PERFORATING GUN AND ARMING METHOD

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Abstract

The perforating gun and method of arming a perforating gun facilitates electrically connecting an arming device carrying the detonator to the loading tube carrying the explosive charges prior to ballistically connecting the arming device to the loading tube. Subsequent to establishing electrical continuity across the loading tube and arming device, the arming device can be ballistically connected to the loading tube thereby arming the perforating gun.
PERFORATING GUN AND ARMING METHOD

RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional application No. 61/468,722 filed on 29 Mar. 2011.

BACKGROUND

[0002] This section provides background information to facilitate a better understanding of the various aspects of the disclosure. It should be understood that the statements in this section of this document are to be read in this light, and not as admissions of prior art.

[0003] Hydrocarbon exploration and production, as well as other subterranean activities (e.g., water exploration and extraction), involve drilling and completing a wellbore. The wellbore is drilled into the ground and then can be lined with metal pipe generally referred to as casing. The casing can extend essentially the entire length of the wellbore or terminate short of the total depth thereby leaving an uncased, open hole, portion of the well. The casing may also be cemented in place, sealing the annulus between the casing and the earthen formation.

[0004] During completion or production of a well it can be desired to create flow paths between the wellbore and the formation. These flow paths are often created by utilizing a perforating gun. Perforating guns are tubular-shaped devices having an outer housing called a carrier. The carrier holds one or more interconnected loading tubes. The loading tubes hold shaped explosive charges that, when detonated, create perforations through the carrier, the wellbore casing, cement and into the earthen formation. Perforating guns can be lowered downhole via wireline, cable, coiled tubing and production tubing, for example. Firing signals can be transmitted to the perforating gun electrically (including by wireline), by wireless electromagnetic signal, by pressure pulses, and acoustically.

[0005] To detonate the shaped charges, the perforating gun includes a firing head. The firing head can receive an electrical signal that is transmitted from the surface and/or from another location within the wellbore (perhaps from an adjacent gun or other device or from a wireline). The electronic signal initiates a detonator in the firing head to ignite a detonating cord of the loading tube. The detonating cord extends through the perforating gun and is interconnected with the shaped charges held by the loading tube.

SUMMARY

[0006] According to one or more embodiments, a method of arming a perforating gun comprises electrically connecting an arming device to a loading tube, and ballistically connecting the arming device to the loading tube after the arming device has been electrically connected to the loading tube.

[0007] In another example, a method of arming a perforating gun includes positioning an arming device comprising an electrical connector and a detonator proximate to an end of a loading tube that is disposed within a carrier. The loading tube comprises an explosive charge, an electrical conductor having an electrical connector that is located proximate the end of the loading tube, and a detonating cord that is connected to the explosive charge and has an end located proximate to the end of the loading tube. The method includes electrically connecting the arming device to the loading tube in response to moving the arming device to a park position, and then ballistically connecting the arming device to the loading tube in response to moving the arming device from the park position to an armed position.

[0008] An embodiment of a perforating gun comprises a loading tube having an explosive charge, an electrical conductor, and a detonating cord; and an arming device comprising a detonator and an electrical connector. The arming device can be moved between a park position and an armed position. In the park position the arming device is electrically connected to the loading tube and the arming device is not ballistically connected to the loading tube. In the armed position the arming device is electrically and ballistically connected to the loading tube.

[0009] The foregoing has outlined some of the features and technical advantages in order that the detailed description of the perforating gun and arming method that follows may be better understood. Additional features and advantages of the perforating gun and arming method will be described hereinafter which form the subject of the claims of the invention. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The disclosure is best understood from the following detailed description when read with the accompanying figures. It is emphasized that, in accordance with standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of various features may be arbitrarily increased or reduced for clarity of discussion.

[0011] FIG. 1 is a pictorial diagram of a perforating gun illustrating an example of an arming device positioned for electrical and ballistic connection to the loading tube of the perforating gun in accordance with one or more embodiments.

[0012] FIG. 2 is a pictorial diagram of a perforating gun illustrating an example of the arming device in a park position, electrically connected to the loading tube of the perforating gun but not ballistically connected to the loading tube, in accordance with one or more embodiments.

[0013] FIG. 3 is a pictorial diagram of an end view of the perforating gun of FIG. 2, illustrating an example of the arming device in the park position in accordance with one or more embodiments.

[0014] FIG. 4 is a pictorial diagram of a perforating gun illustrating an example of the arming device in an armed position, electrically and ballistically connected to the loading tube of the perforating gun, in accordance with one or more embodiments.

[0015] FIG. 5 is a pictorial diagram of an end view of the perforating gun of FIG. 4, illustrating an example of the arming device in the armed position in accordance with one or more embodiments.

[0016] FIG. 6 is a pictorial diagram of a perforating gun illustrating an example of an installation tool for electrically and ballistically connecting the arming device to the loading tube in accordance to one or more embodiments.

[0017] FIG. 7 is a pictorial diagram of an example of a perforating gun illustrating the arming device in the armed position, electrically and ballistically connected to the loading tube, in accordance to one or more embodiments.
FIG. 1 depicts an example of a perforating gun, generally denoted by the numeral 10. Perforating gun 10 includes a loading tube 12 disposed inside of a carrier 14. Loading tube 12 may have one or more receptacles 13 adapted to hold explosive charges 16. A detonating cord 18 is connected to explosive charges 16 and has an end 20 located proximate to an end 19 of loading tube 12. End 20 of detonating cord 18 may be a booster. Electrical conductor 22 extends between electrical connectors 23, 24 located at the respective ends of loading tube 12.

An example of an arming device 26 is depicted in FIG. 1. Located adjacent, or proximate, to end 19 of loading tube 12 prior to being connected to perforating gun 10. In FIG. 1, arming device 26 is not physically, electrically, or ballistically connected to loading tube 12. In the depicted example, arming device 26 includes a detonator 28 (for example an RF-safe initiator), firing electronics 30 (for example, an addressable switch), and an electrical conductor 32 and electrical conductor 33. Firing electronics 30 can initiate detonator 28 in response to receipt of a firing signal from the surface of the well, for example, via electrical conductor 22, pressure pulses and wirelessly. According to one or more embodiments, arming device 26 provides a means to establish an electrical connection between loading tube 12 and arming device 26 prior to ballistically connecting arming device 26 to loading tube 12 and thereby completing the ballistic train 34 (i.e., detonator 28, detonating cord 18, explosive charges 16) as illustrated in FIGS. 4, 6, and 7.

FIG. 2 is a side view of an embodiment of perforating gun 10 illustrated in a “park” position, wherein arming device 26 is electrically connected to loading tube 12 and arming device 26 is not ballistically connected to loading tube 12. FIG. 3 is an end view of the right end of perforating gun 10 illustrated in FIG. 2. In the park position, electrical connector 24 and electrical connector 32 are connected, electrically connecting arming device 26 to loading tube 12 and establishing electrical continuity across loading tube 12 and arming device 26. In the park position, electrical signals can be transmitted between firing electronics 30 and other devices (e.g., sensors, surface controls, and other electronics) via electrical conductor 22 which extends across loading tube 12. In the park position, ballistic train 34 is not completed and therefore explosive charges 16 are not connected to detonator 28 via detonating cord 18, thus, perforating gun 10 is not armed. In the depicted examples, the park position is evidenced by detonator 28 being offset angularly from end 20 of detonating cord 18. In the illustrated examples, detonator 28 is shown offset approximately 180 degrees from end 20 of detonating cord 18; however, it will be recognized by those skilled in the art with benefit of this disclosure that the angular offset may differ from 180 degrees.

According to one or more embodiments, a method or process of arming perforating gun 10 includes aligning arming device 26 proximate to end 19 of loading tube 12 as depicted in FIG. 1. In the illustrated example, loading tube 12 is disposed inside of carrier 14. According to one aspect, aligning arming device 26 includes positioning arming device 26 such that electrical connector 32 of arming device 26 is axially aligned with electrical connector 24 of loading tube 12. Arming device 26 is electrically connected to loading tube 12 prior to ballistically connecting arming device 26 to loading tube 12. To electrically connect arming device 26 to loading tube 12, arming device 26 is moved axially to loading tube 12 as illustrated by the arrow of FIG. 2, electrically connecting electrical connector 32 of arming device 26 and electrical connector 24 of loading tube 12, thereby positioning perforating gun 10 in the park position. In the park position, electrical continuity is established across perforating gun 10 and diagnostic tests and such can be performed on perforating gun 10, including firing electronics 30, without arming perforating gun 10.

Perforating gun 10 is armed by ballistically connecting arming device 26 to loading tube 12 after electrically connecting arming device 26 to loading tube 12. Arming perforating gun 10 includes rotating arming device 26 relative to loading tube 12 until detonator 28 is axially aligned with end 20 of detonating cord 18 as depicted for example in FIGS. 4 and 5. For example, arming device 26 is rotated clockwise from the park position illustrated in FIGS. 2 and 3 to the armed position illustrated in FIGS. 4 and 5. It will be understood by those skilled in the art and with benefit of this disclosure that in some embodiments arming device 26 may be rotated counterclockwise from the park position to the armed position.

According to some embodiments, arming device 26 is moved from the park position to the armed position without disconnecting the previously established electrical connection between arming device 26 and electrical conductor 22 of loading tube 12. Thus, perforating gun 10 can be armed
without interrupting the electrical continuity established across electrical conductors 22 and 33 which was established in the park position.

[0029] Non-exclusive examples of electrical and ballistic connections of arming device 26 with loading tube 12 are illustrated in FIGS. 8 and 9. Electrical connector 24 of loading tube 12 and electrical connector 32 of arming device 26 are depicted as male and female devices, for example RCA connectors, which are mated by axial movement. Arming device 26 and loading tube 12 include a device 36, referred to herein as a lock device, that can facilitate axial movement of arming device 26 to the park position, electrically connecting arming device 26 to loading tube 12, and then rotational movement of arming device 26 to the armed position, ballistically connecting arming device 26 to loading tube 12. In the park position, locking device 36 can block axial movement of arming device 26 away from loading tube 12.

[0030] In the examples depicted in FIGS. 8 and 9, lock device 36 includes a first member 38 disposed with one of arming device 26 and loading tube 12 which is matable with a cooperative second member 40 disposed with the other of arming device 26 and loading tube 12. In the embodiments depicted in FIGS. 8 and 9, first member 38 is illustrated as a protrusion and second member 40 is a groove. Groove 40 includes a first, axial leg 42 and a second leg 44 that extends away from first, axial leg 42 an angular distance that corresponds with the angular distance required to move detonator 28 from the park position to the armed position ballistically aligned with and connected to detonating cord 18.

[0031] In the embodiment of FIGS. 8 and 9, protrusion 38 is depicted as having a head 46 spaced by a post 48 outward from a face 50 of arming device 26. Head 46 has a cross-sectional greater than the cross-sectional diameter of post 48. For example, in FIG. 8, protrusion 38 is a T-shaped member and in FIG. 9, protrusion 38 is an L-shaped member. Groove 40 is formed such that axial leg 42 extends a distance axially into loading tube 12, away from a face 52 of loading tube 12, corresponding substantially with the distance post 48 spaces head 46 from face 50 of arming device 26. Second, angular leg 44 of groove 40 corresponds in size to head 46 of the respective protrusion 38 and extends axially away from the end of axial leg 42 distal from face 52. Thereby, when head 46 is disposed in angular leg 44, head 46 is trapped blocking axial movement of head 46 and thus arming device 26 relative to loading tube 12.

[0032] For example, positioning arming device 26 in the park position includes disposing head 46 of protrusion 38 into axial leg 42 of groove 40 and axially moving arming device 26 toward loading tube 12 interconnecting electrical connectors 24, 32. In this example, face 50 and face 52 abut when arming device 26 and loading tube 12 are in the park position and electrically connected. Arming the perforating gun is accomplished by rotating arming device 26 from the park position to the armed position. From the park position, arming device 26 is rotated with head 46 disposed in and traveling along angular leg 44 of groove 40 until detonator 28 is aligned with end 20 of detonating cord 18. Angular leg 44 may terminate at an end, or stop, 54 positioned to locate detonator 28 in ballistic alignment with detonating cord 18 when head 46 abuts stop 54. In the armed position, lock device 36 blocks axial movement of arming device 26 relative to loading tube 12.

[0033] In some embodiments, arming device 26 can be positioned and moved into the park position and the armed position by hand. In some embodiments, a tool may be utilized to support and position arming device 26. For example, in FIG. 6 arming device 26 is illustrated being manipulated with use of a device 56. An example of a device 56, referred to herein as an installation device, is illustrated as connected to an end of carrier 14, for example, by cap 58 in FIG. 6. Cap 58 is illustrated in this example as being threaded onto an end of carrier 14. A support device 60 is adapted to support arming device 26 and includes a shaft 62 that extends through cap 58 to the exterior of carrier 14. Arming device 26 can be moved axially and rotationally relative to loading tube 12 by manipulating shaft 62. Installation device 56 may further include a biasing device 64, for example a spring, to bias support device 60 toward or away from cap 58. For example, in at least one embodiment, biasing device 64 may bias support device 60 and the carried arming device 26 away from cap 58 and toward loading tube 12 to maintain electrical connection when in the park position.

[0034] FIG. 7 illustrates an example of perforating gun 10 armed and completed for introduction into a wellbore. Arming device 26 is in the armed position wherein it is physically, electrically, and ballistically connected to loading tube 12. Detonator 28 is aligned with and ballistically connected to end 20 of detonating cord 18 which is connected to explosive charges 16, thereby completing ballistic train 34. Electrical continuity is provided across perforating gun 10 by the electrical connection of arming device 26 to electrical conductor 22 of loading tube 12. A pressure bulkhead 66 is illustrated installed in carrier 14 adjacent to arming device 26. The depicted bulkhead 66 includes an electrical feed-through conductor 68 which is electrically connected to electrical conductor 22 of loading tube 12 via electrical conductor 33 of arming device 26 which provides electrical continuity between the surface of the well and the perforating gun string.

[0035] Modularity of the gun components allows for a gun 10 to be configured and assembled for specific down hole needs, along with reducing the need for a significant inventory. To provide modularity of the gun 10, individual sections 14a of the carrier 14 can be secured, end to end, to provide a gun 10 have a desired length. With each carrier section 14a, as shown in FIG. 10, is disposed a loading tube 7, arming device 26 and a bulkhead 66. The carrier sections 14a can be secured to one another by known means, such as a threaded connection. As shown in FIG. 10, the threaded connection can include an interior threaded surface 80 of a carrier portion 14a and a corresponding exterior threaded surface 82 of a carrier portion 14b, the exterior threaded surface 82 and interior threaded surface 80 configured so that the exterior threaded surface 82 of carrier portion 14b is received by the interior threaded portion 80 of carrier portion 14a. To secure the threaded surfaces 80 and 82, the carrier 14a can include a throughbore 84 extending therethrough and through the threaded portion 80. A securing member 86, such as a set screw, is placed within the throughbore 84 and engages the exterior threaded surface 82 resist rotation of the carrier portions 14a and 14b relative to one another. The use of a throughbore 84 and securing member 86 allows an operator to have full discretion as to the orientation of the carrier portions 14a and 14b when secured.

[0036] As shown in FIG. 10, the loading tube 12, arming device 26 and bulkhead 66 are secured within a carrier portion 14b with the bulkhead 66 positioned within the carrier portion 14b adjacent the exterior threaded surface 82. The loading tube 12, with or without the arming device 26 and bulk-
head 66 connected thereto, can be indexed or oriented within the carrier 14 to a specific orientation and secured in that orientation.

[0037] As shown in FIG. 10, the exterior threaded surface 82 can include a throughbore 88 therein. A securing member 90, such as a set screw, can be positioned within the throughbore 88 to abut the bulkhead 66 positioned within the carrier 14 and resist rotation of the bulkhead 66 within the carrier 14. With the bulkhead 66 secured by the securing member 90, the loading tube 12 and arming device 26 are secured in the desired orientation. In one configuration, the bulkhead 66 and arming device 26 can include a structural configuration to resist relative rotation. Alternatively, friction between the arming device 26 and the bulkhead 66 is sufficient to resist rotation of the loading tube 12 and arming device 26 relative to the bulkhead 66 secured to the carrier 15. To achieve a seal between the bulkhead 66 and the carrier 14 a sealing member 91, such as an o-ring, can be positioned between the bulkhead 66 and an inner surface of the carrier 14.

[0038] Once the bulkhead 66 has been secured to carrier portion 14a, carrier portion 14b can be secured to carrier portion 14b via the threaded surfaces 80 and 82 discussed above. To secure the orientation of the carrier portions 14a and 14b relative to one another, the securing member 86 can be inserted into throughbore 84 and abutted against the exterior threaded surface 82 of carrier portion 14b. Once secured, another loading tube 12 can be positioned within the carrier 14a. The electrical connector 23 of the loading tube 12 can then be connected to the bulkhead 66 and rotated along its longitudinal axis to the desired orientation. The orientation of the loading tubes in the various carrier portions can be identical or in varying orientations depending on the desired perforation strategy.

[0039] To secure the bulkhead 66 in place within the carrier 14, the carrier portions 14a and 14b can include shoulders 100 and 102 configured to receive the bulkhead 66 therebetween. In one aspect (not shown), the bulkhead 66 can include an enlarged diameter portion 104 configured to be received between the shoulders 100 and 102. With the bulkhead 66 secured between the shoulders 100 and 102 movement of the bulkhead 66 along the length of the carrier 14 is resisted or prevented.

[0040] Once the loading tube 12 is in the desired orientation and the arming device 26 and bulkhead 66 are connected, the bulkhead 66 can be secured as described above with regard to securing the bulkhead 66 to carrier 14b. Additional carrier portions 14, loading tubes 12 arming devices 26 and bulkheads can be installed to provide a gun 10 having a desired length. Further, the orientation of the loading tubes 12 within the carrier 14 can be selected upon assembly and are not limited to predetermined orientations.

[0041] By securing the individual carrier portions 14a, 14b, etc. of the carrier 14 directly to one another, without an intervening member, the number of connections along the gun 10 is reduced. In a downhole, high pressure environment, leaks through connections in a gun 10 can result in wellbore fluids filling the interior of the gun 10 which reduces or eliminates the possibility of the charges 16 firing. Further, by providing a pre-wired loading tube 7 which can be connected to an arming device 26, and a modular connection allowing for additional loading tubes 7 and arming devices 26 to be connected thereto, the casing 14 can have a solid exterior, without the presence of pluggable ports to allow access to the wiring and arming devices, as is prevalent in the prior art.

[0042] The foregoing outlines features of several embodiments of perforating gun arming devices and methods so that those skilled in the art may better understand the aspects of the disclosure. Those skilled in the art should appreciate that they may readily use the disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the disclosure, and that they may make various changes, substitutions and alterations herein without departing from the spirit and scope of the disclosure. The scope of the invention should be determined only by the language of the claims that follow. The term “comprising” within the claims is intended to mean “including at least” such that the recited listing of elements in a claim are open groups. The terms “a,” “an” and other singular terms are intended to include the plural forms thereof unless specifically excluded.

What is claimed is:

1. A perforating gun apparatus, comprising:
   a loading tube comprising an explosive charge, an electrical conductor, and a detonating cord; and
   an arming device comprising a detonator and an electrical connector, the arming device moveable between a park position and an armed position, in the park position the arming device is electrically connected to the loading tube and in the armed position the arming device is electrically and ballistically connected to the loading tube.

2. The apparatus of claim 1 wherein the detonator is angularly offset from the detonating cord when the arming device is in the park position.

3. The apparatus of claim 1 wherein in the park position the detonator is angularly offset from an end of the detonating cord and in the armed position the detonator is aligned with the end of the detonating cord.

4. The apparatus of claim 1, further comprising a lock device permitting rotational movement of the arming device relative to the loading tube between the park position and the armed position and the locking device blocking axial movement of the arming device relative to the loading tube when the arming device is in the armed position.

5. The apparatus of claim 4 wherein in the park position the detonator is angularly offset from an end of the detonating cord and in the armed position the detonator is aligned with the end of the detonating cord.

6. The apparatus of claim 4 wherein the lock device comprises:
   a protrusion comprising a head extending away from a face of one of the arming device and the loading tube; and
   a groove cooperative to receive the protrusion disposed with the other of the arming device and the loading tube.

7. The apparatus of claim 6 wherein the groove comprises:
   a first leg extending axially from a face of the other of the arming device and the loading tube, and
   a second leg extending angularly away from the first leg to a stop.

8. The apparatus of claim 7 wherein the head of the protrusion is positioned in the second leg of the groove proximate to the stop when the arming device is in the armed position.

9. The apparatus of claim 1, further comprising a locking device comprising:
a protrusion comprising a head extending away from a face of one of the arming device and the loading tube by a post, wherein the head has a cross-sectional diameter greater than that of the post; and

a groove formed by the other of the arming device and the loading tube comprising a first leg extending axially away from a face of the other of the arming device and the loading tube and a second leg extending angularly from the first leg to a stop, wherein the head of the protrusion is positioned in the second leg of the groove proximate to the stop when the arming device is in the armed position.

10. The apparatus of claim 9, wherein in the park position the detonator is angularly offset from an end of the detonating cord and in the armed position the detonator is aligned with the end of the detonating cord.

11. The apparatus of claim 9, wherein the protrusion is disposed from the arming device and the groove is formed by the loading tube.

12. A method of arming a perforating gun, comprising:

- electrically connecting an arming device to a loading tube; and
- ballistically connecting the arming device to the loading tube after the electrically connecting the arming device to the loading tube.

13. The method of claim 12, wherein the ballistically connecting the arming device to the loading tube comprises aligning a detonator of the arming device with an end of a detonating cord of the loading tube.

14. The method of claim 12, wherein the ballistically connecting the arming device to the loading tube comprises aligning a detonator of the arming device with an end of a detonating cord of the loading tube in response to rotating the arming device relative to the loading tube.

15. The method of claim 12, wherein:

- the electrically connecting the arming device to the loading tube comprises moving the arming device axially to the loading tube to a park position connecting an electrical connector of the arming device to an electrical connector of the loading tube; and
- the ballistically connecting the arming device to the loading tube comprises aligning a detonator of the arming device with an end of a detonating cord of the loading tube in response to rotating the arming device relative to the loading tube from the park position to an armed position.

16. The method of claim 12, further comprising blocking, when the arming device is in the armed position, axial movement of the arming device relative to the loading tube.

17. A method for arming a perforating gun, comprising:

- positioning an arming device comprising an electrical connector and a detonator proximate an end of a loading tube disposed within a carrier, the loading tube comprising an explosive charge, an electrical conductor having an electrical connector located proximate the end of the loading tube, and a detonating cord connected to the explosive charge and having an end located proximate to the end of the loading tube;
- electrically connecting the arming device to the loading tube in response to moving the arming device to a park position; and
- ballistically connecting the arming device to the loading tube after electrically connecting the arming device to the loading tube in response to moving the arming device from the park position to an armed position.

18. The method of claim 17, wherein:

- the moving the arming device to a park position comprises axially moving the arming device to the loading tube connecting the electric connector of the arming device to the electric connector of the loading tube; and
- the moving the arming device from the park position to the armed position comprises rotating the arming device relative to the loading tube.

19. The method of claim 18, wherein the perforating gun further comprises a locking device comprising:

- a protrusion comprising a head extending away from a face of one of the arming device and the loading tube by a post, wherein the head has a cross-sectional diameter greater than that of the post; and
- a groove formed by the other of the arming device and the loading tube comprising a first leg extending axially away from a face of the other of the arming device and the loading tube and a second leg extending angularly from the first leg to a stop, wherein the head of the protrusion is positioned in the second leg of the groove proximate to the stop when the arming device is in the armed position.

20. The method of claim 18, further comprising blocking, when the arming device is in the armed position, axial movement of the arming device relative to the loading tube.

21. The method of claim 18, wherein the carrier does not include ports in the side thereof for electrically connecting the arming device to the loading tube or ballistically connecting the arming device to the loading tube.

22. A method of assembling a perforating gun, comprising:

- inserting a first loading tube assembly into a first tubular carrier member;
- indexing the first loading tube assembly to a first desired orientation relative to the first tubular carrier member;
- securing the first loading tube assembly to the first tubular carrier member to resist indexing of the first loading tube assembly from the first desired orientation;
- securing a second tubular carrier member to the first tubular carrier member;
- inserting a second loading tube assembly into the second tubular carrier member;
- indexing the second loading tube assembly to a desired orientation relative to the second tubular carrier member; and
- securing the second loading tube assembly to the second tubular carrier member to resist indexing of the second loading tube assembly from the second desired orientation.

23. The method of claim 23, wherein the second desired orientation is the same as the desired orientation.

24. The method of claim 23 wherein securing the second tubular carrier member to the first tubular carrier member includes securing the second tubular carrier member directly to the first tubular carrier member.

25. The method of claim 23 wherein securing the second tubular carrier member to the first tubular carrier member
includes rotating the second tubular carrier member directly to the first tubular carrier member to threadingly connect the first and second tubular carrier members.

26. The method of claim 24, wherein securing the second tubular carrier member to the first tubular carrier member further includes inserting a securing member into an opening of one of the first and second carrier members to engage the other of the first and second carrier members to resist rotation of the one carrier member relative to the other carrier member.

27. The method of claim 23, wherein the first loading tube can be indexed to unlimited positions relative to the first tubular carrier member.

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