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(54) **SURGICAL INSTRUMENT WITH COLLECT LOCKING AND INDEXING SYSTEM**

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(57) **ABSTRACT**

A surgical instrument is provided for cutting bone and other tissue. The surgical instrument includes a motor assembly, a collet, a locking nut, and an attachment. The motor assembly includes a cavity having a groove on an inner surface that corresponds to a groove on an outer surface of the collet. The corresponding grooves form an aperture when the collet is inserted into the cavity. The insertion of a pin into the aperture prevents rotation of the collet relative to the cavity. The locking nut is placed over the collet and fastened to the motor assembly to secure the collet to the motor assembly. The attachment is fastened to the collet by placing protuberances on the attachment into corresponding apertures on the collet. The consistent alignment provided by the locking and indexing system enables the motor assembly and attachment to receive alignment markings before the surgical instrument is assembled.

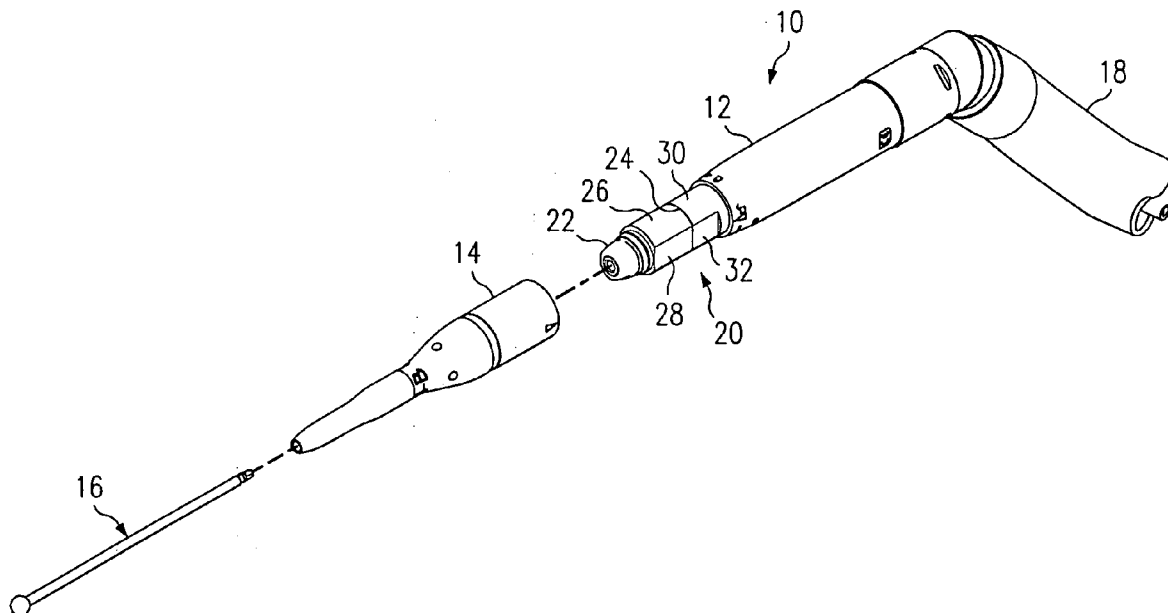
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(63) Continuation of application No. 10/164,880, filed on Jun. 7, 2002.





*Fig. 1*

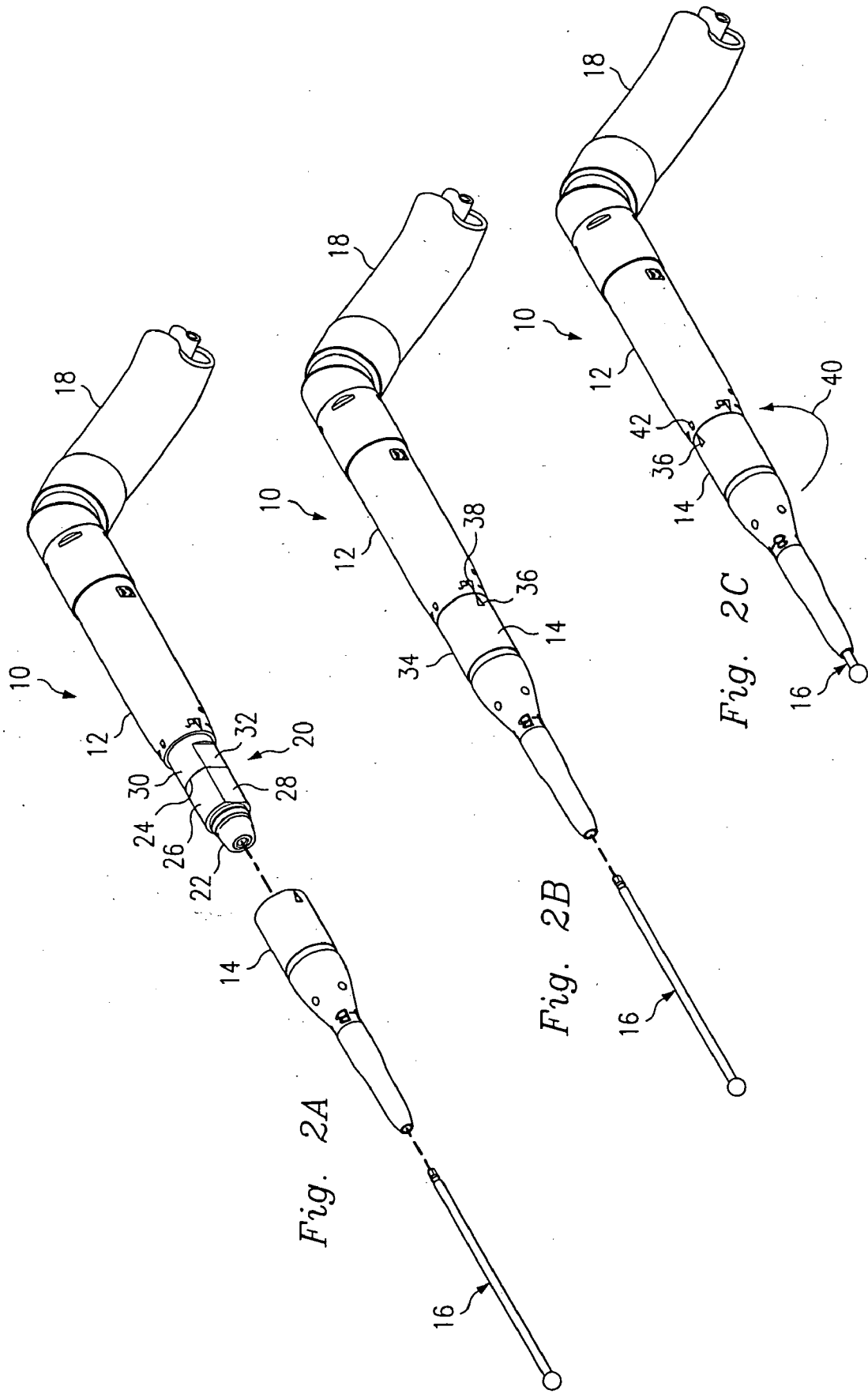


Fig. 2A

Fig. 2B

Fig. 2C

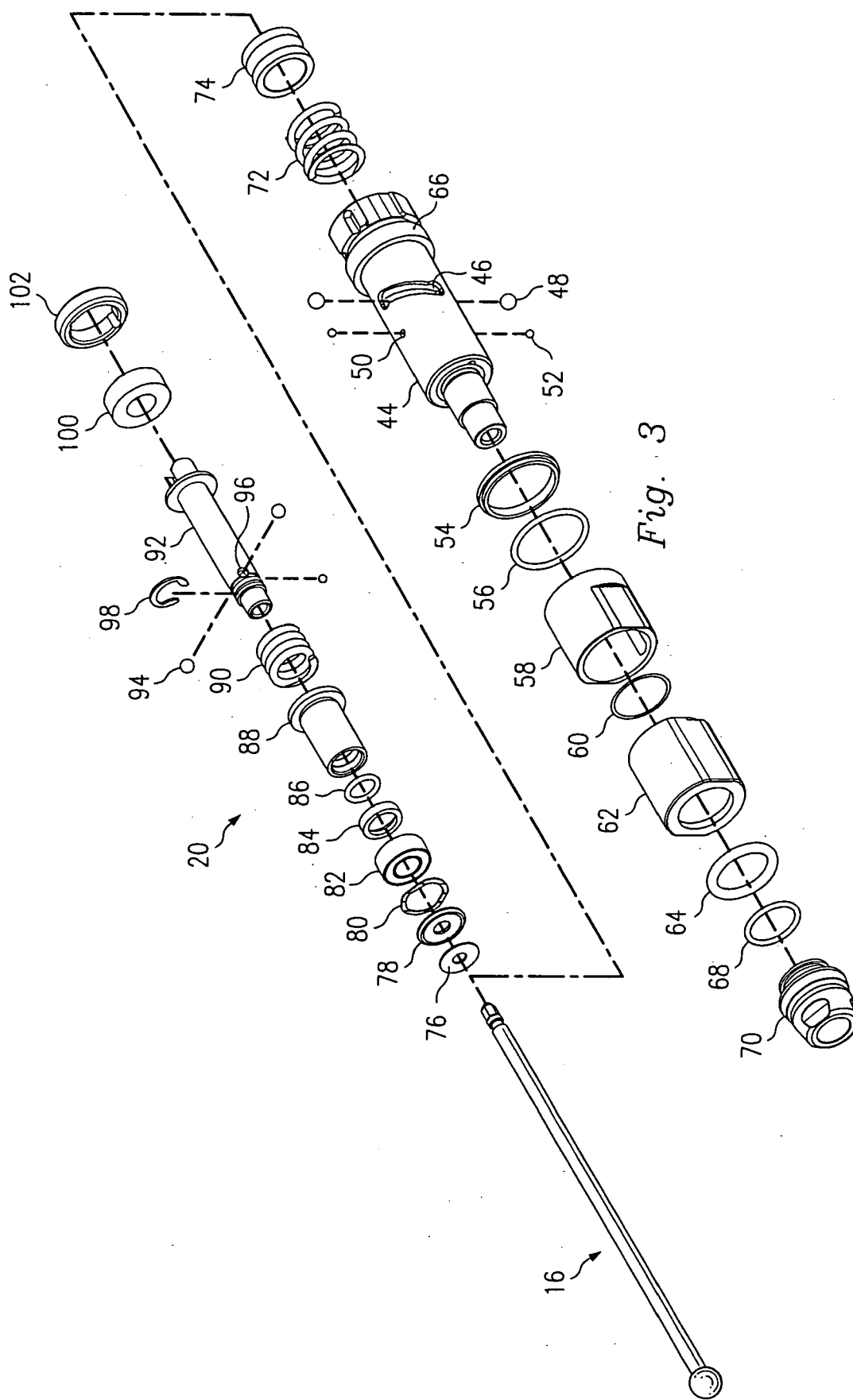


Fig. 3

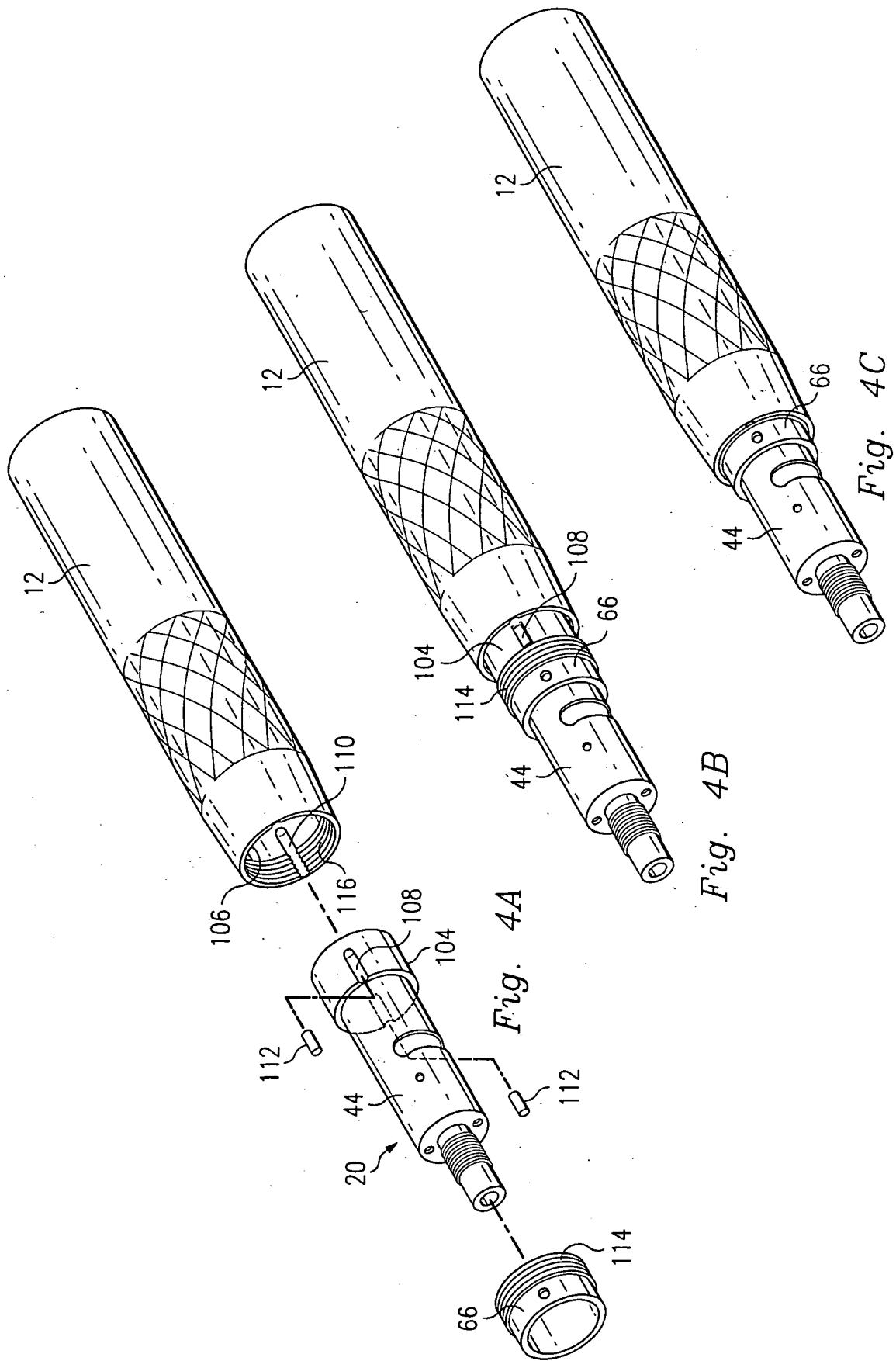


Fig. 4B

Fig. 4C

Fig. 4A

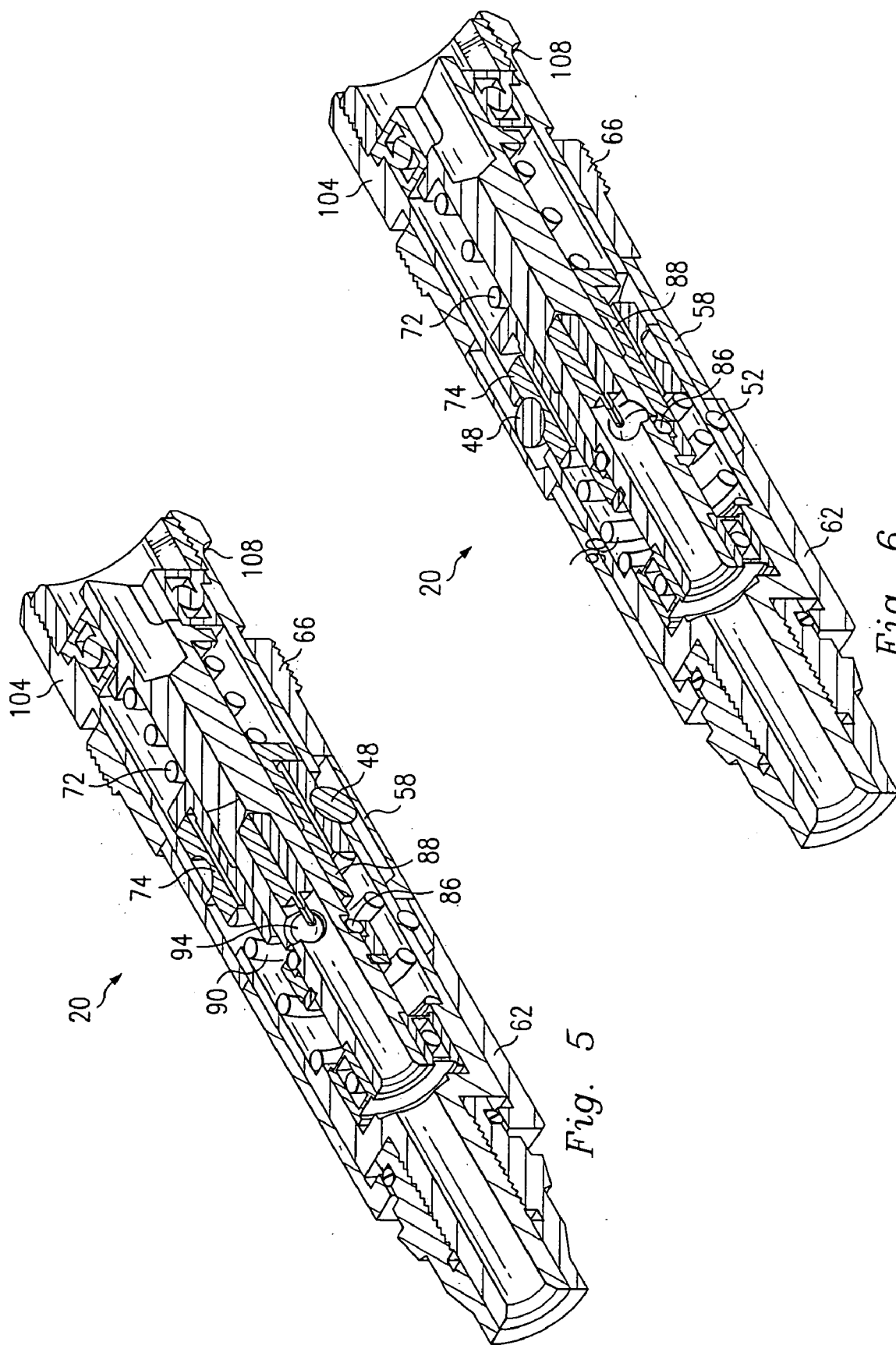


Fig. 5

Fig. 6

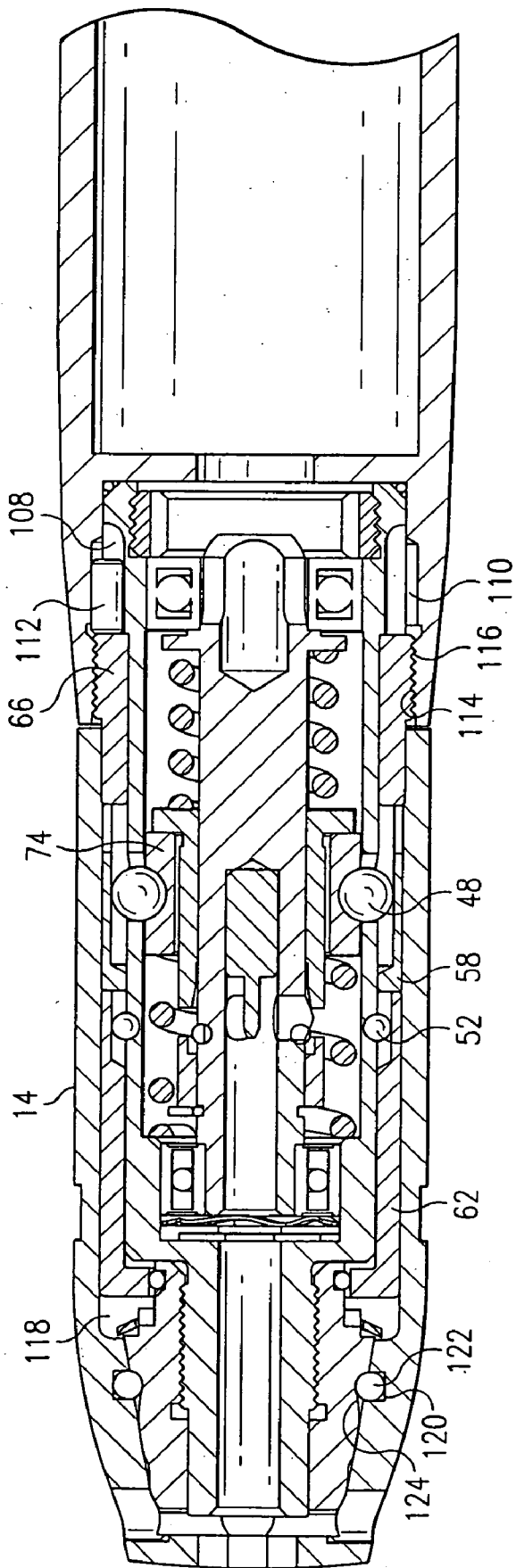


Fig. 7

**SURGICAL INSTRUMENT WITH COLLETT LOCKING AND INDEXING SYSTEM**

**CROSS REFERENCE**

[0001] This application is a continuation of U.S. application Ser. No. 10/164,880 filed Jun. 7, 2002, entitled, "Surgical Instruments With Collett Locking and Indexing System," and the following related patent applications are hereby made of record and incorporated by reference: U.S. patent Ser. No. 10/102,762, U.S. patent Ser. No. 09/303,781, and U.S. Patent Ser. No. 60/352,609.

**FIELD OF THE INVENTION**

[0002] The present disclosure generally relates to surgical instruments and their use. More particularly, the present disclosure relates to a collet locking and indexing system for surgical instruments.

**BACKGROUND**

[0003] Surgical instruments, in general, should satisfy several requirements in order to fulfill their various roles during surgery. One requirement is that certain components of a multi-part instrument, such as an instrument used for dissecting bone or tissue, should be aligned properly when the instrument is assembled. For example, alignment-sensitive components forming the instrument should be in certain positions relative to the other components when the instrument is originally assembled. Thereafter, each time the instrument is reassembled after being disassembled, each of the alignment-sensitive components should be returned to the same relative position. Among other benefits, consistent alignment ensures that the instrument is correctly positioned to receive a surgeon's hand in an optimal manner. Such optimal alignment may take into account such factors as the location of any controls and the angle of a tool associated with the instrument, such as a cutting tool. If the alignment of the various components is not correct, a surgeon may be unable to access the controls when the cutting tool is properly positioned.

[0004] Typically, to ensure that the instrument is properly aligned, marks are placed on the exterior of the instrument in the following manner. The instrument, which often includes a locking device such as a collet, a motor and motor assembly, and an attachment, is fully assembled. The assembly process includes attaching the collet to the motor assembly, sliding the attachment over the collet, and securing the attachment to the collet. Marks may then be made on the exterior of the motor assembly and the attachment to indicate their relative positions ("locked" or "unlocked") when the instrument is fully assembled. To attach a cutting tool, the attachment is loosened (moved to the "unlocked" position), the collet is opened and the tool is inserted into the collet. The collet is then closed to securely retain the tool and the attachment is tightened until the mark on the attachment is aligned with the corresponding mark on the motor assembly (the "locked" position). Accordingly, the alignment marks prevent the attachment from being over-tightened, which could damage the instrument, and from not being tightened enough, which could have disastrous consequences during surgery. As the alignment marks depend on the relative positions of the attachment, motor assembly, and collet, these components play an important role in the alignment process.

[0005] While frequently used, this post-assembly marking process presents a number of difficulties. For example, when one of the alignment-sensitive components in the instrument must be replaced, the instrument will likely need to be remarked. For example, if the collet must be replaced, the original collet must be removed and a new collet must be attached to the motor assembly. However, the likelihood that the new collet will accept the original attachment in exactly the same manner is doubtful. For example, if the motor assembly and the collet are threaded, there is very little likelihood that the threads of the new collet will engage the threads of the motor assembly in the exact manner as the old collet. Accordingly, the new collet will not be in the same position relative to the motor assembly as the old collet. Therefore, when the attachment is connected to the new collet, it is unlikely that the mark on the attachment will properly align with the mark on the motor assembly. As the markings are often permanent, one or more components that are otherwise perfectly functional may be discarded and replaced with unmarked components that can be marked appropriately.

[0006] Therefore, what is needed is a locking and indexing system that enables various alignment-sensitive components of a surgical instrument to be assembled in a consistent manner, allowing alignment markings to be placed on components before the instrument is assembled.

**SUMMARY**

[0007] The present disclosure provides many technological advances that can be used, either alone or in combination, to provide an improved powered surgical instrument and/or an improved system and method for using powered surgical instruments.

[0008] In one embodiment, a locking system for a surgical instrument is provided. The locking system includes a collet including a first rotation-prevention mechanism and a motor housing operable to receive the collet. The motor housing includes a second rotation-prevention mechanism operable to engage the first rotation-prevention mechanism to prevent rotation of the collet relative to the motor housing. The surgical instrument also includes a sleeve operable to secure the collet to the motor housing.

[0009] In another embodiment, the locking system includes a collet having either a protuberance or aperture and a motor assembly having the other of the protuberance or aperture corresponding to the collet. The protuberance and aperture are operable to align and prevent rotation of the collet relative to the motor assembly. The locking system also includes a slidable locking member operable to secure the collet to the motor assembly.

[0010] In another embodiment, a collet for insertion into a cavity of a surgical instrument is provided. The collet includes a distal portion having an opening for receiving a tool, a first fastening element for accepting an attachment, and a proximal portion with a first alignment element. The first alignment element is for engaging a second alignment element present in the cavity to align and prevent rotation of the collet and the surgical instrument. The collet also includes a locking member rotatable about an axis of the collet, the locking member for securing the collet to the surgical instrument.



[0011] Further forms and embodiments of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiments of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present disclosure will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0013] **FIG. 1** is an environmental view of a surgical instrument for the dissection of bone and other tissue according to the teachings of a preferred embodiment of the present disclosure operatively associated with a patient for performing a craniotomy.

[0014] **FIG. 2A** is a partially exploded perspective view of a surgical dissection tool according to the present disclosure.

[0015] **FIG. 2B** is a partially exploded perspective view of the surgical dissection tool of **FIG. 2A**.

[0016] **FIG. 2C** is an assembled perspective view of the surgical dissection tool of **FIG. 2A**.

[0017] **FIG. 3** is an exploded perspective view of a portion of the surgical dissection tool of **FIGS. 2A-2C**.

[0018] **FIGS. 4A and 4B** are partially exploded views of the surgical instrument of **FIGS. 2A-2C** and **3**.

[0019] **FIG. 4C** is an assembled perspective view of the surgical instrument of **FIGS. 4A and 4B**.

[0020] **FIG. 5** is a partial quarter-section perspective view of a portion of the surgical dissection tool of **FIG. 3** illustrating the unlocked position.

[0021] **FIG. 6** is a partial quarter-section perspective view of a portion of the surgical dissection tool of **FIG. 5** rotated 90° illustrating the locked position.

[0022] **FIG. 7** is a partial cross-section view of a portion of the surgical dissection tool of **FIG. 6** illustrating the locked position

#### DETAILED DESCRIPTION

[0023] The present disclosure relates to surgical tools, and more particularly, to a collet locking and indexing system for surgical instruments. It is understood, however, that the following disclosure provides many different embodiments, or examples, for implementing different features of the invention. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.

[0024] Referring initially to **FIG. 1**, a surgical instrument for the dissection of bone and other tissue constructed in accordance with the teachings of a first preferred embodiment is illustrated and generally identified at reference numeral **10**. The surgical instrument **10** is shown operatively

associated with a patient A for performing a craniotomy. It will become apparent to those skilled in the art that the described instrument is not limited to any particular surgical application but has utility for various applications in which it is desired to dissect bone or other tissue. Additional applications include:

- [0025] 1. Arthroscopy—Orthopaedic
- [0026] 2. Endoscopic—Gastroenterology, Urology, Soft Tissue
- [0027] 3. Neurosurgery—Cranial, Spine, and Otolology
- [0028] 4. Small Bone—Orthopaedic, Oral-Maxiofacial, Ortho-Spine, and Otolology
- [0029] 5. Cardio Thoracic—Small Bone Sub-Segment
- [0030] 6. Large Bone—Total Joint and Trauma
- [0031] 7. Dental.

[0032] With reference to **FIGS. 2A-2C**, the surgical instrument **10** is illustrated to generally include a motor assembly **12**, an attachment **14**, and a surgical tool **16**. The attachment **14** may provide a gripping surface for use by a surgeon and may also shield underlying portions of the instrument **10** during a surgical procedure. In a preferred embodiment, the surgical tool **16** is a cutting tool or dissection tool, although the type of tool is not essential to implementing the present disclosure.

[0033] The surgical instrument **10** is shown connected to a hose assembly **18** for providing a source of pressurized fluid (e.g., air) to the motor assembly **12** and venting exhaust air away from the surgical site. In the exemplary embodiments that will be described, the surgical instrument **10** is pneumatically powered. It is further understood, however, that many of the teachings discussed herein will have equal application for an electrically powered surgical instrument.

[0034] As shown in **FIG. 2A** and described later in greater detail, the motor housing **12** includes a coupling assembly **20** with a tapered leading portion **22** and a Double D region comprising a pair of opposed and substantially parallel planar portions interrupting the cylindrical body to define two opposed substantially parallel cylindrical portions. These portions are separated by junction **24** into an axially translatable segment having cylindrical portion **26** and flat portion **28**, and a rotatably translatable segment having cylindrical portion **30** and flat portion **32**.

[0035] Referring now to **FIG. 2B**, attachment housing **14** includes an internal cavity (not shown) adapted and configured to engage coupling assembly **20** of motor assembly **12**. In an initial position with first cylindrical portion **34** substantially abutting motor assembly **12**, attachment indicator mark **36** is in substantial alignment with unlocked indicator mark **38** on the motor assembly. In this position, dissection tool **16** may be inserted into attachment housing **14** and be received in the coupling assembly **20** within motor assembly **12**. Referring now to **FIG. 2C**, with dissection tool **16** inserted within attachment housing **14** and engaged in the coupling assembly **20**, attachment housing **14** may be rotated in the direction of arrow **40** with respect to motor assembly **12**. Movement in this direction moves attachment indicator marking **36** into substantial alignment with the

locked indicator marking **42** on motor assembly **12**. Such movement also operates the coupling assembly **20** to lock dissection tool **16** into driving engagement with the internal motor.

[0036] In the present embodiment, the motor assembly **12**, attachment **14**, and coupling assembly **20** are designed so that indicator marks **36, 38, 42** may be placed on attachment **14** and motor assembly **12** at the component level (e.g., before assembly) rather than the assembly level. The ability to add the indicator marks **36, 38, 42** at the component level provides a number of advantages. For example, the indicator marks **36, 38, 42** (and other labeling or lettering) are typically either scratched or laser etched onto the surface of the motor assembly **12** and attachment **14**. Both of these methods may produce a white or metallic marking on the anodized surface. Using scratching or laser etching, the marking can be applied at either the component level or the assembled level. However, some color schemes (such as black markings on a gold anodized surface) may be difficult or impossible to achieve once assembly of the instrument is completed and so the markings should be made at the component level. For example, the markings may be stamped onto a surface of a component using a force that may damage an assembled instrument.

[0037] Referring now to FIG. 3, one embodiment of the coupling assembly **20** of FIGS. 2A-2C that may be used to overcome the marking difficulties previously described is shown in detail. The coupling assembly **20** includes a locking nut **66** positioned on a collet housing **44**. The collet housing **44** has a helical slot **46** adapted to receive ball bearings **48**, and a pair of apertures **50** adapted to receive alignment balls **52**. Coupling assembly **20** further includes a housing spacer **54** and an O-ring **56** associated with posterior Double D-collet **58**. Posterior Double D-collet **58** is spaced from anterior Double D-collet **62** by shim **60**. The assembly further includes O-rings **64** and **68** and tapered nose **70**. A number of the remaining components are disposed within collet housing **44**. More specifically, spring **72** and ball carrier **74**, along with additional components washer **76**, seal **78**, wave spring **80**, bearing tube **82**, sleeve keeper **84** and O-ring **86** are assembled within collet housing **44**. Coupling assembly **20** also includes hex closure sleeve **88**, spring **90**, rotor shaft **92**, and ball bearings **94** retained in openings **96** in the rotor shaft by retaining ring **98**. This internal assembly is completed by bearing **100** and lock ring **102**.

[0038] Referring now to FIGS. 4A-4C, in one embodiment, the coupling assembly **20** may be attached to the motor assembly **12** as follows. It is understood in the following example that the coupling assembly **20** is represented only by the collet housing **44** for purposes of clarity, but the coupling assembly **20** may include other components as illustrated in FIG. 3. The coupling assembly **20** includes a base **104** sized for insertion into a cavity **106** of the motor assembly **12**. The base **104** includes one or more apertures **108** that extend from the distal end of the base **104** (relative to the motor assembly **12**) towards the proximal end of the base **104**. However, the apertures **108** do not extend the entire length of the base **104**.

[0039] The cavity **106** in the motor assembly **12** includes one or more apertures **110** that correspond to the apertures **108** of the coupling assembly **20**. Accordingly, a pin **112**

may be placed in each aperture **108** of the coupling assembly **20** during before the coupling assembly **20** is inserted into the cavity **106**. The pins **112** may then be aligned with the apertures **110** of the motor assembly **12** and the coupling assembly **20** may be inserted into the motor assembly **12**. As the proximal end of the base **104** is not grooved, the pins **112** will not extend past the base **104**. Once inserted, the pins **112** serve to align the coupling assembly **20** and the motor assembly **12** and also prevent the coupling assembly **20** from rotating within the motor assembly **12**. In addition, the pin and groove arrangement provides sufficient structural strength to survive the loading created by the rotation of the tool **16** during surgery. Removal of the coupling assembly **20** will remove the pins **112**.

[0040] It is understood that alternate methods of assembly may be desirable. For example, before placing the pins **112** into the apertures **108**, the coupling assembly **20** may be inserted into the motor assembly **12** and rotated to align the apertures **108, 110**. When this is achieved, the matching grooves will be accessible via the origination points of the apertures **108, 110** in the distal portion of the base **104** and the motor assembly **12**, respectively. The pins **112** may then be inserted into each pair of aligned apertures **108, 110**.

[0041] Regardless of the assembly procedure used for alignment, after the coupling assembly **20** is inserted into the cavity **106**, the locking nut **66** may be used to secure the coupling assembly **20** to the motor assembly **12** as follows. The locking nut **66** includes a plurality of threads **114** that mate with corresponding threads **116** on the motor assembly **12**. In the present embodiment, the distal end of the base **104** has a larger diameter than the remainder of the coupling housing **44**. The interior diameter of the locking nut **66** is sized so that the locking nut **66** may slide over the coupling assembly **20** until it reaches the base **104**, which serves as a lip that prevents the locking nut **66** from further movement in the direction of the motor assembly **12**. The threads **114** of the locking nut **66** may then engage the threads **116** of the motor assembly **12** and the locking nut **66** may be rotated until the coupling assembly **20** is secured to the motor assembly **12**. Once in place, the locking nut **66** covers the exposed apertures **108** in the base **104**. Accordingly, the locking nut **66** serves to both fasten the coupling assembly **20** to the motor assembly **12** and to retain the pins **112** in the apertures **108, 110**.

[0042] Using the pin and aperture arrangement described above ensures that the coupling assembly **20** may be attached to the motor assembly **12** with a known alignment. As will be described later, this predictable alignment between the coupling assembly **20** and the motor assembly **12** enables the attachment **14** to be aligned predictably with the motor assembly **12**.

[0043] Referring again to FIG. 3 and with additional reference to FIGS. 5-7, the coupling assembly **20** of FIG. 4 is shown in cross-section and quarter-section in its assembled configuration while unlocked (FIG. 5) and locked (FIGS. 6 and 7).

[0044] Referring particularly to FIG. 5, coupling assembly **20** is shown in the unlocked position. Ball **48** is positioned in helical groove **46** in the proximal position. Ball **48** rides in ball carrier **74** and is moved by ball **48** to the proximal position shown in FIG. 5. In the proximal position, ball carrier **74** urges closure sleeve **88** to compress spring **72**

and permits spring **90** to expand to a relaxed position. In the unlocked proximal position, closure sleeve **88** is moved away from locking ball **94** permitting it to move at least partially out of hole **96**. However, o-ring **86** tends to urge locking ball **94** into hole **96**. This arrangement provides positive positioning of locking ball **94** in hole **96** and into an aperture (not shown) in tool **16**, providing tactile feedback to the user that tool **16** is properly positioned in coupling assembly **102**.

[0045] Referring particularly to **FIGS. 6 and 7**, after the dissection tool **16** has been properly positioned in coupling assembly **20**, proximal Double D collet **58** may be rotated with respect to the other elements of the housing to urge ball **48** and ball carrier **74** to their distal, locking position. **FIGS. 6 and 7** shows coupling assembly **20** with proximal Double D collet **58** and balls **48** shown in the position of **FIG. 5** and the remaining elements rotated approximately 90°. It will be understood that in operation of the illustrated preferred embodiment, proximal Double D collet **58** and balls **48** are moved while the other elements remain stationary. During the closure operation, as ball carrier **74** advances distally, spring **90** is compressed and spring **72** is allowed to expand. As spring **72** expands, it urges closure sleeve **88** distally. Internal taper surface of closure sleeve **88** engages locking ball **94** and urges it into locking engagement with the aperture (not shown) located on the tool **16**. Closure sleeve **88** continues to advance over locking ball **94** to securely hold locking ball **94** in the aperture, thereby inhibiting movement of dissection tool **16** along the longitudinal axis.

[0046] Referring still to **FIG. 7**, attachment housing **14** is adapted to engage the coupling assembly **20** in an interference fit. Further, attachment housing **14** and coupling assembly **20** are configured to provide the user with tactical feedback indicating positive engagement. More specifically, attachment housing **14** includes an internal cavity **118** having a configuration substantially matching the external configuration of coupling assembly **20**. The cavity **118** includes an internal annular groove **120** carrying an O-ring **122**. Coupling assembly **20** defines an external annular groove **124** adapted to receive a portion of O-ring **122**. Thus, it will be understood that as attachment housing **14** is advanced over coupling assembly **20**, O-ring **122** will be slightly compressed into groove **120** as it engages tapered front end **22** to an expanded inner diameter. When O-ring **122** is positioned over annular groove **124**, the compressed O-ring **122** will quickly relax into a smaller inner diameter shape engaging annular groove **124** providing the user with a tactile sensation. Preferably such tactile sensation will include both a vibration and auditory signal, indicating that the attachment **14** is in the proper position on motor assembly **12**.

[0047] While the movement of O-ring **122** into annular groove **124** provides tactile sensation of the proper positioning of attachment housing **14** with respect to motor assembly **12**, it will be appreciated that the attachment housing **14** is not positively locked to motor assembly **12**. Rather, the configuration of internal cavity **118** closely matches the external configuration of coupling assembly **20** to create an interference fit sufficient to prevent accidental dislodging of attachment housing **14** from motor assembly **12**. However, it will be understood that manual pulling along the longitudinal axis of attachment housing **14** will easily dislodge the attachment housing from motor assembly **12**. In this

preferred aspect, it is contemplated that the user will not have to operate any mechanical locking members to lock or unlock the attachment housing to the motor assembly thereby easing the operation for the end user. Accordingly, position of the attachment **14** relative to the motor assembly **12** may be calculated prior to assembly of the instrument **10**. Because of this, the indicator marks may be applied to the attachment **14** and motor assembly **12** at the component level before the instrument **10** is assembled.

[0048] In still another embodiment, the apertures **108** of the coupling assembly **20** may be replaced by one or more protuberances. Rather than inserting and aligning pins **112** as previously described, the protuberances may be aligned with the apertures **110** of the motor assembly **12**. The protuberances may then engage the apertures **110** when the base **104** of the coupling assembly **20** is inserted into the motor assembly **12**. Accordingly, the protuberances may align the coupling assembly **20** and the motor assembly **12** and may also prevent the coupling assembly **20** from rotating relative to the motor assembly **12**. Furthermore, this arrangement may provide sufficient structural strength to survive the loading created by the rotation of the tool **16** during surgery.

[0049] It is understood that alternative embodiments may reverse the arrangement so that the protuberances are located on the motor assembly **12** to engage the apertures **108** located on the coupling assembly **20**, the apertures may be angled differently, and/or other engaging means may be used to achieve the same result. Likewise, variations of the protuberance and aperture approach described above may be used to fasten the attachment **14** to the coupling assembly **20**.

[0050] Using the above described locking and indexing system, the relative positions that will be occupied by the motor assembly **12**, attachment **14**, and coupling assembly **20** with respect to one another may be determined before the instrument is assembled. Accordingly, alignment markings and other labeling/lettering may be applied at the component level and be in alignment when the instrument **10** is assembled. Furthermore, the locking and indexing system described above enables fabrication of housings while maintaining the alignment between any finger controls and the coupling assembly **20**. In addition, the system securely attaches the coupling assembly **20** to the motor assembly **12** in a manner that may withstand with repeated loading caused by the rotation of the tool **16** during use.

[0051] While the invention has been particularly shown and described with reference to the preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention. For example, while the present illustrative embodiments show pneumatic powered motors, it is contemplated that the improvements described herein may be applied in an equal fashion to other motors, such as electric motors operating on AC or DC currents and ultrasonic motors run by piezoelectric or magneto-strictive forces. Furthermore, the various means described for connecting various housings or components may be replaced by other suitable means in ways known to those in the art. Therefore, the claims should be interpreted in a broad manner, consistent with the present invention.

What is claimed is:

- 1. A surgical instrument comprising:  
 a collet including a first rotation-prevention mechanism;  
 a motor housing operable to receive the collet, the housing including a second rotation-prevention mechanism operable to engage the first rotation-prevention mechanism to prevent rotation of the collet relative to the motor housing; and  
 a sleeve operable to secure the collet to the motor housing.
- 2. The surgical instrument of claim 1 further comprising:  
 a third rotation-prevention mechanism on the collet; and  
 an attachment having a fourth rotation-prevention mechanism operable to engage the third rotation-prevention mechanism.
- 3. The surgical instrument of claim 2 wherein one of the third and fourth rotation-prevention mechanism is a groove and the other is a protuberance.
- 4. The locking system of claim 1 further comprising an attachment having an engagement element for selectively securing to the collet.
- 5. The locking system of claim 4 wherein one of the third engagement elements is a protuberance.
- 6. The collet of claim 5 wherein the first fastening element is an aperture operable to receive a protuberance.

- 7. A locking system for a surgical instrument comprising:  
 a collet having either a protuberance or aperture;  
 a motor assembly having the other of the protuberance or aperture corresponding to the collet, wherein the protuberance and aperture are operable to align and prevent rotation of the collet relative to the motor assembly; and  
 a slidable locking member operable to secure the collet to the motor assembly.
- 8. A collet for insertion into a cavity of a surgical instrument, the collet comprising:  
 a distal portion having an opening for receiving a tool;  
 a first fastening element for accepting an attachment;  
 a proximal portion with a first alignment element for engaging a second alignment element present in the cavity, the first alignment element and the second alignment element operable to align and prevent rotation of the collet and the surgical instrument; and  
 a locking member rotatable about an axis of the collet, the locking member for securing the collet to the surgical instrument.

\* \* \* \* \*