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ADAPTER, EXTENSION, AND CONNECTOR ASSEMBLIES FOR SURGICAL DEVICES

Abstract

An assembly including an adapter assembly and an extension assembly for connecting an end effector to an electrosurgical instrument is provided. The adapter assembly includes first and second pusher assemblies configured for converting rotational motion into linear motion and a drive member for transferring rotational motion. The extension assembly includes at least one flexible band assembly for transferring the linear motion from the adapter assembly and a trocar assembly configured for converting rotational motion into linear motion. Also provided is a connection assembly for connecting a first tubular member to a second tubular member.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. application Ser. No. 17/878,131 filed Aug. 1, 2022, which is a continuation application of U.S. application Ser. No. 16/262,242 filed Jan. 30, 2019, now U.S. Pat. No. 11,399,836, which is a divisional of U.S. application Ser. No. 14/875,766 filed Oct. 6, 2015, now U.S. Pat. No. 10,226,254, which claims the benefit of and priority to U.S. Provisional Patent Application No. 62/066,518 filed Oct. 21, 2014, the entire disclosures each of which are incorporated by reference herein.

FIELD

[0002] The present disclosure relates generally to powered surgical devices. More specifically, the present disclosure relates to adapter and extension assemblies for selectively connecting end effectors to the actuation units of the powered surgical devices.

BACKGROUND

[0003] Powered devices for use in surgical procedures are known. To permit reuse of the handle assemblies of these powered surgical devices and so that the handle assembly may be used with a variety of end effectors, adapter assemblies and extension assemblies have been developed for selective attachment to the handle assemblies and to a variety of end effectors. Following use, the adapter and/or extension assemblies may be disposed of along with the end effector. In some instances, the adapter assemblies and extension assemblies may be sterilized for reuse.

SUMMARY

[0004] An assembly for operably connecting an end effector to an electrosurgical instrument is provided. The assembly includes an adapter assembly and an extension assembly. The adapter assembly includes a connector assembly, a drive transfer assembly operably received through the connector assembly and including first, second, and third rotatable shafts, a first pusher assembly operably connected to the first rotatable shaft for converting rotational motion from the first rotatable shaft to longitudinal movement to perform a first function, a second pusher assembly operably connected to the second rotatable shaft for converting rotational motion from the second rotatable shaft to longitudinal movement to perform a second function, and a drive member operably connected to the third rotatable shaft for transferring rotational motion from the third rotatable shaft to perform a third function. The drive transfer assembly and the first and second pusher assemblies are operably received within a single outer tube. The extension is operably connected to a distal end of the adapter assembly and includes at least one flexible band assembly operably connected to one of the first and second pusher assemblies.

[0005] In embodiments, the first pusher assembly includes a first planetary gear assembly and the second pusher assembly includes a second planetary gear assembly. Each of the first and second planetary gear assemblies may include a first planetary gear system and a second planetary gear system. Each of the first and second planetary gear systems may be configured to reduce a speed of rotation of the first and second rotatable shafts. The first pusher assembly may include a first drive screw operably connected to the first planetary gear assembly and the second pusher assembly may

include a second drive screw operably connected to the second planetary gear assembly. The first pusher assembly may include a first pusher member operably received about the first drive screw and the second pusher assembly may include a second pusher member operably received about the second screw member. Rotation of the first drive screw may cause longitudinal movement of the first pusher member and rotation of the second drive screw may cause longitudinal movement of the second pusher member. The adapter assembly may further include a base and a support structure rotatable relative to the base along a longitudinal axis, the connector assembly and the drive transfer assembly being disposed with in the base and the first and second pusher assemblies being disposed within the support structure. The connection assembly may be configured for operable connection to an electrosurgical instrument.

[0006] In some embodiments, the extension assembly includes a second flexible band assembly operably connected to the other of the first and second pusher assemblies. The extension assembly may include a trocar assembly operably connected to the drive member. The trocar assembly may convert rotational motion from the drive member into linear motion. The extension assembly may include a link assembly operably connecting the trocar assembly to the drive member. The link assembly may include a first drive shaft pivotally connected to a second drive shaft and a coupling member pivotally connected to the second drive shaft.

[0007] An extension assembly for operably connecting an end effector to an electrosurgical instrument is also provided. The extension assembly includes an outer sleeve, a frame assembly received within the outer sleeve, an inner flexible band assembly slidably disposed within the frame assembly for performing a first function, an outer flexible band assembly slidably disposed within the frame assembly and relative to the inner flexible band assembly for performing a second function, and a trocar assembly disposed within the frame assembly and including a trocar member for performing a third function. The inner flexible band assembly may include a proximal end configured for connection to a first linear drive member and the outer flexible band assembly may include a proximal end configured for connection to a second linear drive member. A proximal end of the trocar assembly may be configured for connection to a rotatable drive shaft. Rotation of the rotatable drive shaft may cause linear advancement of the trocar member. The extension assembly may further include a connection assembly configured for operable connection with an end effector. A distal end of the inner flexible band assembly may include a flange configured for operable connection with an end effector and a distal end of the outer flexible band assembly includes a flange configured for operable connection with an end effector. The trocar member may be configured for operably connection with an anvil assembly. The extension assembly may further include a link assembly for operable connection with the trocar assembly, the link assembly including a first shaft pivotally secured to a second shaft and a coupling member.

[0008] Also provided is a connection assembly for securing a first tubular member to a second tubular member. The connection assembly includes a tubular base having a flange and an annular rim. The connection assembly further includes a tubular extension having first and second sections and an outer sleeve slidably disposed about the first and second sections. The first and second sections may define an annular groove positioned to receive the annular rim of the tubular base when the first and second sections are received about the flange. The tubular base may be secured to the first tubular member and the tubular extension may be secured to the second tubular member. The tubular base may be formed on an end of the first tubular member and the tubular extension is formed on an end of the second tubular member.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Embodiments of the present disclosure are described herein with reference to the

accompanying drawings, wherein:
[0010] FIG. **1** is a perspective separated view of an adapter assembly, in accordance with an embodiment of the present disclosure, an extension assembly, in accordance with an embodiment of the present disclosure, and an exemplary electromechanical surgical device;
[0011] FIG. **2** is a perspective side view of the exemplary electromechanical surgical device of FIG. **1**;
[0012] FIG. **3** is a perspective side view of the adapter assembly of FIG. **1**;
[0013] FIG. **4** is a perspective side view of the adapter assembly of FIG. **3** with the outer sleeve removed;
[0014] FIG. **5** is a perspective side view of the adapter assembly of FIGS. **3** and **4** with proximal and distal housings of first and second pusher assemblies removed;
[0015] FIG. **6** is a cross-sectional side view of the adapter assembly of FIGS. **2-4** taken along line **6-6** in FIG. **3**;
[0016] FIG. **7** is a cross-sectional side view of the adapter assembly of FIGS. **2-5** taken along line **7-7** in FIG. **5**;
[0017] FIG. **8** is an enlarged, perspective view of a coupling assembly and a transfer assembly of the adapter assembly of FIGS. **2-7**;
[0018] FIG. **9** is a perspective side view of adapter assembly of FIGS. **2-7** with the housing assemblies removed;
[0019] FIG. **10** is an enlarged view of the indicated area of detail of FIG. **9**;
[0020] FIG. **11** is an enlarged view of the indicated area of detail of FIG. **6**;
[0021] FIG. **12** is an enlarged view of the indicated area of detail of FIG. **7**;
[0022] FIG. **13** is a perspective end view of the transfer assembly of FIG. **8**;
[0023] FIG. **14** is an enlarged view of the indicated area of detail of FIG. **6**;
[0024] FIG. **15** is an enlarged view of the indicated area of detail of FIG. **7**;
[0025] FIG. **16** is an enlarged view of the indicated area of detail of FIG. **9**;
[0026] FIG. **17** perspective side view of the extension assembly of FIG. **1**;
[0027] FIG. **18** is a perspective side view of an inner flexible band assembly of the extension assembly of FIG. **17**;
[0028] FIG. **19** is a perspective side view of an outer flexible band assembly of the extension assembly of FIG. **17**;
[0029] FIG. **20** is a perspective side view of the inner and outer flexible band assemblies of FIGS. **18** and **19** and an exploded view of a frame assembly of the extension assembly of FIG. **17**;
[0030] FIG. **21** is a perspective side view of the inner and outer flexible band assemblies and frame assembly of FIG. **20**;
[0031] FIG. **22** is an enlarged view of the indicated area of detail of FIG. **21**;
[0032] FIG. **23** is a front, perspective view of the inner and outer flexible band assemblies and frame assembly of FIG. **20**;
[0033] FIG. **24** is an enlarged view of the indicated area of detail of FIG. **23**;
[0034] FIG. **25** is a cross-sectional end view taken along line **25-25** of FIG. **17**;
[0035] FIG. **26** is a cross-sectional end view taken along line **26-26** of FIG. **17**;
[0036] FIG. **27** is an enlarged perspective side view of a distal end of the inner and outer flexible band assemblies and frame assembly of FIG. **20** including a proximal seal member and first and second distal seal members;
[0037] FIG. **28** is an exploded perspective view of the proximal seal member and first and second distal seal members of FIG. **27**;
[0038] FIG. **29** is an exploded view of a trocar assembly of the extension assembly of FIG. **17**;
[0039] FIG. **29**A is a perspective side view of a link assembly of the extension assembly of FIG. **17**;
[0040] FIG. **29**B is a cross-sectional side view of the link assembly of FIG. **29**A;

[0041] FIG. **30** is a perspective side view of the trocar assembly of FIG. **29**;
[0042] FIG. **31** is a cross-sectional side view taken along line **31**-**31** of FIG. **30**;
[0043] FIG. **32** is a cross-sectional top view taken along line **32**-**32** of FIG. **17**;
[0044] FIG. **33** is an enlarged cross-sectional view of the distal end of the extension assembly of FIG. **17**;
[0045] FIG. **34** is a perspective side view of the adapter assembly of FIG. **3** connected to the extension assembly of FIG. **17** and an end effector and an anvil assembly connected to the extension assembly;
[0046] FIG. **35**A is an enlarged cross-sectional top view of the indicated area of detail of FIG. **34**;
[0047] FIG. **35**B is an enlarged cross-sectional side view of the indicated area of detail in FIG. **34**;
[0048] FIG. **36** is a rear, perspective view of an adapter assembly according to another embodiment of the present disclosure;
[0049] FIG. **37** is a perspective side view of the adapter assembly of FIG. **36** with an outer sleeve and a handle member removed;
[0050] FIG. **38** is a perspective side view of adapter assembly of FIG. **37** with a base and housing members removed;
[0051] FIG. **39** is a perspective side view of the adapter assembly of FIG. **38** with a support structure removed;
[0052] FIG. **40** is a cross-sectional side view taken along line **40**-**40** of FIG. **36**;
[0053] FIG. **41** is a cross-sectional side view taken along line **41**-**41** of FIG. **40**;
[0054] FIG. **42** is a rear, perspective view of an adapter assembly according to yet another embodiment of the present disclosure;
[0055] FIG. **43** is a cross-sectional side view taken along line **43**-**43** of FIG. **42**;
[0056] FIG. **44** is a cross-sectional side view taken along line **44**-**44** of FIG. **42**;
[0057] FIG. **45** is a perspective view of a connector assembly according to an embodiment of the present disclosure;
[0058] FIG. **46** is an exploded perspective view of the connector assembly of FIG. **45**;
[0059] FIG. **47** is a perspective view of the connector assembly of FIG. **45** with a sleeve and first section of a tubular extension removed;
[0060] FIG. **48** is a perspective view of the connector assembly of FIG. **45** with the sleeve removed; and
[0061] FIG. **49** is a cross-sectional side view taken along line **49**-**49** of FIG. **45**.

DETAILED DESCRIPTION

[0062] Embodiments of the presently disclosed adapter assemblies and extension assemblies for surgical devices and/or handle assemblies are described in detail with reference to the drawings, in which like reference numerals designate identical or corresponding elements in each of the several views. As used herein the term “distal” refers to that portion of the adapter assembly or surgical device, or component thereof, farther from the user, while the term “proximal” refers to that portion of the adapter assembly or surgical device, or component thereof, closer to the user.
[0063] With reference to FIG. **1**, an adapter assembly in accordance with an embodiment of the present disclosure, shown generally as adapter assembly **100**, and an extension assembly according to an embodiment of the present disclosure, shown generally as extension assembly **200**, are configured for selective connection to a powered hand held electromechanical instrument shown, generally as surgical device **10**. As illustrated in FIG. **1**, surgical device **10** is configured for selective connection with adapter assembly **100**, and, in turn, adapter assembly **100** is configured for selective connection with an extension assembly **200**. Extension assembly **200** is configured for selective connection with a tool assembly or end effector, e.g. tool assembly **30** (FIG. **34**), including a loading unit, e.g. loading unit **40** (FIG. **34**), and an anvil assembly, e.g., anvil assembly **50** (FIG. **34**), for applying a circular array of staples (not shown) to tissue (not shown).
[0064] As illustrated in FIGS. **1** and **2**, surgical device **10** includes a handle housing **12** having a

lower housing portion **14**, an intermediate housing portion **16** extending from and/or supported on lower housing portion **14**, and an upper housing portion **18** extending from and/or supported on intermediate housing portion **16**. A distal half-section of upper housing portion **18** defines a nose or connecting portion **18***a* configured to accept a corresponding drive coupling assembly **110** (FIG. **10**) of adapter assembly **100**. For a detailed description of the structure and function of an exemplary electromechanical instrument, please refer to commonly owned U.S. Pat. Appl. Publ. No. 2012/0253329 ("the '329 application"), the contents of which is incorporated by reference herein in its entirety.

[0065] Adapter assembly **100** will now be described with reference to FIGS. **3-20**. Referring initially to FIG. **3**, adapter assembly **100** includes a proximal end **102** configured for operable connection to connecting portion **18***a* (FIG. **1**) of surgical device **10** (FIG. **1**) and a distal end **104** configured for operable connection to extension assembly **200** (FIG. **1**).

[0066] Turning to FIGS. **3-5**, from proximal end **102** to distal end **104** of adapter assembly **100** includes a drive coupling assembly **110**, a drive transfer assembly **130** operably connected to drive coupling assembly **110**, a first pusher assembly **160** operably connected to drive transfer assembly **130**, and a second pusher assembly **180** operably connected to drive transfer assembly **130**. Each of drive transfer assembly **130**, first pusher assembly **160** and second pusher assembly **180** are operably maintained within an outer sleeve **106** (FIG. **3**). As will be described in further detail below, a shaft **108** (FIG. **3**) extends longitudinally through adapter assembly **100** and is operably connected to drive transfer assembly **130**.

[0067] With reference to FIGS. **5-9**, drive coupling assembly **110** has a cylindrical profile and is configured to selectively secure adapter assembly **100** to surgical device **10** (FIG. **1**). Drive coupling assembly **110** includes a connector housing **112** and a connector extension **114** fixedly connected to connector housing **112** by a mounting plate **113**. Connector housing **112** and connector extension **114** operate to rotatably support a first rotatable proximal drive shaft **116**, a second rotatable proximal drive shaft **118**, and a third rotatable proximal drive shaft **120**. Connector housing **112** and connector extension **114** of drive coupling assembly **110** also rotatably supports first, second, and third connector sleeves **116**, **118**, and **120**, respectively. Each of connector sleeves **122**, **124**, **126** is configured to mate with respective first, second, and third drive connectors (not shown) of surgical device **10** (FIG. **1**). Each connector sleeve **122**, **124**, **126** is further configured to mate with a proximal end **116***a*, **118***a*, **120***a* of respective first, second and third proximal drive shafts **116**, **118**, **120**.

[0068] Drive coupling assembly **110** also includes first, second and third biasing members **122***a*, **124***a* and **126***a* disposed distally of respective first, second and third connector sleeves **122**, **124**, **126**. Each of biasing ember **122***a*, **124***a* and **126***a* is disposed about respective first, second, and third rotatable proximal drive shafts **122**, **124** and **126** to help maintain connector sleeves **122**, **124**, and **126** engaged with the distal end of respective drive rotatable drive connectors (not shown) of surgical device **10** when adapter assembly **100** is connect to surgical device **10**. In particular, first, second and third biasing members **122***a*, **124***a* and **126***a* function to bias respective connector sleeves **122**, **124** and **126** in a proximal direction.

[0069] For a detailed description of an exemplary drive coupling assembly, please refer to the '329 application, the contents of which was previously incorporated by reference herein.

[0070] With reference to FIGS. **9-13**, drive transfer assembly **130** has a cylindrical profile and operably connects distal ends of first, second and third rotatable proximal drive shafts **116**, **118** and **120** to shaft **108**, first pusher assembly **160**, and second pusher assembly **180**, respectively. Drive transfer assembly **130** includes a support plate **132** (FIGS. **11** and **12**) secured to a proximal end of connector housing **112** and a drive transfer housing **134** positioned adjacent support plate **132**. Support plate **132** and housing **134** operate to rotatably support a first rotatable distal drive shaft **136**, a second rotatable distal drive shaft **138** and a drive member **140**.

[0071] First and second rotatable distal drive shafts **136** and **138** are each operably connected to

respective first and second rotatable proximal drive shafts **116** and **118** of drive coupling assembly **110** by a pair of gears. In particular, distal ends of each of first and second rotatable proximal drive shaft **116** and **118** include a geared portion **142***a* and **144***a*, respectively, which engages a proximal drive gear **142***b* and **144***b* on a proximal end of respective first and second distal drive shafts **136** and **138**. As shown, each of respective paired geared portion and proximal drive gear **142***a*, **142***b* and **144***a*, **144***b* are the same size to provide a 1:1 gear ratio between the respective rotatable proximal and distal drive shafts. In this manner, respective rotatable proximal and distal drive shafts rotate at the same speed. However, it is envisioned that either or both of the paired geared portions and proximal drive gears may be of different sizes to alter the gear ratio between the rotatable proximal and distal drive shafts.

[0072] A distal end of third proximal drive shaft **120** of drive coupling assembly **110** includes a geared portion **146***a* that engages a geared portion **146***b* formed on a proximal end of drive member **140** of drive transfer assembly **130**. The size of geared portion **146***a* on third proximal drive shaft **120** and geared portion **146***b* on drive member **140** are the same size to provide a 1:1 gear ratio between third proximal drive shaft **120** and drive member **140**. In this manner, third proximal drive shaft **120** and drive member **140** rotate at the same speed. However, it is envisioned that either or both of geared portions **146***a*, **146***b* may be of different sizes to alter the gear ratio between third proximal drive shaft **120** and drive member **140**. A distal end of drive member **140** defines a socket **145** that receives a proximal end **108***a* of shaft **108**. Alternatively, socket **145** may be configured to operably engage a proximal end **208***a* of a drive shaft (FIG. **17**) of an extension assembly **200** (FIG. **17**).

[0073] Drive transfer assembly **130** also includes a drive connector **148** (FIG. **11**) operably connecting first rotatable distal drive shaft **136** to first pusher assembly **160** and a tubular connector **150** operably connecting second rotatable distal drive shaft **138** to second pusher assembly **180**. In particular, a distal end of first rotatable distal drive shaft **136** includes a geared portion **152***a* that engages a geared portion **152***b* of drive connector **148**. A distal end of second rotatable distal drive shaft **138** includes a geared portion **154***a* that engages a drive gear **154***b* secured to a distal end of tubular connector **150**.

[0074] As shown, geared portion **152***a* of first rotatable distal drive shaft **136** is smaller than geared portion **152***b* of drive connector **148** to provide a gear ratio of greater than 1:1 between first rotatable distal drive shaft **136** and drive connector **148**. In this manner, drive connector **148** rotates at a slower speed than first rotatable distal drive shaft **136**. Similarly, geared portion **154***a* of second rotatable distal drive shaft **138** is smaller than drive gear **154***b* on tubular connector **150** to provide a gear ratio of greater than 1:1 between second rotatable distal drive shaft **138** and drive connector **148**. In this manner, tubular connector **150** rotates at a slower speed than second rotatable distal drive shaft **138**. However, it is envisioned that each of paired geared portion **152***a* and geared portion **152***b*, and geared portion **154***a* and drive gear **154***b* may be the same size to provide a gear ratio of 1:1 between respective first rotatable distal drive shaft **136** and drive connector **148** and between second rotatable distal drive shaft **138** and tubular connector **150**.

[0075] With particular reference to FIGS. **9-13**, first pusher assembly **160** includes proximal and distal housing sections **162**, **164** (FIG. **11**), a planetary gear assembly **166** operably mounted within proximal housing section **162**, a screw member **168** (FIG. **11**) operably connected to planetary gear assembly **166** and rotatably supported within distal housing section **164**, and a pusher member **170** (FIG. **11**) operably connected screw member **168** and slidably disposed within distal housing section **164**. Proximal housing section **162** includes a pair of longitudinal flanges **162***a* (FIG. **4**; only one shown) and distal housing section **164** includes a pair of longitudinally flattened portions **164***a*. Each of the flanges **162***a* and the flattened portions **164***a* of respective proximal and distal housing sections **162**, **164** engage an inner surface of sleeve **106** to prevent rotation of respective proximal housing section **162** and distal housing section **164** relative to sleeve **106** during operation of surgical device **10**. Planetary gear assembly **166** includes first and second planetary gear systems

166*a*, **166***b* (FIG. **10**). First planetary gear system **166***a* includes a central drive gear **172***a* mounted on a distal end of drive connector **148** of drive transfer assembly **130** and a plurality of planetary gears **174***a* rotatably mounted to a rotatable support ring **176**.

[0076] Each planetary gear **174***a* engages central drive gear **172***a* and a toothed inner surface **165** of proximal housing section **162**. As central drive gear **172***a* rotates in a first direction, i.e., clockwise, each planetary gear **174***a* rotates in a second direction, i.e., counter-clockwise. As each planetary gear **174***a* rotates in the second direction, engagement of planetary gears **174***a* with toothed inner surface **165** of distal housing section **162** causes rotatable support ring **176** to rotate in the first direction. Conversely, rotation of central drive gear **172***a* in the second direction causes rotation of each planetary gear **174***a* in the first direction thereby causing rotation of rotatable support ring **176** in the second direction. The configuration of first planetary gear system **166***a* provides a reduction in the gear ratio. In this manner, the speed of rotation of rotatable support ring **174** is less than the speed of rotation of central drive gear **172***a*.

[0077] Second planetary gear system **166***b* includes a central drive gear **172***b* securely affixed to rotatable support ring **176** and a plurality of planetary gears **174***b* rotatably mounted to a proximal end surface **168***a* of screw member **168**. Each planetary gear **174***b* engages central drive gear **172***b* and toothed inner surface **165** of proximal housing section **162**. As rotatable support ring **176** of first planetary gear system **166***a* rotates in the first direction thereby causing central drive gear **172***b* to also rotate in the first direction, each planetary gear **174***b* rotates in the second direction. As each planetary gear **174***b* rotates in the second direction, engagement of planetary gears **174***b* with toothed inner surface **165** of proximal housing section **162** causes screw member **168** to rotate in the first direction. Conversely, rotation of central drive gear **172***b* in the second direction causes rotation of each planetary gear **174***b* in the first direction, thereby causing screw member **168** to rotate in the second direction. The configuration of second planetary gear system **166***b* provides a reduction in the gear ratio. In this manner, the speed of rotation of screw member **168** is less than the speed of rotation of central drive gear **172***b*. First and second planetary gear systems **166***a*, **166***b* operate in unison to provide a reduction in the gear ratio between first rotatable proximal drive shaft **116** and screw member **168**. In this manner, the reduction in the speed of rotation of screw member **168** relative to drive connector **148** is a product of the reduction provided by the first and second planetary gear systems **166***a*, **166***b*.

[0078] Screw member **168** is rotatably supported within proximal housing portion **162** and includes a threaded distal end **168***b* that operably engages a threaded inner surface **170***a* of pusher member **170**. As screw member **168** is rotated in the first direction, engagement of threaded distal end **168***b* of screw member **168** with threaded inner surface **170***a* of pusher member **170** causes longitudinal advancement of pusher member **170**, as indicated by arrows “A” in FIG. **12**. Conversely, rotation of screw member **168** in the second direction causes retraction of pusher member **170**.

[0079] Pusher member **170** includes a pair of tabs **178** formed on a distal end thereof for engaging connector extensions **240**, **242** (FIG. **19**) of outer flexible band assembly **230** (FIG. **19**) of extension assembly **200** (FIG. **17**). Although shown as tabs **178**, it is envisioned that pusher member **170** may include any structure suitable for selectively engaging connector extensions **240**, **242** of outer flexible band **230** of extension assembly **200**.

[0080] With particular reference now to FIGS. **14-16**, second pusher assembly **180** is substantially similar to first pusher assembly **160**, and includes proximal and distal housing sections **182**, **184**, a planetary gear assembly **186** operably mounted within proximal housing section **182**, a screw member **188** operably connected to planetary gear assembly **186** and rotatably supported within distal housing section **184**, and a pusher member **190** operably connected to screw member **188** and slidably disposed within distal housing section **184**. Each of proximal housing section **182** and distal housing section **184** includes a pair of longitudinal flanges **182***a*, **184***a* (FIG. **4**; only one shown), respectively, engage an inner surface of sleeve **106** of adapter assembly **100** to prevent rotation of respective proximal housing section **182** and distal housing section **184** relative to

sleeve **106** during operation of surgical device **10**. Planetary gear assembly **186** includes first and second planetary gear systems **186***a*, **186***b* (FIG. **16**). First planetary gear system **186***a* includes a central drive gear **192***a* mounted on a distal end of tubular connector **150** of drive transfer assembly **130** and a plurality of planetary gears **194***a* rotatably mounted to a rotatable support ring **196**.

[0081] Each planetary gear **194***a* engages central drive gear **192***a* and a toothed inner surface **185** of proximal housing section **182**. As central drive gear **192***a* rotates in a first direction, i.e., clockwise, each planetary gear **194***a* rotates in a second direction, i.e., counter-clockwise. As each planetary gear **194***a* rotates in the second direction, engagement of planetary gears **194***a* with toothed inner surface **185** of distal housing section **182** causes rotatable support ring **196** to rotate in the first direction. Conversely, rotation of central drive gear **192***a* in the second direction causes rotation of each planetary gear **194***a* in the first direction thereby causing rotation of rotatable support ring **196** in the second direction. The configuration of first planetary gear system **186***a* provides a reduction in the gear ratio. In this manner, the speed of rotation of rotatable support ring **194** is less than the speed of rotation of central drive gear **190***a*.

[0082] Second planetary gear system **186***b* includes a central drive gear **192***b* securely affixed to rotatable support ring **196** and a plurality of planetary gears **194***b* rotatably mounted to a proximal end surface **188***a* of screw member **188**. Each planetary gear **194***b* engages central drive gear **192***b* and toothed inner surface **185** of proximal housing section **182**. As rotatable support ring **196** of first planetary gear system **186***a* rotates in the first direction thereby causing central drive gear **192***b* to also rotate in the first direction, each planetary gear **174***b* rotates in the second direction. As each planetary gear **194***b* rotates in the second direction, engagement of planetary gears **194***b* with toothed inner surface **185** of proximal housing section **182** causes screw member **188** to rotate in the first direction. Conversely, rotation of central drive gear **192***b* in the second direction causes rotation of each planetary gear **194***b* in the first direction, thereby causing screw member **198** to rotate in the second direction. The configuration of second planetary gear system **186***b* provides a reduction in the gear ratio. In this manner, the speed of rotation of screw member **188** is less than the speed of rotation of central drive gear **182***b*. First and second planetary gear systems **186***a*, **186***b* operate in unison to provide a reduction in the gear ratio between second rotatable proximal drive shaft **118** and screw member **188**. In this manner, the reduction in the speed of rotation of screw member **188** relative to tubular connector **150** is a product of the reduction provided by the first and second planetary gear systems **186***a*, **186***b*.

[0083] Screw member **188** is rotatably supported within proximal housing portion **182** and includes a threaded distal end **188***b* that operably engages a threaded inner surface **190***a* of pusher member **190**. As screw member **188** is rotated in the first direction, engagement of threaded distal end **188***b* of screw member **188** with threaded inner surface **190***a* of pusher member **190** causes longitudinal advancement of pusher member **190**. Conversely, rotation of screw member **188** in the second direction causes retraction of pusher member **190**. Pusher member **190** includes a pair of longitudinal flanges **191** (FIG. **5**; only one shown) that engage distal housing section **184** of second pusher assembly **180** for preventing rotation of pusher member **190** relative distal housing section **184**.

[0084] Pusher member **190** includes a pair of tabs **198** formed on a distal end thereof for engaging connector extensions **220**, **224** (FIG. **18**) of inner flexible band assembly **210** (FIG. **18**) of extension assembly **200** (FIG. **17**). Although shown as tabs **198**, it is envisioned that pusher member **190** may include any structure suitable for selectively engaging connector extensions **240**, **242** of outer flexible band **230** of extension assembly **200**.

[0085] Extension assembly **200** for operably connecting adapter assembly **100** (FIG. **3**) with a circular loading unit, e.g. loading unit **40** (FIG. **34**) and an anvil assembly, e.g., anvil assembly **50** (FIG. **34**) will be described with reference now to FIGS. **17-34**. In particular, a proximal end **202** of extension assembly **200** operably connects with distal end **104** (FIG. **3**) of adapter assembly **100** (FIG. **3**) and a distal end **204** of extension assembly **200** operably connects with loading unit **40**

and anvil assembly **50**. As shown, extension assembly **200** provides a slight curvature between proximal and distal end **202**, **204**. In alternative embodiment, extension assembly **200** may be straight or may include a greater curvature. Although extension assembly **200** will be shown and described as being used to connect loading unit **40** and anvil assembly **50** to adapter assembly **100** (FIG. **3**), it is envisioned that the aspects of the present disclosure may be modified for use with various loading units, anvil assemblies, and adapter assemblies. Exemplary loading units and anvil assemblies are described in commonly owned U.S. Pat. No. 8,590,763and U.S. patents application Ser. Nos. 14/056,301 and 14/149,355, the contents of each being incorporated herein by reference in their entirety.

[0086] Extension assembly **200** includes an inner flexible band assembly **210** (FIG. **18**), about an outer flexible band assembly **230** (FIG. **19**) slidably disposed about inner flexible band assembly **210**, a frame assembly **250** (FIG. **20**) for supporting inner and outer flexible band assemblies **210**, **230**, a trocar assembly **270** (FIG. **29**) operably received through inner and outer flexible band assemblies **210**, **230**, and a connector assembly **290** for securing loading unit **40** (FIG. **34**) to extension assembly **200**. An outer sleeve **206** (FIG. **17**) is received about frame assembly **250** and trocar assembly **270** and inner and outer flexible band assemblies **210**, **230** are slidably received through outer sleeve **206**. As will be described in further detail below, extension assembly **200** may include a drive shaft **208** operably connected to trocar assembly **270** and extending through proximal end **202** of extension assembly **200**.

[0087] With reference to FIG. **18**, inner flexible band assembly **210** includes first and second inner flexible bands **212**, **214**, a support ring **216**, a support base **218**, and first and second connection extensions **220**, **222**. Proximal ends **212***a*, **214***a* of respective first and second inner flexible bands **212**, **214** are laterally spaced apart and securely attached to support ring **216**. Distal ends **212***b*, **214***b* of first and second inner flexible bands **212**, **214** are laterally spaced apart and securely attached to a proximal end **218***a* of support base **218**. Each of first and second inner flexible bands **212**, **214** may be attached to support ring **216** and/or support base **218** in any suitable manner, including, for example, by press-fitting, welding, adhesives, and/or with mechanical fasteners. As will be described in further detail below, inner flexible band assembly **210** is configured to be slidably received about trocar assembly **270** (FIG. **28**) and within outer flexible band assembly **230** (FIG. **19**) and outer sleeve **206** (FIG. **17**).

[0088] First and second connection extensions **220**, **222** of inner flexible band assembly **210** extend proximally from support ring **216** and operably connect inner flexible band assembly **210** with pusher member **190** (FIG. **15**) of second pusher assembly **180** (FIG. **15**) of adapter assembly **100** (FIG. **3**). In particular, each of first and second connection extensions **220**, **222** define openings **221**, **223** configured to receive tabs **198** (FIG. **15**) of pusher member **190** (FIG. **15**) of second pusher assembly **180**. Receipt of tabs **198** of pusher member **190** within openings **221**, **223** of respective first and second extensions **220**, **222** secure inner flexible band assembly **210** of extension assembly **200** with second pusher assembly **180** of adapter assembly **100**. First and second connection extensions **220**, **222** may be integrally formed with support ring **216**, or attached thereto in any suitable manner.

[0089] Support base **218** extends distally from inner flexible bands **212**, **214** and is configured to selectively connect extension assembly **200** with loading unit **40** (FIG. **34**). Specifically, a distal end **218***b* **218***a* of support base **218** includes a flange **224** for operable engagement with an axially movable assembly (not shown) of loading unit **40** (FIG. **34**). In one embodiment, flange **224** is configured for connection with a knife assembly (not shown) of loading unit **40** (FIG. **34**).

[0090] With reference now to FIG. **19**, outer flexible band assembly **230** is substantially similar to inner flexible band assembly **210** and includes first and second flexible bands **232**, **234** laterally spaced and connected on proximal ends **232***a*, **234***a* to a support ring **236** and on distal ends **232***b*, **234***b* to a proximal end **238***a* of a support base **238**. Each of first and second outer flexible bands **232**, **234** may be attached to support ring **236** and support base **238** in any suitable manner,

including, for example, by press-fitting, welding, adhesives, and/or with mechanical fasteners. As will be described in further detail below, outer flexible band assembly **230** is configured to receive trocar assembly **270** (FIG. **28**) therethrough.

[0091] First and second connection extensions **240**, **242** of outer flexible band assembly **230** extend proximally from support ring **236** and operably connect outer flexible band assembly **230** with pusher member **170** (FIG. **12**) of first pusher assembly **160** (FIG. **12**) of adapter assembly **100** (FIG. **1**). In particular, each of first and second connection extensions **240**, **242** define openings **241**, **243** configured to receive tabs **178** (FIG. **12**) of pusher member **170** of first pusher assembly **180**. Receipt of tabs **178** of pusher member **170** within openings **241**, **243** of respective first and second extensions **240**, **242** secures outer flexible band assembly **230** of extension assembly **200** with first pusher assembly **180** of adapter assembly **100**. First and second connection extensions **240**, **242** may be integrally formed with support ring **236**, or attached thereto in any suitable manner.

[0092] Support base **238** extends distally from outer flexible bands **232**, **234** and is configured to selectively connect extension assembly **200** with loading unit **40** (FIG. **34**). Specifically, a distal end **238***b* of support base **238** includes a flange **244** for operable engagement with an axially movable assembly (not shown) of a loading unit (not shown). In one embodiment, flange **244** is configured for connection with a staple pusher assembly (not shown) of loading unit **40** (FIG. **34**).

[0093] With reference now to FIGS. **20-26**, frame assembly **250** includes first and second proximal spacer members **252**, **254**, and first and second distal spacer members **256**, **258**. When secured together, first and second proximal spacer members **252**, **254** define a pair of inner longitudinal slots **253***a* for slidably receiving first and second flexible bands **212**, **214** (FIG. **18**) of inner flexible band assembly **210** (FIG. **18**) and a pair of outer longitudinal slots **253***b* for slidably receiving first and second flexible bands **232**, **234** (FIG. **19**) of outer flexible band assembly **230** (FIG. **19**). First and second proximal spacer members **252**, **254** further define a longitudinal passage **255** for receipt of trocar assembly **270**.

[0094] In one embodiment, and as shown, first and second proximal spacer members **252**, **254** are formed of plastic and are secured together with a snap-fit arrangement. Alternatively, first and second proximal spacer members **252**, **254** may be formed of metal or other suitable material and may be secured together in any suitable manner, including by welding, adhesives, and/or using mechanical fasteners.

[0095] First and second distal spacer members **256**, **258** define a pair of inner slots **257***a* for slidably receiving first and second flexible bands **212**, **214** (FIG. **18**) of inner flexible band assembly **210** (FIG. **18**) and a pair of outer slots **257***b* for slidably receiving first and second flexible bands **232**, **234** (FIG. **19**) of outer flexible band assembly **230** (FIG. **19**). First and second distal spacer members **256**, **258** further define a longitudinal passage **259** for receipt of trocar assembly **270**.

[0096] In one embodiment, and as shown, each of first and second distal spacer members **256**, **258** are secured about inner and outer flexible band assemblies **210**, **230** and to outer sleeve **206** (FIG. **17**) by a pair of screws **260***a*, **260***b* (FIG. **26**). Alternatively, first and second distal spacer members **256**, **258** may be secured together in any suitable manner, including by welding, adhesives, and/or using mechanical fasteners. First and second distal spacer members **256**, **258** may be formed of metal or any other suitable material.

[0097] With reference now to FIGS. **27** and **28**, frame assembly **250** further includes a proximal seal member **252** and first and second distal seal members **264**, **266**. Each of proximal seal member **252** and first and second distal seal members **264**, **266** include seals halves **262***a*, **262***b*, **264***a*, **264***b*, **266***a*, **266***b*, respectively. Proximal seal member **262** is received between first and second proximal spacer members **252**, **254** and first and second distal spacer members **256**, **258**. First half **264***a* of first distal seal member **264** is secured to first half **266***a* of second distal seal member **266** and second half **264***b* of first distal seal member **264** is secured to second half of second distal seal

member **266**. Proximal seal member **262** and first and second distal seal members **264**, **266** engage outer sleeve **206** (FIG. **17**), inner and outer flexible bands **212**, **214** and **232**, **234** of respective inner and outer flexible band assemblies **210**, **230** and trocar assembly **270** (FIG. **28**) in a sealing manner. In this manner, proximal seal member **262** and first and second distal seal members **264**, **266** operate to provide a fluid tight seal between distal end **204** and proximal end **202** of extension assembly **200**.

[0098] With reference to FIGS. **29-32**, trocar assembly **270** of extension assembly **200** includes an outer housing **272**, a trocar member **274** slidably disposed within tubular outer housing **272**, and a drive screw **276** operably received within trocar member **274** for axially moving trocar member **274** relative to tubular housing **272**. In particular, trocar member **274** includes a proximal end **274***a* having an inner threaded portion **273** which engages a threaded distal portion **276***b* of drive screw **276**. As drive screw **276** is rotated within trocar member **274**, engagement of inner threaded portion **273** of trocar member **274** with threaded distal portion **276***b* of drive screw **276** causes longitudinal movement of trocar member **274** within outer housing **272** of trocar assembly **270**. Rotation of drive screw **276** in a first direction causes longitudinal advancement of trocar member **274** and rotation of drive screw **276** in a second direction causes longitudinal retraction of trocar member **274**. A distal end **274***b* of trocar member **274** is configured to selectively engage anvil assembly **50** (FIG. **34**).

[0099] A bearing assembly **278** is mounted to a proximal end **272***a* of outer housing **272** of trocar assembly **270** for rotatably supporting a proximal end **276***a* of drive screw **276** relative to outer housing **272** and trocar member **274**. Bearing assembly **278** includes a housing **278***a*, proximal and distal spacers **278***b*, proximal and distal retention clips **278***c*, proximal and distal bearings **278***d*, and a washer **278***e*. As shown, proximal end **276***a* of drive screw **276** includes a flange **276***c* for connection with a link assembly **280**.

[0100] Link assembly **280** operably connects transfer assembly **130** (FIG. **6**) of adapter assembly **100** with trocar assembly **270** (FIG. **30**) of extension assembly **200**. More particularly, link assembly **280** transfers rotational energy from drive member **140** (FIG. **6**) of transfer assembly **130** of adapter assembly **100** through the curved outer tube **206** (FIG. **17**) of extension assembly **200** to flange **276***c* (FIG. **29**) on proximal end **276***a* of drive screw **276** of trocar assembly **270** of extension assembly **200**, with reference to FIGS. **29**A and **29**B, link assembly **280** includes a coupling member **282**, a first drive shaft **284**, and a second drive shaft **286**. A proximal end **282***a* of coupling member **282** defines a recess **283***a* for receiving a distal end **284***b* of first drive shaft **284**. A distal end **282***b* of coupling member **282** defines a recess **283***a* for operably receiving flange **276***c* on proximal end **276***a* of drive screw **276**. Coupling member **282** includes an annular flange **282***c* for rotatably receiving coupling member **282** between first and second proximal spacer members **252**, **254** (FIG. **32**). Proximal and distal ends **284***a*, **284** of first drive shaft **284** define oversized openings **285***a*, **285***b*, respectively, for receiving pins **288***a*, **288***b*, respectively. A distal end **286***b* of second drive shaft **286** defines a recess **287** for operably receiving proximal end **284***a* of drive shaft **284**. A proximal end **286***a* of drive shaft **286** includes a flange **286***c* for operable receipt within socket **145** of drive member **140** of drive transfer assembly **130** of adapter assembly **100** (FIG. **12**).

[0101] With particular reference to FIG. **29**B, proximal end **284***a* of first drive shaft **284** is operably received within recess **287** in distal end **286***b* of second drive shaft **286**. Distal end **284***b* of first drive shaft **284** is pivotally secured within recess **283***a* of coupling member **282** by pin **288***a* received through oversized opening **285***b* in distal end **284***b* of first drive shaft **284**. Proximal end **284***a* of first drive shaft **284** is pivotally secured within recess **287** in distal end **286***b* of second drive shaft **286** by pin **288***b* received through oversized opening **285***a* in proximal end **284***a* of first drive shaft **284**. Recesses **283***a* and **287** of coupling member **282** and second drive shaft **286**, respectively, and oversized openings **285***a*, **285***b* of first drive shaft **284** are configured to permit pivoting of second drive shaft **286** relative to first drive shaft **284** and pivoting of first drive shaft

284 relative to coupling member **282** as each of first and second drive shaft **284**, **286**, and coupling member **282** are rotated about their respective longitudinal axes to transfer rotational force from transfer assembly **130** (FIG. **6**) of adapter assembly **100** to trocar assembly **270** (FIG. **30**) of extension assembly **200**.

[0102] With reference now to FIGS. **32** and **33**, connector assembly **290** of extension assembly **200** includes a tubular connector **292** attached to a distal end **206***b* of outer sleeve **206** and about distal ends of inner and outer flexible assemblies **210**, **230** (FIG. **26**) and trocar assembly **270**. In particular, a proximal end **292***a* of tubular connector **292** is received within and securely attached to distal end **206***b* of outer sleeve **206** by a retaining clip **294**. An O-ring **296** forms a fluid tight seal between tubular connector **292** of connector assembly **290** and outer sleeve **206**. A distal end **292***b* of tubular connector **292** is configured to selectively engage a proximal end of loading unit **40** (FIG. **34**). Distal end **292***b* of tubular connector **292** engages the circular loading unit with a snap-fit arrangement, bayonet coupling, or in another suitable manner.

[0103] With reference now to FIGS. **34** and **35**, extension assembly **200** is connected to adapter assembly **100** by receiving proximal end **202** (FIG. **17**) of extension assembly **200** within distal end **104** of adapter assembly **100**. In particular, first and second connection extensions **220**, **240**, **222**, **242** of respective inner and outer flexible band assemblies **210**, **230** are received within sleeve **106** of adapter assembly **100** such that tabs **178** of pusher member **170** of first pusher assembly **160** of adapter assembly **100** are received within openings **241**, **243** of respective first and second connection extensions **240**, **242** of outer flexible band assembly **230** to secure outer flexible band assembly **230** with first pusher assembly **160** and tabs **198** of pusher member **190** of second pusher assembly **180** of adapter assembly **100** are received within openings **221**, **223** of first and second connection extensions **221**, **223** of inner flexible band assembly **210** to secure inner flexible band assembly **210** with second pusher assembly **180**.

[0104] As noted above, adapter assembly **100** may include a drive shaft **108** (FIG. **3**) that extends from distal end **104** of adapter assembly **100**. Prior to receipt of proximal portion **202** of extension assembly **200** within distal end **104** of extension assembly **100**, drive shaft **108** is removed from adapter assembly **100**. As proximal portion **202** of extension assembly **200** is received within distal end **102** of adapter assembly **100**, proximal end **286***a* (FIG. **17**) of second drive shaft **286** (FIG. **17**) is received within socket **145** of drive member **140** of drive transfer assembly **130** of extension assembly **100** (FIG. **12**).

[0105] After extension assembly **200** is operably engaged with adapter assembly **100**, and adapter assembly **100** is operably engaged with surgical device **10** (FIG. **1**), loading unit **40** (FIG. **34**) of end effector **30** (FIG. **34**) may be attached to connector assembly **290** of extension assembly **200** and an anvil assembly **50** (FIG. **34**) may be attached to distal end **274***b* of trocar **274** of extension assembly **200** in a conventional manner. During actuation of loading unit **40** and anvil assembly **50**, longitudinal advancement of pusher member **190** of second pusher assembly **180** of adapter assembly **100**, as described above, and as indicated by arrows "C" in FIG. **35**A, causes longitudinal advancement of outer flexible band assembly **230** of extension assembly **200** and longitudinal advancement of pusher member **170** of first pusher assembly **160**, as described above, and as indicated by arrows "D" in FIG. **35**A, causes longitudinal advancement of inner flexible band assembly **210**. Rotation of drive shaft **108** in a first direction, as described above, and as indicated by arrow "E", causes advancement of trocar **274** of extension assembly **200**. Conversely, longitudinal retraction of pusher member **190** causes longitudinal retraction of outer flexible band assembly **230**, longitudinal retraction of pusher member **170** causes longitudinal retraction of inner flexible band assembly **210**, and rotation of drive shaft **108** in a second direction causes retraction of trocar **274** of extension assembly **200**.

[0106] In embodiments, inner flexible band assembly **210** operably connects second pusher assembly **180** of adapter assembly **100** with a knife assembly (not shown) of loading unit **40** (FIG. **34**) of end effector **30** (FIG. **34**) attached to connector assembly **290** of extension assembly **200**.

Outer flexible band assembly **230** operably connects first pusher assembly **160** of adapter assembly **100** with a staple driver assembly (not shown) of loading unit **40**. Trocar assembly **270** operably connects drive transfer assembly **130** of adapter assembly **100** to anvil assembly **50** (FIG. **34**) of end effector **30** (FIG. **34**). In this manner, operation of second pusher assembly **160** causes longitudinal movement of inner flexible band assembly **210** which causes longitudinal movement of the knife assembly, operation of first pusher assembly **180** causes longitudinal movement of outer flexible band assembly **230** which causes longitudinal movement of the staple driver assembly, and operation of drive transfer assembly **130** causes longitudinal movement of trocar **274** which causes longitudinal movement of anvil assembly **50** relative to loading unit **40**.

[0107] By stacking first and second pusher assemblies **160**, **180** of adapter assembly **100**, as described, and positioning the drive shaft **108** of the transfer assembly **130** through first and second pusher assemblies **160**, **180**, adapter assembly **100** can perform three functions through an access port or other opening (not shown) having a small diameter, e.g., 21 mm. Similarly, by configuring inner flexible band assembly **210** within outer flexible band assembly **230** and receiving trocar assembly **270** through the inner and outer flexible band assemblies **210**, **230**, extension assembly **200** can perform three functions through an access port or other opening (not shown) having a small diameter, e.g., 21 mm.

[0108] With reference to FIGS. **36-41**, an adapter assembly according to another embodiment of the present disclosure is shown as adapter assembly **300**. Adapter assembly **300** is substantially similar to adapter assembly **100** described hereinabove and will only be described as relates to the differences therebetween.

[0109] As will become apparent from the following description, the configuration of adapter assembly **300** permits rotation of a distal portion **304** of adapter assembly **300** about a longitudinal axis "x" (FIG. **36**), relative to a proximal portion **302** of adapter assembly **300**. In this manner, an end effector, e.g. end effector **30** (FIG. **34**) secured to distal portion **304** of adapter assembly **300** or an end effector secured to an extension assembly, e.g., extension assembly **200** (FIG. **17**) which is secured to distal portion **304** of adapter assembly **300** is rotatable about longitudinal axis "x" independent of movement of the surgical device (not shown) to which adapter assembly **300** is attached.

[0110] Adapter assembly **300** includes a base **306** and a support structure **308** rotatable relative to base **306** along longitudinal axis "x" of adapter assembly **300**. A rotation handle **310** is rotatably secured to base **306** and fixedly secured to a proximal end of support structure **308**. Rotation handle **310** permits longitudinal rotation of distal portion **304** of adapter assembly **300** relative to proximal end **302** of adapter assembly **300**. As will be described in further detail below, a latch **312** is mounted to rotation handle **310** and selectively secures rotation handle **310** in a fixed longitudinal position.

[0111] Proximal portion **302** of adapter assembly **300** includes a drive coupling assembly **320** and a drive transfer assembly **330** operably connected to drive coupling assembly **320**. Distal portion **304** of adapter assembly **300** includes a first pusher assembly **340** operably connected to drive transfer assembly **330**, and a second pusher assembly **350** operably connected to drive transfer assembly **330**. Drive coupling assembly **320** and drive transfer assembly **330** are mounted within base **306**, and thus, remain rotationally fixed relative to the surgical device (not shown) to which adapter assembly **300** is attached. First pusher assembly **340** and second pusher assembly **350** are mounted within support structure **308**, and thus, are rotatable relative to the surgical device (not shown) to which adapter assembly **300** is attached.

[0112] Drive coupling assembly **320** is configured to selectively secure adapter assembly **300** to a surgical device (not shown). For a detailed description of an exemplary surgical device and drive coupling assembly, please refer to commonly owned U.S. Provisional Patent Application Ser. No. 61/913,572, filed Dec. 9, 2013, the content of which is incorporated by reference herein in its entirety.

[0113] Rotation knob **310** is rotatably secured to base **306**. Latch **312** includes a pin **312***a* (FIG. **38**) configured to lock rotation knob **310** relative to base **306**. In particular, pin **312***a* of latch **312** is received within a slot **307** formed in base **306** and is biased distally by a spring **314** into a notch **307***a* (FIG. **40**) formed in base **306** and in communication with slot **307** to lock rotation knob **310** relative to base **306**. Proximal movement of latch **312**, as indicated by arrow "F" in FIG. **38**, retracts pin **312***a* from within notch **307***a* to permit rotation of rotation knob **310** relative to base **306**. In embodiments, base **306** defines a second notch (not shown) diametrically opposed to notch **307***a* for locking rotation knob **310** in a first longitudinal orientation when pin **312***a* of latch **312** is received within notch **307***a* and in a second longitudinal orientation that is one-hundred eighty degrees (180°) rotated from the first longitudinal orientation when the pin **312***a* of latch **312** is received within the second notch. Alternatively, it is envisioned that base **306** may define a number of notches radially spaced about base **306** and in communication with slot **307** that permit rotation knob **310** to be locked in a number of longitudinal orientations relative to base **306**.
[0114] Drive transfer assembly **330**, first drive pusher assembly **340**, and second drive pusher assembly **350** of adapter assembly **300** are substantially identical to respective drive transfer assembly **130**, first drive pusher assembly **160**, and second drive pusher assembly **180** of adapter assembly **100** described hereinabove, and therefore, will only be described as relates to the differences therebetween.
[0115] Support structure **308** is fixedly received about first and second drive pusher assemblies **340**, **350** and rotatably relative to base **306**. As noted above, rotation knob **310** is fixedly secured to the proximal end of support structure **308** to facilitate rotation of support structure **308** relative to base **306**. Support structure **308** is retained with outer sleeve **305** of adapter assembly **300** and is configured to maintain axial alignment of first and second drive pusher assemblies **340**, **350**. Support structure **308** may also reduce the cost of adapter assembly **300** when compared to the cost of adapter assembly **100**.
[0116] Support structure **308** respectively includes first, second, third, fourth, fifth, sixth, and seventh plates **360***a*, **360***b*, **360***c*, **360***d*, **360***e*, **360***f*, **360***g*, first and second pluralities of tubular supports **362***a*, **362***b*, first and second support rings **364***a*, **364***b*, first and second plurality of ribs **366***a*, **366***b*, and a plurality of rivets **368**. From proximal to distal, first and second plates **360***a*, **360***b* are maintained in spaced apart relation to each other by the first plurality of tubular supports **362***a*, second and third plates **360***b*, **360***c* are maintained in spaced apart relation to each other by first support ring **364***a*, third and fourth plates **360***c*, **360***d* are maintained in spaced apart relation to each other by first plurality of support ribs **366***a*, fourth and fifth plates **360***d*, **360***e* are maintained in spaced apart relation to each other by second plurality of tubular supports **362***b*, fifth and sixth plates **360***e*, **360***f* are maintained in spaced apart relation to each other by a second support ring **364***b*, and sixth and seventh plates **360***f*, **360***g* are maintained in spaced apart relation to each other by second plurality of support ribs **366***b*. First, second, third, fourth, fifth, sixth, and seventh plates **360***a-g* are held together by a plurality of rivets **368** secured to first and seventh plates **360***a*, **360***g* and extending through second, third, fourth, fifth, and sixth plates **360***b*-**360***f*, first and second support rings **364***a*, **364***b*, and respective first and second plurality of tubular support **362***a*, **362***b*.
[0117] Adapter assembly **300** operates in a substantially similar manner to adapter assembly **100** described hereinabove. In addition, as described in detail above, adapter assembly **300** is configured to permit rotation of an end effector, e.g., end effector **30** (FIG. **34**) attached to adapter assembly **300** or attached to an extension assembly that is attached to adapter assembly **300** to be selectively rotated about longitudinal axis "x" (FIG. **36**) during use.
[0118] With reference now to FIGS. **42-44**, an adapter assembly according to another embodiment of the present disclosure is shown generally as adapter assembly **400**. Adapter assembly **400** is substantially similar to adapter assemblies **100** and **300** described hereinabove, and therefore will only be described as relates to the differences therebetween.
[0119] Adapter assembly **400** includes a proximal portion **402** and a distal portion **404** rotatable

along a longitudinal axis "x" relative to proximal portion **402**. Distal portion **404** includes a support structure **408** secured to outer sleeve **405** and formed about first and second pusher assemblies **440**, **450**. Support structure **408** includes a plurality of reinforcing members **462** extending substantially the length of outer sleeve **405**. Reinforcing members **462** each include a proximal tab **462***a* and a distal tab **462***b* which extend through outer sleeve **405** to secure reinforcing member **462** within outer sleeve **405**. Proximal tabs **462** of reinforcing members **462** are further configured to engage a rotation knob **410** of adapter assembly **400**. Adapter assembly **400** may include annular plates (not shown) positioned radially inward of reinforcing members **462** that maintain proximal and distal tabs **462***a*, **462***b* of reinforcing members **462** in engagement with outer sleeve **405**. The annular plates may also provide structure support to distal portion **404** of adapter assembly **400**. The configuration of adapter assembly **400** allows for a single tube, e.g. outer sleeve **405**, for containing the drive components. With reference to FIGS. **45-49**, a connection assembly according to an embodiment of the present disclosure is shown generally as connection assembly **500**. As shown and will be described, connection assembly **500** is configured to be attached to first and second tubular bodies (not shown) for connecting the first tubular body, i.e., adapter assembly **100** (FIG. **3**), **300** (FIG. **36**), **400** (FIG. **42**), to the second tubular body, i.e., extension assembly **200** (FIG. **17**). It is envisioned, however, that the aspects of the present disclosure may be incorporated directly into the first and second tubular bodies to permit connection of the first tubular body directly to the second tubular body.

[0120] Connection assembly **500** includes a tubular base **510** and a tubular extension **520** formed of first and second sections **520***a*, **520***b* and an outer sleeve **522**. As shown, tubular base **510** defines a pair of openings **511** for securing tubular base **510** to a first tubular body (not shown). Alternatively, tubular base **510** may include only a single opening, one or more tabs (not shown), and/or one or more slots (not shown), for securing tubular base **510** to the first tubular body (not shown). A flange **512** extends from a first end of tubular base **510** and includes an annular rim **514** extending thereabout.

[0121] First and second sections **520***a*, **520***b* of tubular extension **520** are substantially similar to one another and each define a groove **521** formed along an inner first surface thereof. Each of first and second section **520***a*, **520***b* of tubular extension **520** is configured to be received about flange **512** of tubular base **510** such that rim **514** of tubular base **510** is received within grooves **521** of first and second sections **520***a*, **520***b* of tubular extension **520**. Once first and second sections **520***a*, **520***b* of tubular extension **520** are received about flange **512** of tubular base **510**, outer sleeve **522** of tubular extension **520** is received about first and second sections **520***a*, **520***b* of tubular extension **520** to secure tubular extension **520** to tubular base **510**.

[0122] As shown, each of first and second sections **520***a*, **520***b* of tubular extension **520** define an opening **523** configured to be aligned with a pair of openings **525** in outer sleeve **522** to secure outer sleeve **522** to first and second sections **520***a*, **520***b*. Either or both of first and second sections **520***a*, **520***b* and outer sleeve **522** may include one or more tabs, and/or one or more slots for securing outer sleeve **522** about first and second extensions. Alternatively, outer sleeve **522** may be secured to first and second sections **520***a*, **520***b* in any suitable manner.

[0123] Outer sleeve **522** may be selectively secured about first and second extensions for selective removal of outer sleeve **522** from about first and second sections **520***a*, **520***b* to permit separation of tubular extension **520** from tubular base **510**. Alternatively, outer sleeve **522** may be permanently secured about first and second section to prevent tubular extension **520** from being separated from tubular base **510**. As noted above, although tubular base **510** and tubular extension **520** are shown and described as forming an independent connection assembly **500**, it is envisioned that tubular base **510** may be formed on a first tubular member, i.e., adapter assembly **100** (FIG. **3**) and tubular extension **520** may be formed on a second tubular member, i.e., extension assembly **200** (FIG. **17**) such that the first tubular member may be directly connected to the second tubular member.

[0124] Any of the components described herein may be fabricated from either metals, plastics,

resins, composites or the like taking into consideration strength, durability, wearability, weight, resistance to corrosion, ease of manufacturing, cost of manufacturing, and the like.
[0125] Persons skilled in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments. It is envisioned that the elements and features illustrated or described in connection with one exemplary embodiment may be combined with the elements and features of another without departing from the scope of the present disclosure. As well, one skilled in the art will appreciate further features and advantages of the disclosure based on the above-described embodiments. Accordingly, the disclosure is not to be limited by what has been particularly shown and described, except as indicated by the appended claims.

Claims

1. (canceled)
2. An adapter assembly for operably connecting an end effector to a surgical instrument, comprising: a base; a support structure rotatable relative to the base along a longitudinal axis; a rotation handle rotatably secured to the base and fixedly secured to a proximal end of the support structure, wherein rotation of the rotation handle causes rotation of a distal portion of the adapter assembly relative to a proximal end of the adapter assembly; a latch, mounted to the rotation handle, the latch including a pin biased into engagement with a notch formed in the base to selectively lock the rotation handle in a fixed longitudinal position; a drive coupling assembly disposed within the base and configured for operable connection to the surgical instrument; a drive transfer assembly disposed within the base and operably connected to the drive coupling assembly; and first and second pusher assemblies disposed within the support structure and operably connected to the drive transfer assembly.
3. The adapter assembly of claim 2, wherein the latch includes a spring biasing the pin distally into the notch.
4. The adapter assembly of claim 2, wherein the base defines a second notch diametrically opposed to the notch to lock the rotation handle in a 180 degree rotated position.
5. The adapter assembly of claim 2, wherein the support structure includes a plurality of plates and a plurality of tubular supports maintaining the plates in spaced apart relation.
6. An adapter assembly for operably connecting an end effector to a surgical instrument, comprising: a base; a support structure rotatable relative to the base along a longitudinal axis, the support structure including: a plurality of plates; a plurality of tubular supports maintaining the plates in spaced apart relation; at least one support ring positioned between adjacent plates; a plurality of ribs positioned between adjacent plates; and a plurality of rivets securing the plates, tubular supports, support rings, and ribs together; a drive coupling assembly disposed within the base; and first and second pusher assemblies disposed within the support structure.
7. The adapter assembly of claim 6, wherein the plurality of plates includes first, second, third, fourth, fifth, sixth, and seventh plates.
8. The adapter assembly of claim 7, wherein the first and second plates are maintained in spaced apart relation by the plurality of tubular supports.
9. The adapter assembly of claim 7, wherein the support structure further includes a first support ring positioned between the second and third plates.
10. The adapter assembly of claim 9, wherein the support structure includes a second support ring positioned between the fifth and sixth plates.
11. The adapter assembly of claim 7, wherein the plurality of ribs includes a first plurality of ribs positioned between the third and fourth plates.
12. The adapter assembly of claim 6, further comprising an outer sleeve retaining the support structure.

13. The adapter assembly of claim 6, further comprising a drive transfer assembly, operably connected to the drive coupling assembly, wherein the drive transfer assembly includes a first rotatable distal drive shaft operably connected to the first pusher assembly.

14. An adapter assembly for operably connecting an end effector to a surgical instrument, comprising: a proximal portion; a distal portion rotatable relative to the proximal portion along a longitudinal axis; an outer sleeve; a support structure secured within the outer sleeve, the support structure including a plurality of reinforcing members each having a proximal tab and a distal tab extending at least partially through the outer sleeve; and first and second pusher assemblies disposed within the support structure.

15. The adapter assembly of claim 14, wherein the proximal tab and distal tab of each reinforcing member engage the outer sleeve.

16. The adapter assembly of claim 14, further comprising annular plates positioned radially inward of the reinforcing members to maintain the proximal and distal tabs in engagement with the outer sleeve.

17. The adapter assembly of claim 14, wherein the support structure is formed within a single outer sleeve.

18. The adapter assembly of claim 14, wherein the reinforcing members extend substantially an entire length of the outer sleeve.

19. The adapter assembly of claim 14, wherein the support structure includes a rotation handle rotatably secured to the proximal portion, wherein rotation of the rotation handle causes rotation of the distal portion.

20. The adapter assembly of claim 14, wherein the first and second pusher assemblies are operably connected to a drive transfer assembly disposed within the proximal portion.

21. The adapter assembly of claim 14, wherein the outer sleeve is a single tube comprising the support structure and the first and second pusher assemblies.