermore, according to various embodiments, a single component may be replaced by multiple components, and multiple components may be replaced by a single component, to perform a given function or functions. The foregoing description and following claims are intended to cover all such modification and variations.

[0776] The devices disclosed herein can be designed to be disposed of after a single use, or they can be designed to be used multiple times. In either case, however, a device can be reconditioned for reuse after at least one use. Reconditioning can include any combination of the steps including, but not limited to, the disassembly of the device, followed by cleaning or replacement of particular pieces of the device, and subsequent reassembly of the device. In particular, a reconditioning facility and/or surgical team can disassemble a device and, after cleaning and/or replacing particular parts of the device, the device can be reassembled for subsequent use. Those skilled in the art will appreciate that reconditioning of a device can utilize a variety of techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

[0777] The devices disclosed herein may be processed before surgery. First, a new or used instrument may be obtained and, when necessary, cleaned. The instrument may then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK bag. The container and instrument may then be placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, and/or high-energy electrons. The radiation may kill bacteria on the instrument and in the container. The sterilized instrument may then be stored in the sterile container. The sealed container may keep the instrument sterile until it is opened in a medical facility. A device may also be sterilized using any other technique known in the art, including but not limited to beta radiation, gamma radiation, ethylene oxide, plasma peroxide, and/or steam.

[0778] While this invention has been described as having exemplary designs, the present invention may be further modified within the spirit and scope of the disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles.

[0779] Any patent, publication, or other disclosure material, in whole or in part, that is said to be incorporated by reference herein is incorporated herein only to the extent that the incorporated materials do not conflict with existing definitions, statements, or other disclosure material set forth in this disclosure. As such, and to the extent necessary, the disclosure as explicitly set forth herein supersedes any conflicting material incorporated herein by reference. Any material, or portion thereof, that is said to be incorporated by reference herein, but which conflicts with existing definitions, statements, or other disclosure material set forth herein will only be incorporated to the extent that no conflict arises between that incorporated material and the existing disclosure material.

What is claimed is:

1. A surgical tool assembly, comprising:

a surgical end effector comprising:

a first jaw; and

a second jaw comprising a second jaw body portion and a second jaw mounting portion, said second jaw mounting portion movably coupled to said first jaw for selective movement relative thereto between an open position and closed positions and wherein said surgical instrument further comprises:

a closure member axially movable in response to closing and opening motions applied thereto, said closure member comprising at least one opening cam formed thereon, said at least one opening cam being configured to movably engage a corresponding cam surface formed on said second jaw body portion such that upon application of said opening motion to said closure member, said at least one opening cam movably engages said corresponding cam surface to move said second jaw to said open position and upon application of said closure motion to said closure member, said closure member engages said second jaw to move said second jaw to one of said closed positions.

2. The surgical tool assembly of claim **1**, wherein said at least one opening cam comprises:

a first hook portion extending distally from a distal end of said closure member and being configured to cammingly engage a first one of said cam surfaces formed on said second jaw body portion; and

a second hook portion extending distally from said distal end of said closure member and being configured to cammingly engage a second one of said cam surfaces formed on said second jaw body portion.

3. The surgical tool assembly of claim **1**, wherein said cam surface comprises a downwardly extending ramp surface formed on said second jaw body portion.

4. The surgical tool assembly of claim **3**, wherein each said at least one opening cam comprises a camming end formed thereon configured to cammingly engage said corresponding ramp surface upon application of said opening motion to said closure member.

5. The surgical tool assembly of claim **4**, wherein each said ramp surface comprises a ramp surface end and wherein each said camming end is configured to engage said ramp surface end of said corresponding ramp surface to retain said second jaw in a fully open position relative to said first jaw.

6. The surgical tool assembly of claim **1**, further comprising secondary jaw opening means for applying additional opening motion to said second jaw.

7. The surgical tool assembly of claim **6**, wherein said secondary jaw opening means comprises at least one secondary jaw opening member on said closure member configured to engage a corresponding jaw opening feature on said second jaw to apply said additional opening motion to said second jaw as said opening motion is applied to said closure member.

8. The surgical tool assembly of claim **7**, wherein said secondary jaw opening feature comprises:

at least one first jaw opening tab integrally formed in said closure member and configured to contact a corresponding one of said corresponding jaw opening feature; and

at least one second jaw opening tab integrally formed in said closure member and configured to contact another corresponding one of said corresponding jaw opening feature.

9. The surgical tool assembly of claim **6**, wherein said secondary jaw opening means comprises at least one biasing member configured to apply additional opening motion to said second jaw.

10. The surgical tool assembly of claim **2**, wherein said first and second hook portions each comprise a compliant portion thereon.

11. The surgical tool assembly of claim **10**, wherein said compliant portion comprises a compliant material attached to each of said first and second hook portions.

12. The surgical tool assembly of claim **10**, wherein said at least one biasing member comprises a spring corresponding to each of said first and second hook portions and being attached thereto.

13. A surgical tool assembly, comprising:

a surgical end effector comprising:

an elongate channel configured to operably support a surgical staple cartridge therein; and

an anvil comprising an anvil body and an anvil mounting portion, said anvil mounting portion pivotally supported on said elongate channel for selective movement relative thereto between an open position and closed positions and wherein said surgical instrument further comprises:

a closure member axially movable in response to closing and opening motions applied thereto, said closure member comprising at least one opening cam formed thereon, said at least one opening cam being configured to movably engage a corresponding cam surface formed on said anvil body portion such that upon application of said opening motion to said closure member, said at least one opening cam movably engages said corresponding cam surface to move said anvil to said open position and upon application of said closure motion to said closure member, said closure member engages said anvil to move said anvil to one of said closed positions.

14. The surgical tool assembly of claim **13**, further comprising at least one tissue stop formed on said anvil body and wherein said at least one cam surface is located proximal to said at least one tissue stop.

15. The surgical tool assembly of claim **13**, wherein said at least one opening cam comprises:

a first hook portion extending distally from a distal end of said closure member and being configured to cammingly engage a first one of said cam surfaces formed on said anvil body; and

a second hook portion extending distally from said distal end of said closure member and being configured to cammingly engage a second one of said cam surfaces formed on said anvil body.

16. The surgical tool assembly of claim **15**, wherein said first and second hook portions each comprise a compliant portion thereon.

17. The surgical tool assembly of claim **13**, wherein said first and second hook portions each comprise a compliant portion thereon.

18. The surgical tool assembly of claim **13**, further comprising secondary anvil opening means for applying additional opening motion to said second jaw.

19. The surgical tool assembly of claim **18**, wherein said anvil is pivotally coupled to said elongate channel for selective pivotal travel between said open and closed positions about a pivot axis and wherein said secondary anvil opening means is located proximal to said pivot axis.

20. A surgical tool assembly, comprising:

a surgical end effector comprising:

an elongate channel configured to operably support a surgical staple cartridge therein; and

an anvil comprising an anvil body and an anvil mounting portion, said anvil mounting portion pivotally supported on said elongate channel for selective movement relative thereto between an open position and closed positions and wherein said surgical instrument further comprises:

a closure member axially movable between a fully actuated position corresponding to a fully closed one of said closed positions and an unactuated position corresponding to said open position, said closure member comprising a closure system configured to sequentially apply initial opening motions to said anvil and additional secondary motions to said anvil as said closure member is moved from said fully actuated position to said unactuated position.

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